Water Resources of Monroe County, New York, Water Years 1984-88, With Emphasis on Water Quality in the Irondequoit Creek Basin

Part 2: Atmospheric Deposition, Ground Water, Streamflow, Trends in Water Quality, and Chemical Loads to Irondequoit Bay

By William H. Johnston and Donald A. Sherwood

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CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To Obtain
	Length	
inch (in.)	2.54	centimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
	Area	
square mile (mi^2)	2.59	square kilometer
acre	0.40483	hectare
	Flow	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
inch per year (in/yr)	25.4	millimeter per year
million gallons per day (Mgal/d)	3.785	cubic meters per day
gallons per minute (gal/min)	0.06309	liter per second
gallons per second (gal/s)	0.0010515	liter per second
	Volume	
cubic feet (ft^3)	0.02832	cubic meters
	Temperature	
degree Fahrenheit (°F)	°C = 5/9 (°F-32)	degree Celsius
	Specific Conductance	
	Microsiemens per centimeter at 25° Celsius (μS/cm)	
	Heat	
thermal conductivity: calorie per second centimeter degree Celsius (cal/s-cm-^{0}C)	243.9	British thermal unit per hour foot degree Fahrenheit
	Equivalent Concentration Terms	
	milligrams per liter (mg/L) = parts per million micrograms per liter (μg/L) = parts per billion	
	Load	
Tons per square mile (ton/mi^2)		metric tons per square kilometer

Sea level: 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.

Water Resources of Monroe County, New York, Water Years 1984-88, with Emphasis on Water Quality in the Irondequoit Creek Basin

Part 2. Atmospheric Deposition, Ground Water, Streamflow, Trends in Water Quality, and Chemical Loads to Irondequoit Bay

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Abstract

Irondequoit Creek, which drains 169 square miles in the eastern part of Monroe county, has been recognized as a source of pollution that contributes to the eutrophication of Irondequoit Bay, on Lake Ontario. The discharge of sewage to the creek and its tributaries was eliminated in 1979 by diversion to a wastewater-treatment facility, but sediment and nonpoint-source pollution remains a concern.

Statistically significant trends were noted in 1984-88 concentrations of several chemical constituents of streams in the Irondequoit Creek basin. Total suspended-solids concentrations increased 36 to 37 percent per year in one tributary and at one site on the mainstem of Irondequoit Creek, and volatile suspended-solids concentrations increased 20 to 24 percent per year at the two most downstream sites. Ammonia nitrogen concentration decreased 17 to 28 percent per year at all but one of the five sites, and nitrite plus nitrate concentrations decreased from 6.2 to 8.8 percent per year at one upstream site and the two most downstream sites. Total Kjeldahl nitrogen increased 7.2 percent per year at one upstream site. Total phosphorus concentrations increased 9.2 to 18.5 percent per year at three sites, and orthophosphorus decreased 6.8 percent per year at the most downstream site. Sulfate decreased by 5.1 to 8.4 percent per year at two sites, and chloride increased 2.4 percent per year in Allen Creek.

Median concentrations of constituents were significantly lower in atmospheric deposition than in streamflow, although annual atmospheric loads of ammonia nitrogen, nitrite plus nitrate, total phosphorus, and orthophosphorus into the basin were greater than those removed by streamflow. Loads of dissolved chloride and sulfate in atmospheric deposition, by contrast, represented only 3 and 12 percent, respectively, of the downstream loads in streamflow of Irondequoit Creek (Blossom Road site).

Comparison of water-quality data collected in the Irondequoit Creek basin during water years 1984-88 with corresponding data from the 1980-81 National Urban Runoff Program (NURP) study indicates significant changes in median concentrations of several constituents. Dissolved chloride concentrations in streamwater generally increased from the 1981 study to the 1984-88 study except at Irondequoit Creek at Blossom Road, where they decreased. Total Kjeldahl nitrogen and total phosphorus concentrations decreased at all sites, and total suspended solids showed no change. Mean dissolved chloride and total phosphorus loads in atmospheric deposition increased 25 percent and 35 percent, respectively, from the 1980-81 study to the 1984-88 study, whereas dissolved lead loads decreased more than 80 percent.

These changes resulted from several factors within the basin, including land-use changes, annual and seasonal variations in streamflow, and temporal variations in the application of road-deicing salts on area roads. Residential land use in the Irondequoit Creek basin increased by about 11 percent during 1985-89, and agricultural land use in the towns of Mendon, Pittsford, and Perinton decreased by 13.8 percent. Statistical analyses of long-term (9 years or more) discharge records of three unregulated streams in Monroe County indicate that mean annual discharges for water years 1984-88 were in the normal range; in this period, the greatest annual mean flow—about 130 percent of normal—occurred in 1984, and, lowest mean flow—about 73 percent of normal—occurred in 1988. The average annual mean for 1984-88 was about 104 percent of normal.

The annual mean discharge at these three gaging stations during the 1980-81 study was about 75 percent of normal. The amounts of deicing salt applied to State highways in the Irondequoit Creek basin in 1984-88 decreased during this period, but the decrease was offset during 1984-86 by an increase in salt use on expressways. Total salt use decreased below the 1980-81 level during the 1987-88 water years.

INTRODUCTION

Irondequoit Bay, near the City of Rochester, N.Y., has been eutrophic for several decades (Bubeck and Burton, 1989), largely as a result of sewage, sediment, and nutrients that enter the bay from Irondequoit Creek (fig. 1). The discharge of sewage to Irondequoit Creek was eliminated in 1979, when the County Wastewater Treatment Facility along the shore of Lake Ontario began operation, and Monroe County is making a continuing effort to further improve the chemical quality of Irondequoit Creek and its tributaries and thereby slow the eutrophication of Irondequoit Bay.

Water-resources data have been collected systematically in Monroe County since 1904 (Johnston and Sherwood, 1994), and the chemical quality of Irondequoit Bay and Irondequoit Creek has been documented for nearly 100 years (Kappel and others, 1986). The U.S. Geological Survey (USGS), in cooperation with the Monroe County Health Department and the Monroe County Environmental Health Laboratory, has collected and analyzed water-resources information from the Irondequoit Creek basin since 1980 in an effort to identify sources of contamination and to quantify the annual loads of selected chemical constituents transported to Irondequoit Bay. The USGS National Urban Runoff Program (NURP) study of the Irondequoit Creek basin during water years 1980-81 investigated nonpoint-source contamination from selected land-use areas and provided a basis from which to document changes in the nutrient and chemical loads of Irondequoit Creek.

In 1993, the USGS, in cooperation with the Monroe County Health Department, began a study to analyze water-resources data collected in Monroe County during water years[1] 1984-88. Water-quality data from the Irondequoit Creek basin were analyzed to discern whether the concentrations of selected constituents indicated any significant trends during water years 1984-88. These data were also compared statistically with data from the 1980-81 NURP study to indicate the effects of basinwide changes in land use since the NURP study.

Evaluation of trends in chemical concentrations and loads transported by Irondequoit Creek entailed consideration of other factors as well, such as (1) changes in quantity and chemical quality of atmospheric deposition, a major source of some of the constituents of Irondequoit Creek (Kappel and others, 1986); (2) annual and seasonal variability of streamflow; (3) annual variability in the snowpack and spring runoff (the annual snowmelt period accounts for 50 to 75 percent of the annual chemical load transported by Irondequoit Creek because constituents that have accumulated in the snowpack are suddenly released, along with sediment from soil erosion, during the sustained high flows from snowmelt and spring runoff); (4) annual and seasonal variability in storm intensity, because most of the annual load after the spring snowmelt period is derived from storm washoff; and (5) effects of ground water on concentrations of selected constituents of streamflow, such as chloride from road-deicing salts.

Objectives of the study were to:

1. investigate trends in atmospheric deposition, streamflow, and water quality in the adjacent Genesee River basin to provide a spatial and temporal basis for comparison;
2. analyze data on chemical quality of ground water in Irondequoit Creek basin during 1984-88 and relate the results to surface water data through statistical analyses;
3. investigate trends in ground-water, surface-water and atmospheric-deposition quality in the Irondequoit Creek basin during 1984-88 and determine changes since completion of the 1980-81 NURP study; and
4. document changes in loads of selected chemical constituents transported to Irondequoit Bay by Irondequoit Creek since completion of the 1980-81 NURP study.

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1. Years identified in this report are water years unless designated as calendar years. The water year is the 12-month period from October 1 to September 30 and is designated by calendar year in which it ends. Thus, the year ending September 30, 1985 is the 1985 water year.

The study entailed:

1. statistical analysis to determine whether precipitation volumes measured during water years 1984-88 represent a normal 5-year period, and statistical analyses of the chemical quality of bulk atmospheric deposition to determine possible changes in the chemical contribution of atmospheric deposition to the streamwater in the basin since the 1980-81 NURP study;
2. analyses of ground-water data to (a) determine the relation between ground-water and surface-water flow patterns, (b) calculate the probable range of

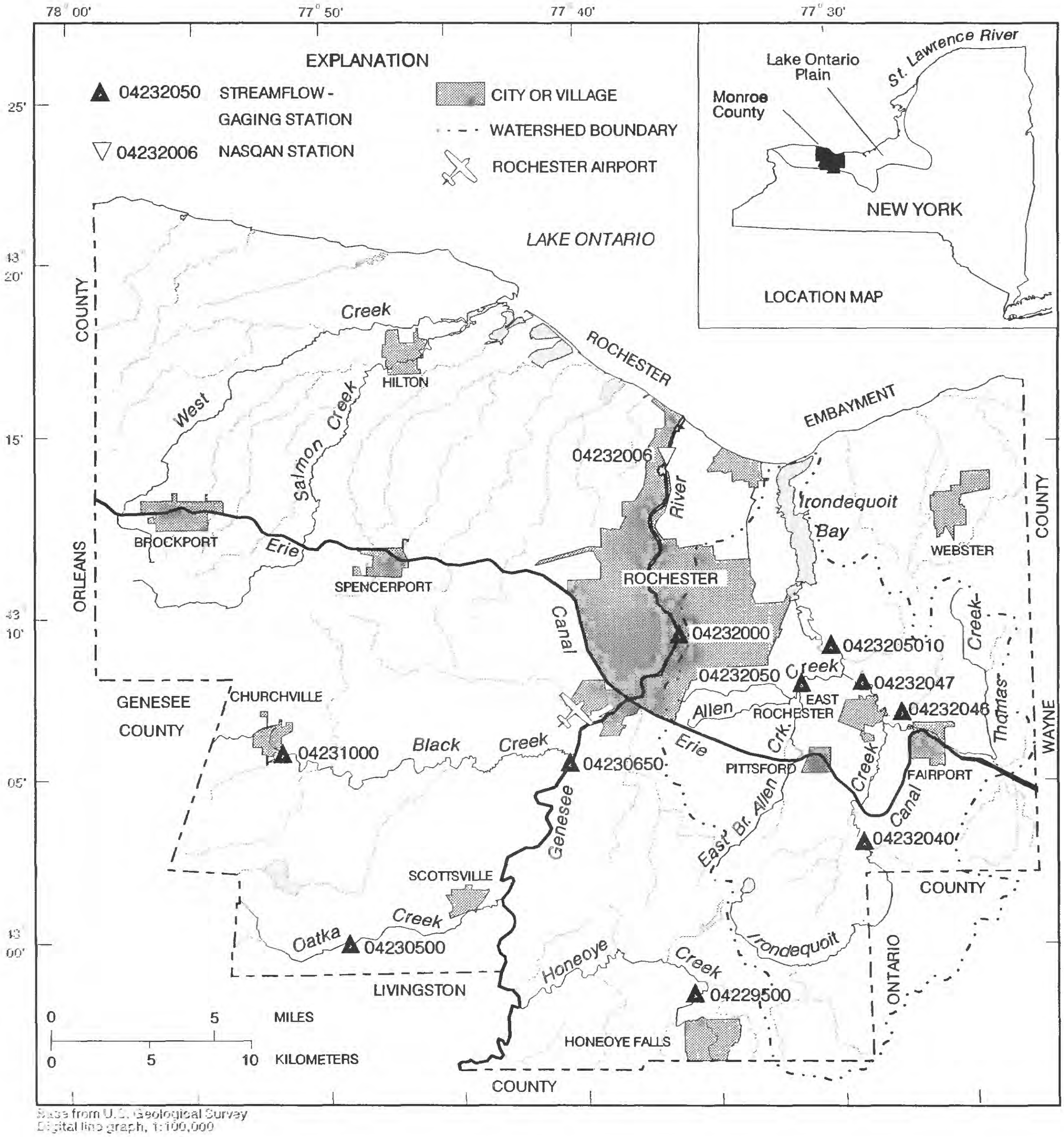


Figure 1. Locations of streamflow-gaging stations and principal geographic features of Monroe County, N.Y. (From Johnston and Sherwood, 1994, fig.1)

downward flow velocities as an indication chloride transport in ground water, and (c) compare the quality of ground water with that of surface water to indicate their possible relation;

3. statistical analyses of long-term (9 years or more) discharge records of three unregulated streams in Monroe County to determine whether streamflow during water years 1984-88 represent a normal 5-year period;
4. statistical analyses of surface-water, ground-water, and precipitation-quality data to document (a) significant trends in the concentration of selected constituents during 1984-88, and (b) changes since the 1980-81 NURP study, and
5. analysis of stream-discharge and chemical-concentration data to estimate annual loads of selected constituents transported to Irondequoit Bay, and comparison of the results with annual loads reported for 1980-81.

Purpose and Scope

This report describes the hydrologic conditions within Monroe County and the Irondequoit Creek basin during 1984-88 and explains the methods of data analysis and the statistical methods used for trend analyses. It also presents (1) comparisons of (a) precipitation volumes during 1984-88 with historic records, and (b) chemical quality of bulk atmospheric deposition during 1984-88 with that of the 1980-81 NURP study; (2) analyses of seasonal fluctuations in ground-water levels and water-table gradients in Powder Mill Park, in the southern (upper) part of the basin and in Ellison Park in the northern (lower) part (fig. 2) and a comparison of chemical quality of ground water in the upper part with that in the lower part; (3) comparisons of streamflow in Monroe County during 1984-88 with historic streamflow records and with streamflow during the 1980-81 NURP study, and (4) analyses of monotonic (overall) trends (increasing or decreasing) in water quality in Monroe County during 1984-88, comparisons of chemical concentrations in 1984-88 with those from the 1980-81 NURP study, and estimates of loads and yields of selected constituents transported to Irondequoit Bay.

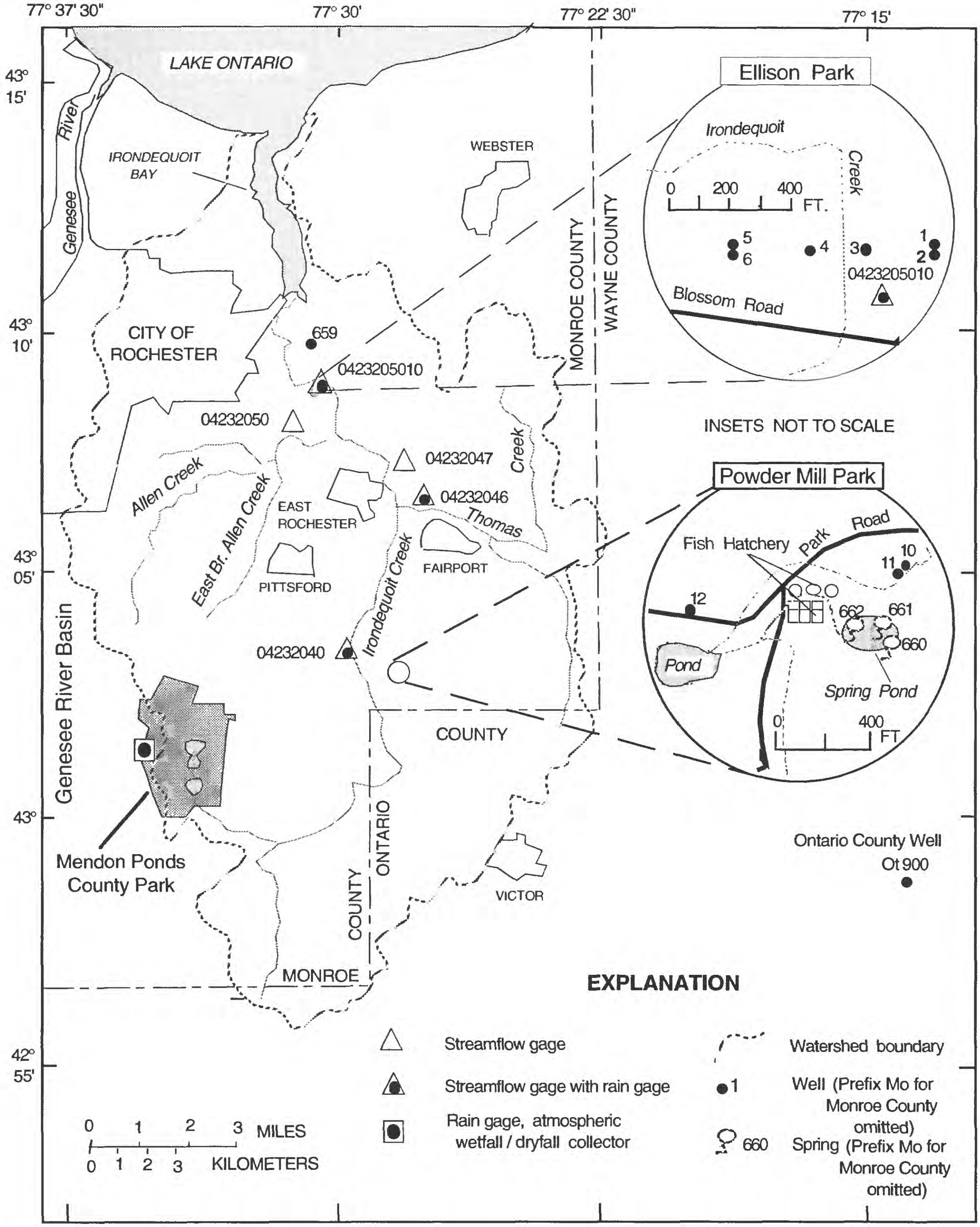
Acknowledgments

The Monroe County Environmental Health Laboratory (MCEHL) provided the water-quality data analyzed in this report. MCEHL staff analyzed water samples and organized and prepared the resulting water-quality data for entry into the USGS data base. Richard Burton, administrator of the MCEHL, provided guidance and suggestions throughout the preparation of this report, and Margy Peet of the Monroe County Department of Planning provided population statistics and information on current land use and development.

Previous Studies

The 1980-81 NURP study of the Irondequoit Creek basin (Zarriello and others, 1985; Kappel and others, 1986) related the chemical constituents of storm runoff from representative land-use areas to the chemical quality of Irondequoit Creek and its tributaries and documented the total annual load of selected constituents transported to Irondequoit Bay. That study provided a basis for (1) development of a water-quality-management plan for the Irondequoit Creek basin, (2) detection of water-quality changes described herein.

Other studies conducted by the USGS in the Irondequoit Creek basin included those by (1) Zarriello and Surface (1989), who simulated changes in stormwater quality at potential stormflow-attenuation sites; (2) Zarriello and Sherwood (1993), who evaluated the effect of stormwater detention on chemical and sediment loads in runoff from a newly constructed housing development in the basin; (3) Yager and others (1985), who summarized the geohydrology of the Irondequoit Creek basin and indicated locations of ground-water recharge areas, recharge rates, and directions of ground-water movement; and (4) Kappel and Young (1989), who summarized the glacial history and geohydrology of the Irondequoit Creek valley and identified the geohydrologic characteristics that affect the flow of ground water in the lower Irondequoit Creek basin. A companion report (Johnston and Sherwood, 1994) presents surface-water, ground-water, water-quality and precipitation data collected during 1984-88; it also explains the data-collection and computation methods, data presentation, and quality-assurance/quality-control procedures. A summary of earlier USGS and other Irondequoit basin reports is given in Kappel and others (1986).



Base from U.S. Geological Survey
State base map, 1: 500,000, 1974

Figure 2. Locations of gages, wells, and springs within Irondequoit Creek basin, Monroe County, N.Y. (From Johnston and Sherwood, 1994, fig. 2.)

Study Area

The study area includes all of Monroe County (673 mi^2). The county lies mostly in the Central Lowland physiographic province; the southeastern and southwestern corners are in the Appalachian Plateau province (Leggette and others, 1935). The plains in the northern part of the county are the result of high glacial lake stages during several glacial advances and retreats; the more rugged topography in the southern part consists of outwash plains with drumlins and morainal deposits. Elevations in the county range from 246 ft above sea level along the shore of Lake Ontario to 1,026 ft in the southeastern corner of the County.

Watersheds in the northwestern part of the county range from less than 5 mi^2 to about 88 mi^2 and drain eastward and northeastward into the western part of the Rochester Embayment (fig. 1). Streams in the southwestern and central part of the county generally drain eastward or westward into the Genesee River, which flows northward into Lake Ontario. The eastern part of the county, which includes the Irondequoit Creek basin, contains several small basins ranging from less than 0.2 mi^2 to nearly 24 mi^2. These streams flow northward into the eastern part of the Rochester Embayment. The Erie (Barge) Canal traverses the central part of the county (fig. 1) and receives flow from the headwater areas of many of the small northward flowing streams. Diversion structures along the canal allow flow augmentation to these small streams from the canal during low-flow conditions.

The Irondequoit Creek basin (169 mi^2), in the eastern part of Monroe County, is drained by Irondequoit Creek, which flows into Irondequoit Bay (1,700 acres) (fig. 1). A map by Yager and others (1985) showing potentiometric-surface contours, general ground-water-flow patterns, and recharge rates in the Irondequoit Creek basin, indicates that the ground-water basin is smaller than the surface-drainage area. General ground-water flow patterns at Powder Mill Park and Ellison Park (fig. 2) are described by Kappel and Young (1989).

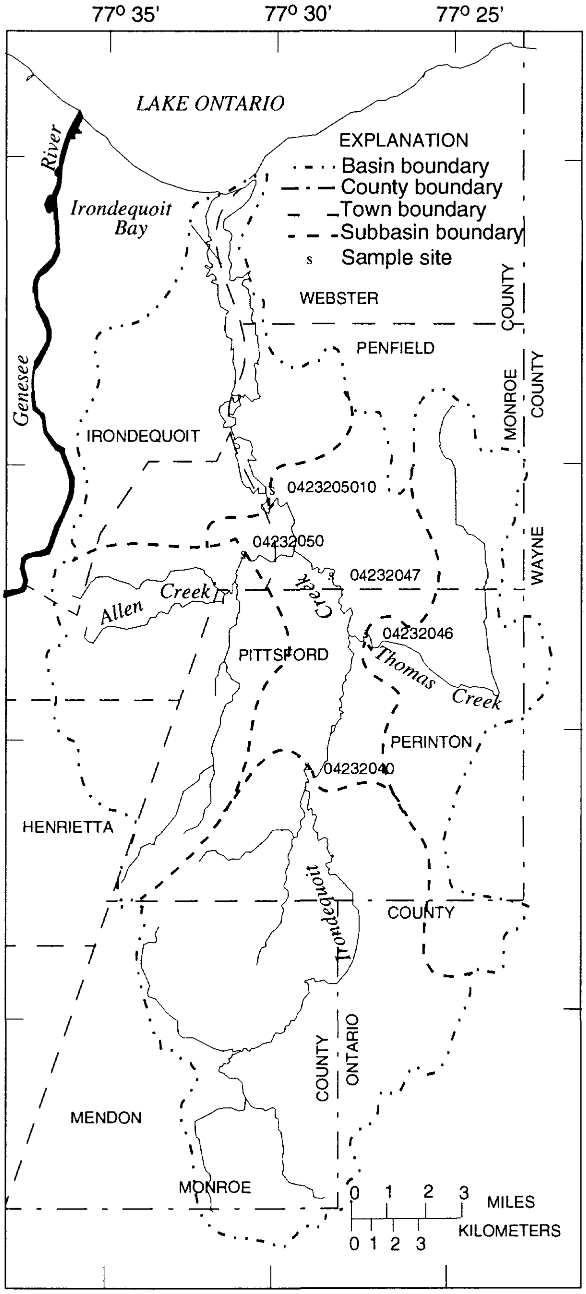
The City of Rochester (fig. 1) is the county seat and the hub of most commercial and industrial activity in the county. In other parts of the county, commercial and industrial activity is mostly along major transportation corridors. The area surrounding the City of Rochester is urban and suburban; the rest of the county is mainly rural-residential and agricultural. Agriculture is still extensive but is decreasing; more than 38 percent of the total acreage in Monroe County was classified as agricultural in 1982 (Census of Agriculture) but had decreased to nearly 31 percent by 1987 (Monroe County Department of Planning, written commun., 1992).

Monroe County and the Irondequoit Creek basin have undergone significant physical changes since the 1980-81 NURP study. Population in parts of Monroe County, especially in and adjacent to the City of Rochester, decreased by 3 to 9 percent during calendar years 1980-90, whereas that in the Towns of Pittsford, Perinton and Penfield, all in the Irondequoit Creek basin, increased by 8 to 12 percent, and that in the Town of Mendon increased by nearly 26 percent (Monroe County Department of Planning, written commun., 1992). Residential land use in the Irondequoit Creek basin increased by about 11 percent during calendar years 1985-89, mainly in the Towns of Perinton, Pittsford, Penfield, and Mendon (table 1). The Towns of Perinton, Pittsford and Penfield each issued more than 200 building permits per year during the 1987 and 1988 calendar years, almost exclusively for single-family residences in subdivisions. During the same years, the Towns of Mendon and Brighton each issued fewer than 100 permits per year. Agricultural land during calendar years 1985-89 decreased significantly in the Towns of Mendon, Perinton, and Pittsford. Town and subbasin boundaries and sampling sites are shown in figure 3; the percent change in land use in selected towns is given in table 1.

Table 1. Population and land-use changes in eastern Monroe County, N.Y., calendar years 1985-89.

[All values are in percent.. Locations are shown in fig. 3. Data from Monroe County Department of Planning]

Municipality	Population 1980-90	Land use acreage: Residential	Land use acreage: Agricultural
Penfield	+11.1	+12	-
Pittsford	+8.3	+10	-16.6
Perinton	+12.2	+9	-15.1
Mendon	+26.0	+14	-9.7



Base from U. S. Geological Survey
Digital line graph, 1:100,000

Figure 3. Town boundaries and subbasin drainage boundaries in the Irondequoit Creek basin, Monroe County, N. Y., (Location is shown in fig. 1).

Methods of Data Collection, Computation, and Laboratory Analysis

Much of the data analyzed in this report were collected by MCEHL in accordance with procedures outlined by the USGS. Streamflow data were collected and processed by methods described in Rantz and others (1982 a, b). Water samples were collected, treated, and transported by procedures described in Britton and Greeson (1989), Goerlitz and Brown (1972), Guy and Norman (1970), Skougstad and others (1979), and Wood (1976). Most samples were analyzed by the MCEHL through analytical methods described in Standard Methods (APHA, 1985).

Long-term data from the Genesee River basin and a nearby observation well, to the southeast (Ot 900, fig. 2) were used in this study to indicate seasonal trends of the period studied and to supply background information from nearby areas not significantly affected by recent land-use changes. Data used in this study, as well as methods of collection and computation, are given in the companion report (Johnston and Sherwood, 1994).

Atmospheric Deposition

Precipitation data for the Irondequoit Creek basin were collected at four sites, one of which (Mendon Ponds Park, fig. 2) provided chemical data on atmospheric deposition. Records of precipitation volume collected at the Monroe County Airport (fig. 1) and published by the National Oceanic and Atmospheric Administration (NOAA) were used for long-term comparisons. Data from Mendon Ponds Park (fig. 2) included (1) wetfall (liquid deposition), (2) dustfall (dry deposition–the fraction that settles out of the atmosphere as dust), and (3) bulk (composite) deposition, which includes the two previous forms. The three forms of deposition were analyzed for common ions, nutrients, lead, and physical characteristics such as pH and specific conductance. The analyses provided information on the atmospheric contribution of these chemical constituents to the land surface.

Ground Water

Ground-water data from 10 wells in the Irondequoit Creek Basin were used; they consist of water-level records, water-temperature profiles, and water-quality analyses. Analyses of water samples collected from three springs in Powder Mill Park (fig. 2) were also available. Water levels in three wells in Powder Mill Park, six wells in Ellison Park, and well Mo 659 (B 86-2), on the northern side of the Pinnacle Hills Moraine (fig. 2), were measured periodically and recorded to the nearest 0.01 ft. Water temperature was measured seasonally at various depths in most wells and recorded to the nearest hundredth of a degree Celsius. Water temperatures inside the well casing were measured with minimal disturbance of the water to obtain temperatures representative of the water-table aquifer. Water samples were collected periodically from the nine wells in Powder Mill and Ellison Parks during water years 1986-88 and analyzed by MCEHL for specific conductance, pH, and concentrations of common ions, nutrients, metals, dissolved solids, alkalinity, and hardness.

Streamflow

Stage and discharge data were collected at five streamflow-gaging stations in the Irondequoit Creek basin and five in the Genesee River basin. Water-quality data were collected at the five streamflow-gaging stations in the Irondequoit Creek basin and at one site on the Genesee River (at Charlotte Docks, 3.6 mi downstream from the streamflow-gaging station Genesee River at Rochester). Data from the Irondequoit Creek sites were used to relate concentrations of selected constituents to discharge and to compute total loads to Irondequoit Bay. Data from the Genesee River basin are from sites with longer periods of record and were used to relate annual and seasonal discharges during 1984-88 to long-term statistics.

Quality Assurance/Quality Control

A quality-assurance/quality-control (QA/QC) program has been an integral part of the cooperative program between Monroe County and USGS since the 1980-81 NURP study. The purpose of the program is to ensure that streamflow measurements and water-quality information obtained meet USGS standards for release.

The QA/QC protocol for water sampling is designed to ensure that samples collected by an automatic sampler represent the water quality throughout the stream cross section. Depth-integrated cross-sectional samples were collected periodically from the stream, while the automatic sampler was activated, to determine whether constituent concentrations in samples collected by automatic sampler reflect the concentrations throughout the stream cross section. Both depth-integrated and automatic samples were then field split into eight equal volumes. Half of the split samples from each source were analyzed by the MCEHL and half by the USGS National Water Quality Laboratory (NWQL) to detect any analytical bias of MCEHL results in relation to those of the NWQL. The MCEHL also participates in the USGS Standard Reference Water Sample (SRWS) program, which compares the analytical results from all participating laboratories to obtain a most probable value (MPV) for each constituent. The analytical results from each laboratory are then compared statistically to the MPV for each constituent to locate consistent differences and are categorized as excellent, good, satisfactory, questionable, or poor. MCEHL results for nutrients and major ions were in the "good" category (0.5 to 1 standard deviation), whereas those for trace elements were in the "satisfactory" category (1 to 1.5 standard deviation).

A more complete description of the QA/QC program in use and of the statistical methods used to evaluate the results is given in the companion report (Johnston and Sherwood, 1994). Additional data on QA/QC programs in which MCEHL participates, either internally or with agencies of the State of New York, are detailed in appendix A. These data include (1) results of MCEHL participation in the New York State Environmental Laboratory Approval Program (ELAP), (2) internal QA/QC measures, and (3) a summary of analytical methods used by MCEHL over the 1984-88 study.

ATMOSPHERIC DEPOSITION

A substantial percentage of the chemical loads transported by Irondequoit Creek are derived from atmospheric deposition as wetfall and dustfall (Kappel and others, 1986). An exception is chloride, which is derived mainly from road-deicing salts and leachate from septic systems. Data from the 1980-81 NURP study of the Irondequoit Creek basin indicated significant spatial variation in the chemical composition of both wetfall and dustfall.

Precipitation Quantity

Precipitation quantity is needed to convert chemical concentrations to total yield of selected constituents for a given area during a selected time period. The formula used to compute annual yield is:

$$\text{Yield} = C \times P \times \text{conversion factor} \quad (1)$$

where: P = precipitation (annual), in inches, and

C = concentration, in milligrams per liter.

The conversion factor transforms the results to the desired units of yield, in weight per unit area. The yield is then multiplied by area to obtain load. This computation assumes that the precipitation recorded at the rain gage fell uniformly over the entire area represented by that particular gage and, therefore could be subject to error.

The National Weather Service station at the Monroe County Airport has collected precipitation-quantity data since May 1, 1929 (National Weather Service, oral commun., 1992). The average monthly and annual precipitation values for 1951-80 were used to calculate the normal precipitation values; the departures from this value in 1984-88 were computed (table 2).

Three rain gages are operated in the Irondequoit Creek basin and one in Mendon Ponds Park, near the divide between the Irondequoit Creek basin and the Genesee River basin (fig. 2). Precipitation at the Mendon Ponds site has been recorded continuously since May 1985; the three others, which are at streamflow-gaging stations, were operated for the entire 5-year period covered in this report. A detailed description of the precipitation data-collection equipment is given in Johnston and Sherwood (1994). This rain-gage network provided detailed information on precipitation quantity in the Irondequoit Creek basin.

The 1980-81 NURP study indicated that 50 to 75 percent of the annual load of sediment and associated chemical constituents is transported to Irondequoit Bay during a 3-month period that includes the major seasonal snowmelt and spring runoff (Kappel and others, 1986). Most ground-water recharge in the basin takes place during the nongrowing season, when evapotranspiration is minimal (Kappel and Young, 1989); therefore, above-normal precipitation during the nongrowing season can cause a significant rise in the water table, although above-normal precipitation during the growing season generally is offset by evapotranspiration. Below-normal precipitation tends to lower the water table during the growing season and has little or no effect during the rest of the year. Thus, seasonal patterns of precipitation quantity are important in the analysis of trends in ground-water levels. Table 2 presents total monthly and annual precipitation at the Rochester Airport for 1984-88, monthly and annual average for the 5-year period, and the normal value for each. These data indicate the representativeness of the 1984-88 study period.

The total monthly precipitation and departures from normal, published by National Weather Service, were used to calculate normal monthly and water-year totals for comparison with equivalent figures for each water year and with the average totals for the study period (1984-88). The average water-year total for the study period (33.22 in.) is about 2 in. greater than the normal water-year total

Table 2.--Monthly and annual precipitation, 5-year average, and normal values at Rochester Airport, Monroe County, N.Y., water years 1984-88.

[All values are in inches; Normal values are based on the average monthly or annual totals for 1951-80. Location is shown in fig. 1]

Water year	Month												Annual total
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	
1984	3.26	4.91	4.47	1.62	2.97	2.08	3.05	5.47	1.67	1.90	6.00	3.34	40.74
1985	0.76	1.47	3.31	2.49	1.78	3.47	1.30	2.08	2.63	1.86	1.11	2.49	24.75
1986	2.34	6.99	1.46	1.63	2.46	1.90	3.80	1.64	4.27	3.13	3.29	5.11	38.02
1987	3.56	1.93	3.56	1.89	0.66	1.98	3.68	1.99	3.94	5.85	3.92	4.60	36.76
1988	1.65	2.74	1.98	0.72	2.18	1.62	2.32	1.73	1.10	4.30	3.81	1.69	25.84
5-year average	2.11	3.61	2.96	1.67	2.01	2.21	2.83	2.42	2.72	3.41	3.63	3.45	33.22
Normal	2.54	2.65	2.59	2.30	2.32	2.53	2.64	2.58	2.78	2.48	3.20	2.66	31.27

(31.27 in). The individual water-year totals range from 6.52 in. below normal (1985) to 9.47 in. above normal (1984). Precipitation data from the Irondequoit Creek basin also indicate that the lowest water-year total for the study period was in 1985, but the the basinwide average was greatest in 1986. In general, total precipitation for water years 1985 and 1988 was somewhat below the 5-year average, and that for water years 1984, 1986, and 1987 was somewhat above average.

Total monthly precipitation at the Rochester Airport during the study period often differed from precipitation patterns recorded in the Irondequoit Creek basin. More than 50 percent of the monthly totals recorded at the airport were within 0.2 in. of the total at one or more of the Irondequoit Creek basin rain gages, however. The order of magnitude of total annual precipitation at the Rochester Airport for 1984-88 was identical to that recorded at the Blossom Road gage on Irondequoit Creek.

The precipitation data collected in this study indicated significant local variability. The maximum variation was in May 1988, ranging from 1.54 in. at Fairport to 6.16 in. at the gage near Pittsford. In general, however, all gages showed close agreement with at least one other gage (fig. 4). Monthly precipitation totals for the four Irondequoit Creek basin sites during 1984-88 are plotted in figure 4.

Chemical Quality

A network of three wetfall/dryfall collectors and one bulk collector was used during the 1980-81 NURP study to obtain data on chemical quality of atmospheric deposition in the Irondequoit Creek basin. The wetfall data provided estimates of atmospheric loads deposited in rainfall, and dryfall data provided estimates of loads deposited as dustfall between storms. A bulk-deposition collector was used to supplement other atmospheric data during the nonwinter period (Kappel and others, 1986). The resulting data indicated that atmospheric deposition contributed significant amounts of all constituents except chloride to the chemical loads transported. For example, atmospheric deposition contributed about 65 percent of the phosphorus load and more than 100 percent of the total Kjeldahl nitrogen (TKN) load transported out of the basin, indicating retention of TKN in the basin.

Although sampling of atmospheric deposition can provide relatively accurate estimates of the amounts of chemical constituents that reach the land surface, their effect on the loads of these chemicals transported by the streams should be interpreted with caution because of the uncertainties associated with the interactions of chemicals from their deposition until assimilation by the streams, as discussed by Kappel and others (1986).

The atmospheric-deposition data network was not continued after completion of the NURP study, but equipment for collection of wetfall, dryfall, and bulk samples was kept in operation by Monroe County at the Mendon Ponds site, near the southwestern edge of the Irondequoit Creek basin (fig. 2). This site was selected to represent atmospheric deposition that is unaffected by urban factors. In addition, a rain gage has been operated at that site since May 1985 to monitor precipitation quantity.

Of the three forms of deposition analyzed, the bulk-deposition samples appeared to provide the most reliable results and, therefore, are the only data used for comparison herein. Bulk-deposition data from 1984-88 were compared with those collected at the Mendon Ponds site during 1980-81 to detect significant changes in the atmospheric contribution to streamflow quality and also were analyzed statistically for indications of seasonal patterns.

Data from the three sites operated during the 1980-81 NURP study indicated wide areal variability. For example, atmospheric loads of dissolved chloride and total lead at the Mendon Ponds site were much smaller than at the other two sites, whereas total phosphorus loads at Mendon Ponds were considerably higher. TKN loads were about the same at all three sites. The lack of a consistent relation among constituent concentrations at the three sites indicates that the data from Mendon Ponds Park would not provide useful estimates of concentrations or loads for the entire basin, but the deposition data do indicate the magnitude of the effect of atmospheric deposition on stream-water quality in the basin.

Despite uncertainties associated with the collection of atmospheric-quality data, comparison of 1984-88 data from the Mendon Ponds site with data from that site during the 1980-81 study provides an indication of changing conditions. In general, mean annual constituent loads during 1984-88 were smaller than those during 1980-81. (See section "Comparison with 1980-81 [NURP] data," table 18, further on.)

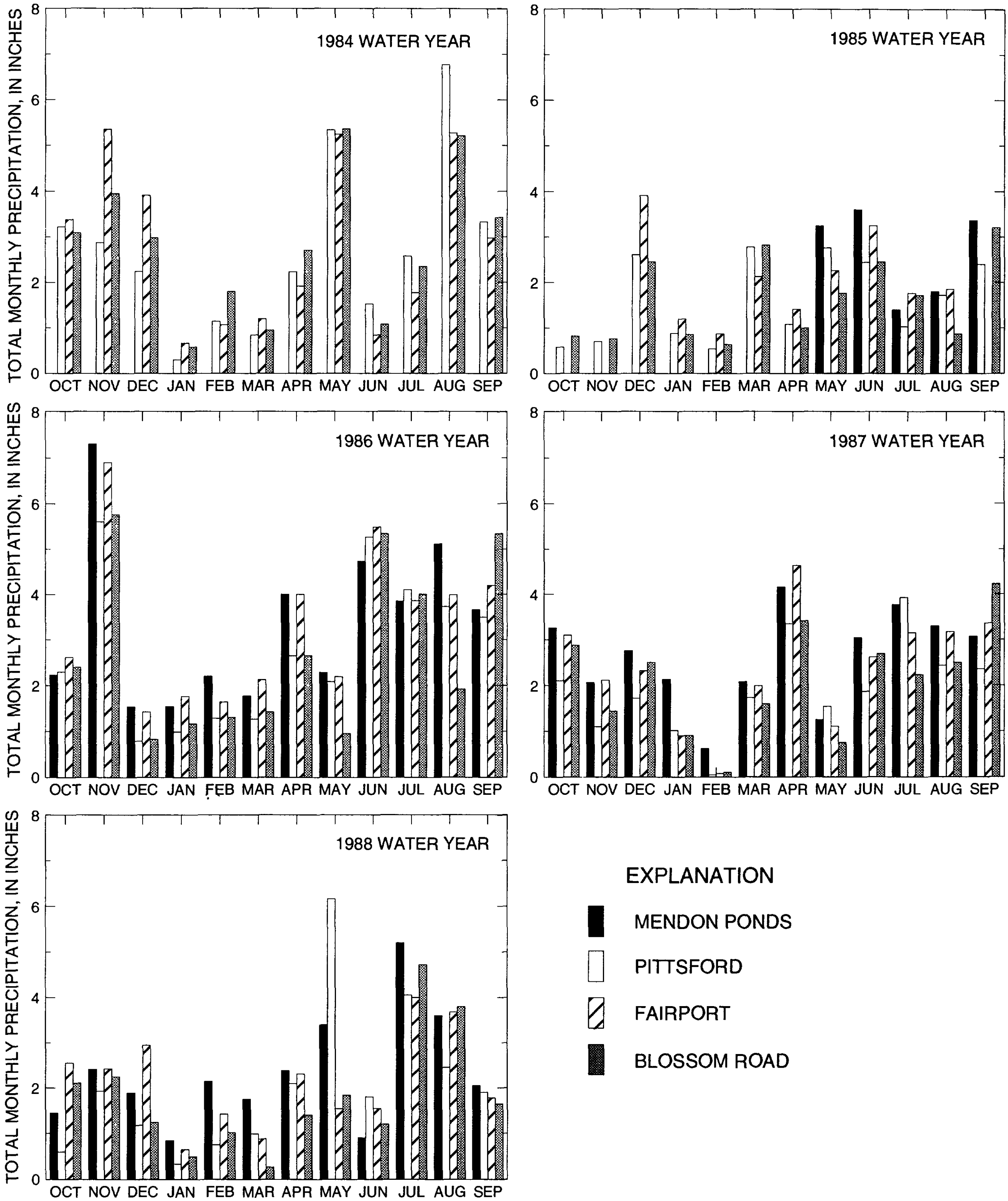


Figure 4. Monthly precipitation at Mendon Ponds, Pittsford, Fairport, and Blossom Road near Rochester, N.Y., 1984-88 water years. (Locations are shown in fig. 2.)

GROUND WATER

The ground-water data analyzed in this report were collected during water years 1984-88 and include water levels in wells, water-temperature profiles, and chemical data. The wells represented are at Powder Mill Park (3 wells) in the upper (southern) part of the Irondequoit Creek basin and in Ellison Park (6 wells) in the lower (northern) part. All well locations are shown in figure 2.

Water-level data from the three Powder Mill Park wells represent water years 1984-88, but water-temperature profiles and water-quality data were not collected prior to 1986 and represent only water years 1986-88. Water-level data from the wells in Ellison Park represent water years 1985-88, the water-temperature profiles represent February 1985 through September 1988, and the water-quality data represent January 1986 through September 1988.

Geohydrologic maps of the Irondequoit Creek basin (Yager and others, 1985) indicate that recharge to the Powder Mill Park aquifer is greatest in areas east of Powder Mill Park and from southeast of the park to the ground-water divide in the Town of Victor (fig. 2). These maps also indicate the general direction of ground-water flow to be westward from these recharge areas toward Irondequoit Creek, then northward, following the surface-drainage pattern, toward Irondequoit Bay.

A local well-numbering system was used to help county employees, who were recording water levels and collecting samples, to identify well locations (the prefix PM represents Powder Mill Park wells; El represents Ellison Park wells). The USGS well-numbering system, which uses a county code and numerical designation, is required for storage in the USGS data base; both numbers are used throughout this report for clarity.

Water Levels

Water-level data indicate seasonal fluctuations in the water table as well as the slope, or gradient, of the water table in relation to other parts of the aquifer or to the water surface in nearby streams. Where paired wells are screened at differing depths in a water-table aquifer, the difference between the two water levels can be used to indicate whether the wells are in a ground-water discharge area or recharge area.

Seasonal Fluctuations

Sand and gravel aquifers in the glaciated northeastern United States are recharged by snowmelt and precipitation, either by direct infiltration or by underflow from the upgradient aquifer system. Ground-water levels reflect these seasonal patterns. During a normal year, the recharge and ground-water levels are highest during the spring snowmelt period and are lowest during midsummer, when evapotranspiration is greatest. Significant recharge can also occur during the fall, when evapotranspiration decreases; for example, the greatest total monthly precipitation recorded at the Rochester Airport during the study, 4.34 in. above normal, was during November 1985 (table 2), but this wet November was preceded by seven consecutive months of below-normal precipitation. This November precipitation raised the December ground-water level to well above its 5-year average, even though precipitation for that December was more than 1 in. below normal.

Powder Mill Park

Water levels in the Powder Mill Park wells were not measured in every month of the study; therefore data for certain periods are missing. Observation wells Mo 10 (PM 83-1) and Mo 11 (PM 83-2) are paired water-table wells finished at differing depths in sand and gravel and are on the bank of Park Road Creek in Powder Mill Park (fig. 2), about 7.5 ft above the channel bottom. Water levels at wells Mo 10 and Mo 11 showed an average seasonal fluctuation of about 2 ft/yr during 1984-88, and the annual mean declined. In contrast, well Mo 12 (PM 83-4), which is downgradient from wells Mo 10 and Mo 11, is finished in lake silt and clay (Kappel and Young, 1989) and showed a seasonal fluctuation of only 0.58 ft/yr.

Water levels in wells Mo 10 and Mo 11 generally followed normal seasonal fluctuation patterns throughout 1984-88 but rose higher than normal during the 1984 growing season in response to widespread precipitation of more than 5 in. during May and unusually high precipitation again in August. Water levels during 1988 were below those of all other years of the study, even though precipitation in May 1988 was the highest of any May during 1984-88. The general water-table decline at wells Mo 10 and Mo 11 during 1984-88 most likely reflects land-use changes east of Powder

Mill Park that decrease the recharge area and limit infiltration.

Water levels in well Mo 12 seem to have responded more slowly to seasonal factors than those in the two nearby water-table wells during 1984-85, but this lag is not apparent in 1986-88 (fig. 5A). Monthly mean water levels in well Mo 12 during 1987, unlike those in wells Mo 10 and Mo 11, exceeded the average for the 5-year period of study and, except for November 1986, were above the monthly mean for each of the other 4 years. The trend toward elevated water levels in well Mo 12 continued into 1988 until May, when, as in the other two wells, the mean water level dropped below the mean for the previous 4 years.

Ellison Park

Sporadic water-level observations in all six Ellison Park wells (fig. 2) showed similar seasonal fluctuation patterns, but the degree of fluctuation differed across the valley (fig. 4B). Paired wells Mo 1 (El 84-1) and Mo 2 (El 84-2), near the east wall of the valley, showed similar seasonal fluctuation patterns; monthly means of the observed water-levels were within 0.10 ft of each other, except in February 1985, when the water level in well Mo 2 (the deeper well) was 0.26 ft higher than that in well Mo 1 as a result of high recharge from snowmelt. The monthly means of the observed water levels ranged from 0.82 ft above land surface to 1.46 ft below.

Paired wells Mo 5 (El 84-5) and Mo 6 (El 84-6), in the middle of the Irondequoit Creek flood plain, showed the same seasonal fluctuation pattern as those along the east wall, but monthly mean water levels at these two wells differed by more than 0.10 ft, and the maximum difference (0.68 ft) was reached in April 1985. The monthly means ranged from 1.04 ft above land surface to 2.09 ft below. Water levels in wells Mo 3 (El 84-3) and Mo 4 (El 84-4), near the right and left banks of Irondequoit Creek, respectively, were responsive to stage in the creek and showed similar patterns of seasonal fluctuation. Monthly means remained below land surface, however, and the range was greater in these wells than in either set of paired wells farther from the stream. Monthly mean water levels at well Mo 3 ranged from 0.49 to 4.10 ft below land surface, and those at well Mo 4 ranged from 0.25 to 4.21 ft below land surface (fig. 5B).

The Ellison Park wells (Mo 1 through Mo 6) are within the flood plain of Irondequoit Creek; thus, the water levels respond to high stages in the creek and reflect aquifer recharge from ground water flowing downvalley (Yager and others, 1985). The seasonal patterns of fluctuation in these wells differ somewhat from those in Powder Mill Park, which have a relatively small, local recharge area. The hydrographs for these wells (fig. 5) indicate that seasonal environmental changes had a greater effect on ground-water levels than did precipitation .

Water-Table Gradient

The water-table gradient indicates the direction of ground-water flow and whether the stream reach in that area is gaining or losing water. During base-flow periods, most or all of the streamflow consists of ground water, and the water-table gradient in most reaches is toward the stream. Large discharges that cause the stream stage to increase substantially can cause the water-table gradient to reverse temporarily, allowing stream water to recharge the aquifer.

The monthly means of water levels observed up to 4 times a month from December 1983 through September 1988 (except March, May and June 1986, and July and August 1988) were consistently below the bottom of the stream channel, except during May and June 1984 and April 1986 (fig. 6A). Park Road Creek was observed flowing during summer base-flow periods, indicating a poor hydraulic connection between the stream and aquifer. The hydrographs for wells Mo 10 and Mo 11 during water years 1984-88 (fig. 6A) indicate frequent reversal of hydraulic head.

The water-table gradient in Ellison Park is generally toward the creek but can reverse during high creek stages (fig. 7). In general, ground-water levels on the eastern side of this reach of Irondequoit Creek (wells Mo 1 through Mo 3) are slightly higher than those on the western side (wells Mo 4 through Mo 6, fig. 7).

The well pairs in Ellison Park (Mo 1 and Mo 2 near the east wall of the valley and Mo 5 and Mo 6, in the middle of the left-bank flood plain), show frequent reversals in hydraulic-head differences, largely in response to stage changes in Irondequoit Creek (fig. 6B). The hydraulic head differences between paired wells Mo 1 and Mo 2 do not parallel those of paired wells Mo 5 and Mo 6, however. The range of observed water levels during 1985-88 in

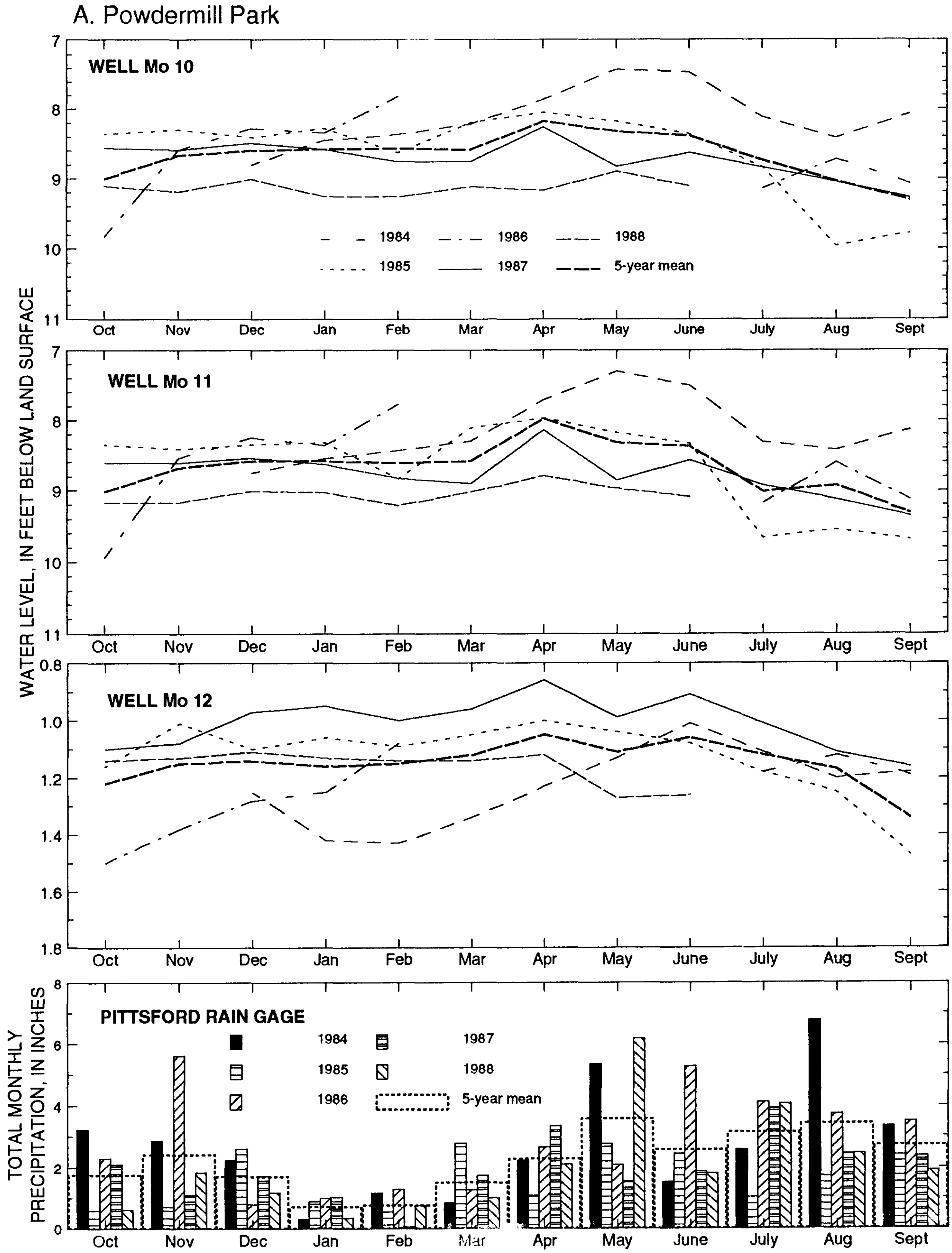


Figure 5A. Monthly and 5-year mean water levels in three Powder Mill Park observation wells, and total monthly precipitation at Pittsford rain gage, water years 1984-88. (Locations are shown in fig. 2.)

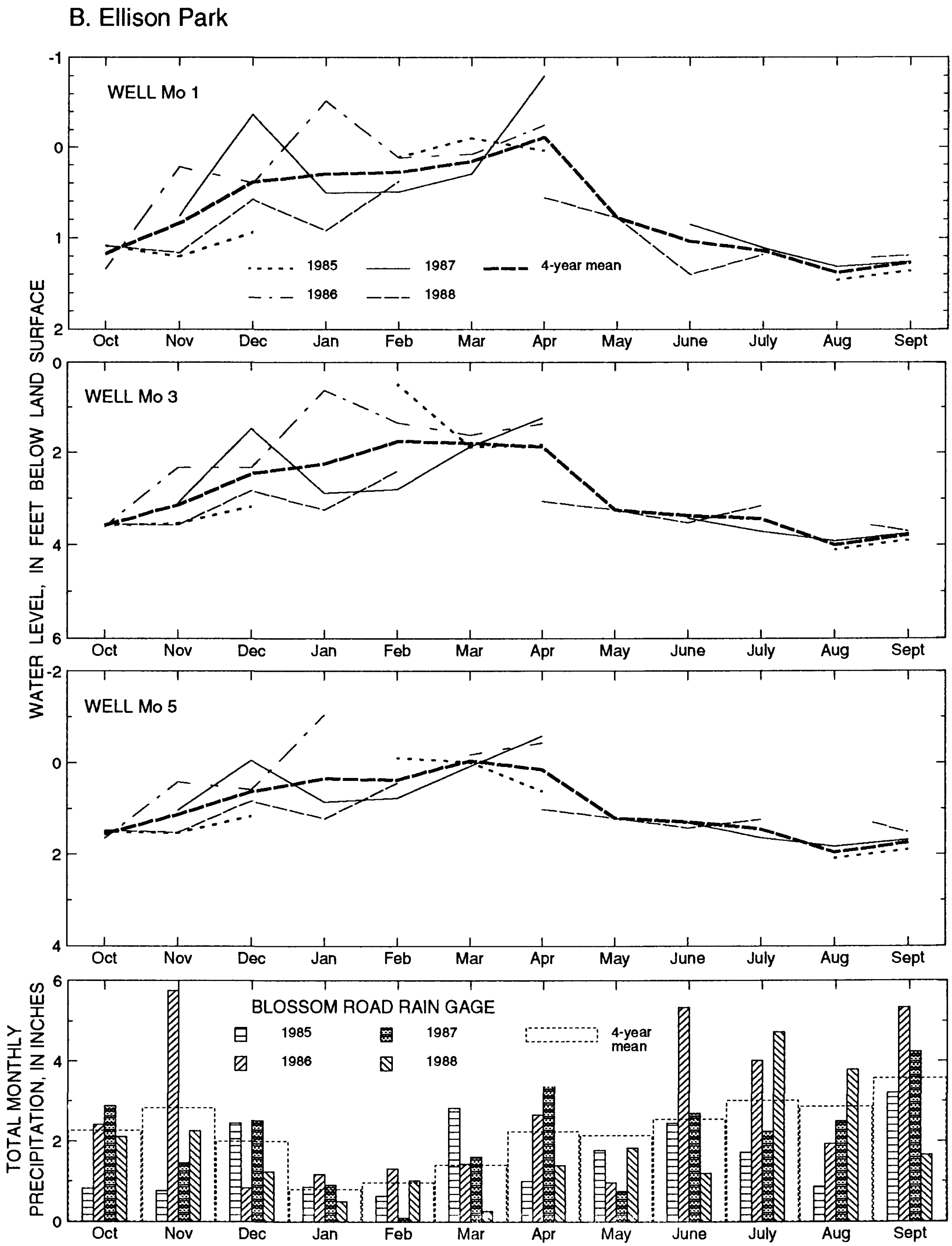
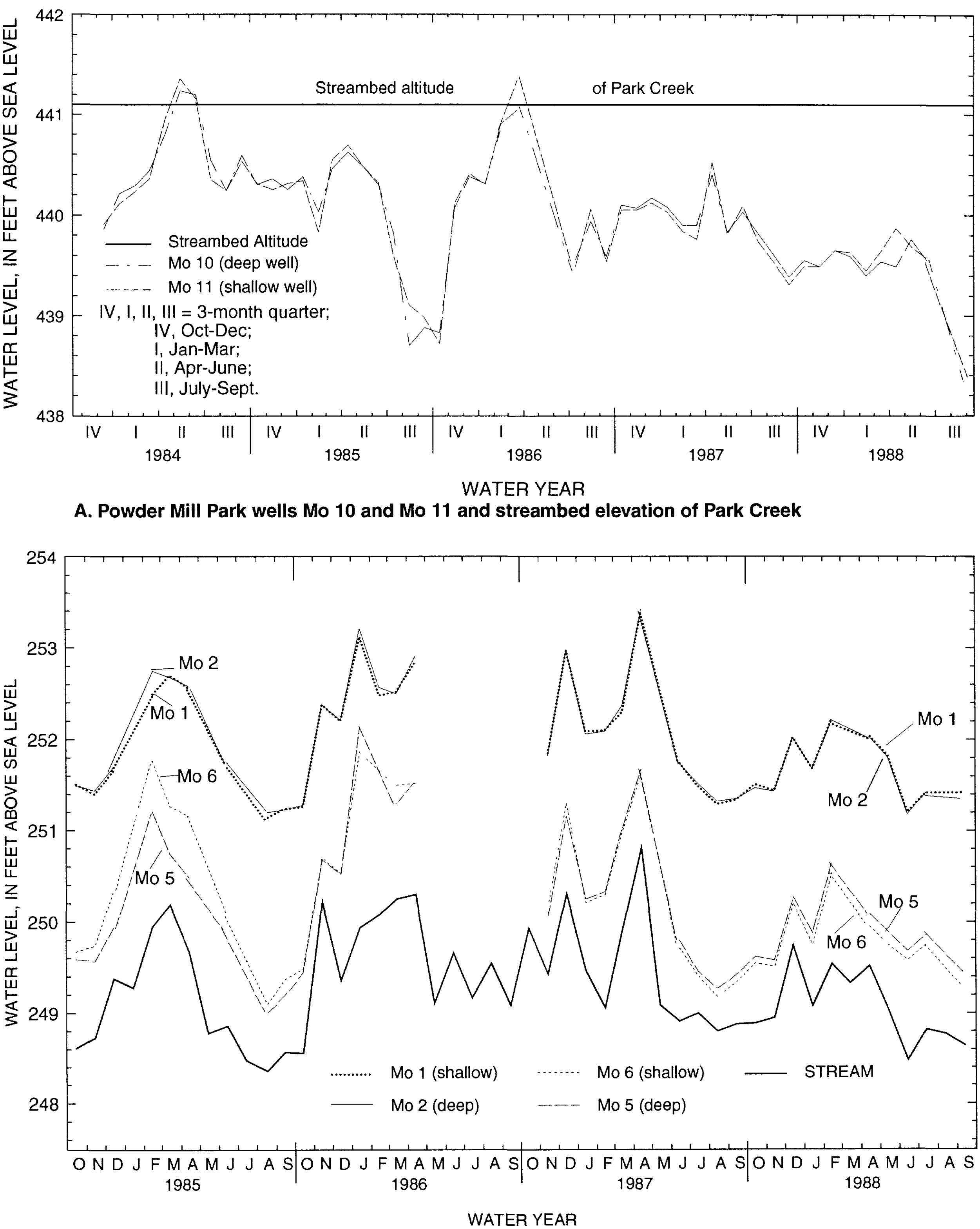


Figure 5B. Monthly and 4-year mean water levels in three Ellison Park observation wells, and total monthly precipitation at Blossom Road rain gage, water years 1985-88. (Locations are shown in fig. 2.)



A. Powder Mill Park wells Mo 10 and Mo 11 and streambed elevation of Park Creek

B. Ellison Park wells Mo 1 and Mo 2 (east bank) and Mo 5 and Mo 6 (west bank) of Irondequoit Creek

Figure 6. Monthly mean water levels in Powder Mill Park and Ellison Park wells, water years 1984-88. (Locations are shown in fig. 2.)

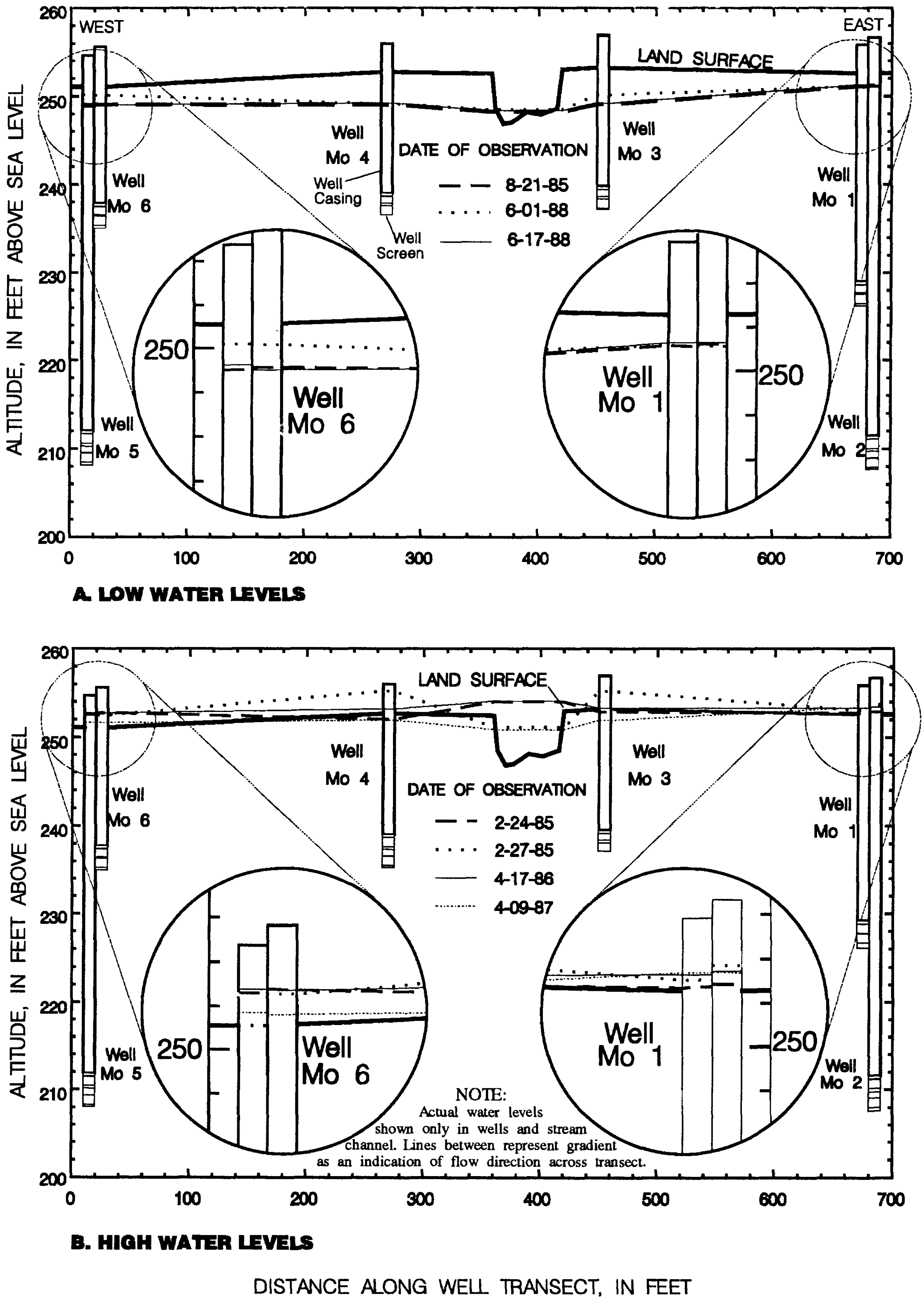


Figure 7. Water-level gradient at Ellison Park well transect during (A) selected low ground-water levels, and (B) selected high ground-water levels. (Locations are shown in fig. 2.)

wells Mo 1 and Mo 2 was 2.61 ft, whereas that in wells Mo 5 and Mo 6 was 3.73 ft. Observed heads in wells Mo 1 and Mo 2 are normally within 0.04 ft of each other and rarely differed by more than 0.10 ft. Greater differences (maximum 0.64 ft) were observed only in the latter part of February 1985. Heads in wells Mo 5 and Mo 6 were within 0.10 ft of each other only 45 percent of the time; in 1985, the difference exceeded 0.50 ft on four occassions, the largest of which was 1.39 ft on February 27.

Water levels during the spring and late summer of 1985 were greater in well Mo 2 (the deeper well) than those in well Mo 1, indicating a net upward ground-water gradient (fig. 8), whereas water levels in wells Mo 5 and Mo 6 at the same times indicated a downward net gradient. Wells Mo 5 and Mo 6 showed a significant reversal from mid 1987 through 1988 from the net gradients of 1985-86, as indicated in figure 8.

Temperature

The rate of ground-water movement is determined by the hydraulic conductivity of the aquifer material and the head difference between points in the aquifer. Lapham (1989) demonstrated that seasonal changes in water-temperature profiles can be used to estimate the vertical component of the soils hydraulic conductivity because shallow ground water responds more rapidly than deep ground water to air temperature. This vertical component of hydraulic conductivity, together with concentration data for selected chemicals, can be used to predict the downward movement of the chemical loads.

A theoretical Fourier Series solution for vertical flow of heat and ground water in a homogeneous aquifer of infinite width was compared graphically with water-temperature profiles measured in wells to obtain an estimate of effective vertical hydraulic conductivity. In Lapham's method, the vertical velocity varied in the theoretical solution varied until the geometric temperature envelope (formed by curves on either side of, and tangent to, each member of the set of curves) for the predicted temperature profile produced a best fit match of the profiles measured in the field (fig. 9). Darcy's Law is then used to convert vertical velocity to effective vertical hydraulic conductivity.

Water-temperature profiles were measured two or three times a year during 1985-88 at Ellison Park

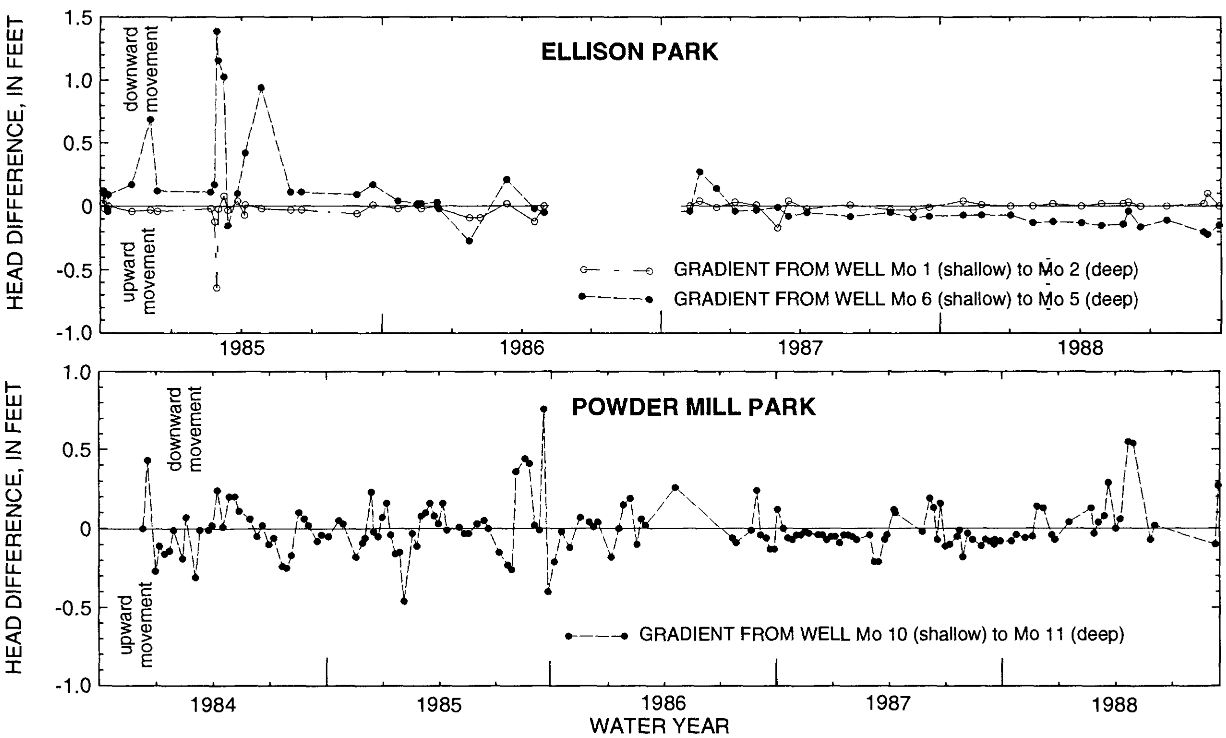


Figure 8. Water-level gradients (head difference in paired wells) in Ellison Park and Powder Mill park, water years 1984-88. Gradient represents head in shallow wells minus head in deep well; a positive value indicates downward ground-water movement, and a negative value indicates upward movement. (Locations are shown in fig. 2.)

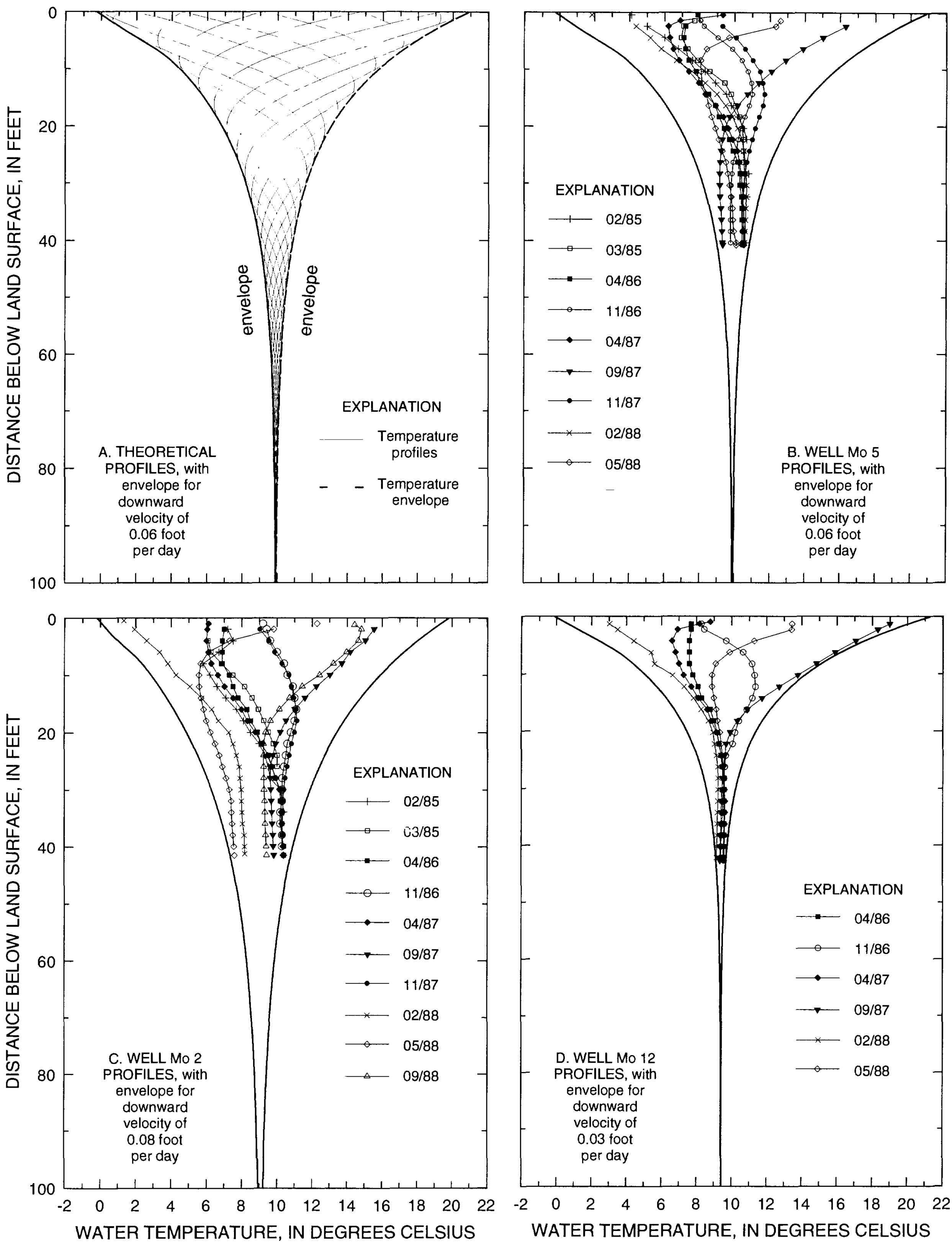


Figure 9. Ground-water temperature profiles. A. Theoretical temperature profiles with annual temperature envelope (Lapham, 1989). B, C, D, Profiles at Ellison and Powder Mill Park deep wells (Mo 5, Mo 2, Mo 12) with temperature envelopes for selected downward ground-water flow velocities. (Locations are shown in fig. 12.)

wells and during 1986-88 at Power Mill Park wells; this provided from 6 to 10 profiles for each well, but because temperature was measured during the same month in more than 1 year, only five or six different months of the year are represented. Months excluded are January, June, July, August, October, and December.

The Fourier Series model accommodates adjustment for a winter period, when the first few feet of soil are frozen. A 2-month winter period was selected as the best fit of the field data for the deeper wells, from which the most data were available. Also, the temperature at a depth of 100ft was held constant at about that of the mean annual ambient air temperature. The temperatures used were those suggested by the profiles measured in each well, after the winter-period adjustment, and ranged from 10.4C^{o} at well pair Mo 10 and Mo 11, in a shaded area of Powder Mill Park, to 11.9^{o}C at wells Mo 3 through Mo 6, in more open areas of Ellison Park. This divergence is probably due to differences in daily periods of direct sunlight and to the nearly 200-ft difference in elevation between the two parks.

The comparison of the synthesized water-temperature profiles with those made in Ellison Park during 1985-88 indicates an effective net downward vertical velocity of about 0.08 ft/d in wells Mo 1 through Mo 3 (El 84-1 through El 84-3) on the left bank of Irondequoit Creek, and about 0.07 ft/d at well Mo 4 (El 84-4), on the right bank, decreasing to 0.06 ft/d in wells Mo 5 and Mo 6 (El 84-5 and El 84-6) as distance from the stream increases (fig. 10). A similar comparison of Powder Mill Park data collected during 1986-88 indicates an effective downward vertical velocity of about 0.08 ft/d at wells Mo 10 and Mo 11 (PM 83-1 and PM 83-2) and an effective downward vertical velocity of 0.03 ft/d at well Mo 12 (PM 83-4).

The Fourier Series solution assumes that (1) ground-water velocity is constant over time and is constant at all depths, (2) ground-water flow is vertical near the wells studied, so that temperature profiles are not affected by horizontal flow, and (3) only the temporal variation in surface temperature affects temperatures in the aquifer (Lapham, 1989). Results of this analysis must be viewed with caution however, because (1) the well logs for each site indicate nonhomogeneous soil, (2) vertical hydraulic gradients between paired wells reverse frequently, and (3) horizontal hydraulic gradient between wells can reverse during high discharges. No known studies have been conducted, as yet, to evaluate the effects that these violations may have on the results, but the lack of homogeniety and consistent downward vertical velocity is probably the reason that the patterns of the measured individual temperature profiles do not cross and fill the envelope as completely as the theoretical profiles.

All head differences indicating downward ground-water flow at the paired wells were used to obtain a range of vertical hydraulic conductivities for the soils at each well pair. The results of these calculations are presented in table 3. Geologic logs for the three well pairs are plotted in figure 10, which also shows horizontal hydraulic conductivity ranges given by Heath (1983, p. 13) and vertical hydraulic conductivity calculated from the temperature profiles. Freeze and Cherry (1979) report that horizontal hydraulic conductivity generally is 2 to 10 times greater than vertical hydraulic conductivity.

The hydraulic conductivity values derived from the temperature profiles through the best-fit method closely match the published ranges for the soils recorded in the well logs. Therefore, the temperature profiles for all wells yielded reasonable estimates of the vertical component of ground water flow in the underlying aquifer system.

Table 3. Effective vertical velocities of ground water and effective vertical hydraulic conductivity of sediments at paired wells in Powder Mill and Ellison Parks, Monroe County, N.Y.

[Well locations are shown in fig. 2]

Well pair numbers	Thickness of sediment between well points, in feet	Difference in head of paired wells, in feet		Hydraulic gradient, in feet per foot		Vertical velocity determined from temperature envelopes, in feet per day	Effective vertial hydraulic conductivity, in feet per day	
		Min	Max	Min	Max		Min	Max
Mo 11, Mo 10	27	0.01	0.76	0.00037	0.02815	0.08	2.84	216
Mo 1 - Mo 2	18	.01	.10	.00056	.00556	.08	14.4	143
Mo 6 - Mo 5	26.5	.02	1.16	.00075	.04377	.06	1.37	79.5

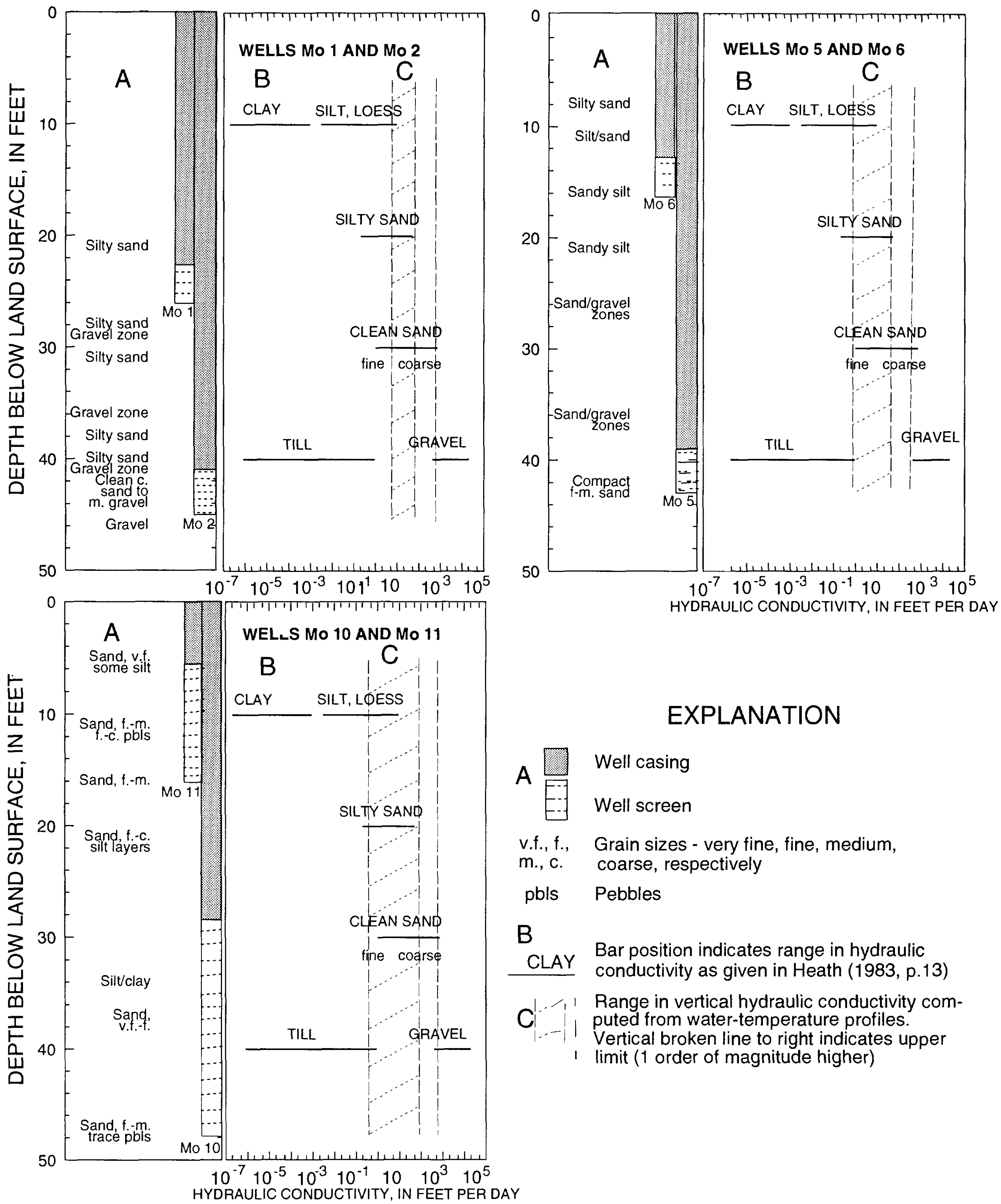


Figure 10. Logs of paired wells in Ellison and Powder Mill Parks: A. Geologic logs based on core samples. B) Hydraulic conductivity of selected glacial deposits as indicated by Heath (1983, p. 13). (C) Vertical hydraulic conductivity range of deposits at well, as calculated from water-temperature profiles. (Locations are shown in fig. 2.)

Chemical Quality

Chemical analyses are used to determine the presence and concentration of selected chemical constituents in water samples from a given well. Comparison of analyses among selected wells indicates local differences in water quality within a given aquifer and can indicate ground-water movement to or from a stream as well as possible sources of chemical constituents and the degree of mixing. Water-quality data are also used to compare temporal trends in chemical quality of ground water.

Sample Collection and Data Analysis

Water samples were collected only after three casing volumes of water had been removed from the well, and physical characteristics, such as temperature, pH, and specific conductance, had stabilized. The well was then allowed to recover, and water samples were collected by a peristaltic pump, as explained in Johnston and Sherwood, (1994).

Median and range of concentration of selected chemical constituents from the wells were compared through box plots, and temporal trends were identified through the Kendall slope estimator. Piper diagrams (shown further on) were used to compare the chemical composition of samples from differing sources. Samples from wells with similar water chemistry tend to form clusters within each plot, making similar and dissimilar groups easy to identify.

Areal Variability

Box plots indicated differences in concentrations of selected constituents among groups of wells and between individual wells in a group. Except for dissolved chloride and dissolved sulfate (fig. 11), median concentrations did not indicate any spatial trends within Ellison Park or Powdermill Park, nor did they indicate any differences between parks. Median concentrations of all but these two constituents in Powder Mill Park wells were in the range of those in Ellison Park wells (fig. 12)

Ellison Park wells on the east side of Irondequoit Creek (Mo 1, Mo 2, Mo 3) indicated significantly (95-percent confidence limits) higher concentrations of dissolved chloride than those on the west side of the creek and in Powder Mill Park (fig. 11). The elevated concentrations are probably due to winter runoff from Blossom Road, which collects in a swale along the east valley wall near wells Mo 1 and Mo 2. All wells on the eastern side of the creek in Ellison Park also showed significantly higher concentrations of dissolved sulfate than the shallow wells on the western side of the creek and the paired wells at Powder Mill Park. Dissolved sulfate concentrations in the deeper well on the western side of the creek in Ellison Park (Mo 5) and the well associated with the esker in Powder Mill Park (Mo 12) are in the same range as those closest to the east valley wall in Ellison Park; this suggests that the elevated dissolved sulfate concentrations could result from flow through bedrock or gravel deposits.

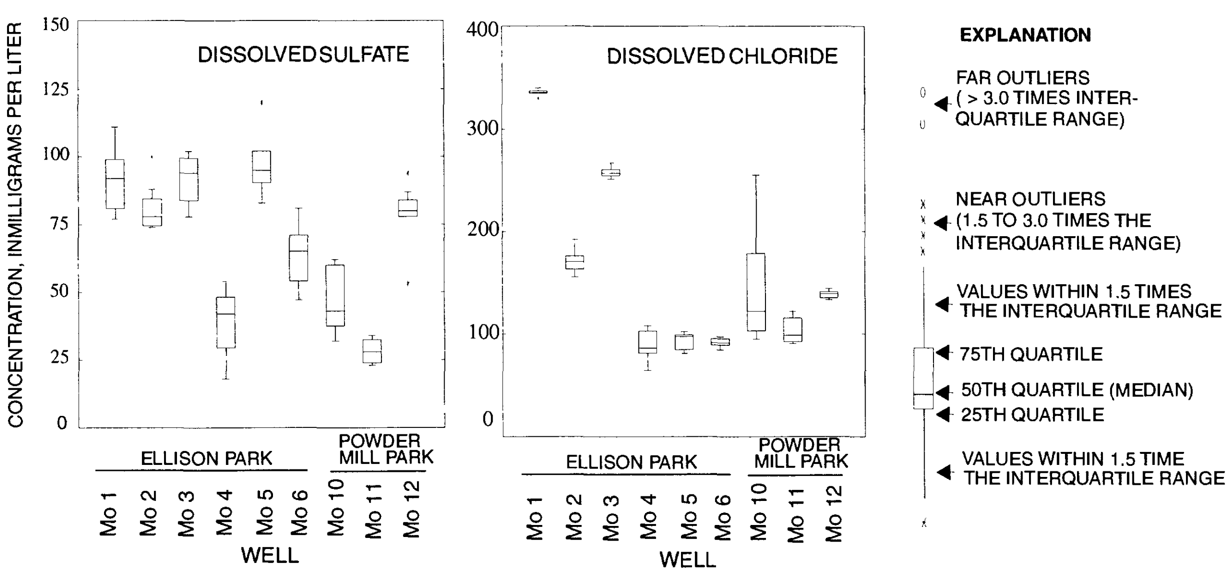


Figure 11. Distribution of dissolved chloride and dissolved sulfate concentrations in water from Powder MIll Park and Ellison Park wells, water years 1986-88. (Locations are shown in fig. 2.)

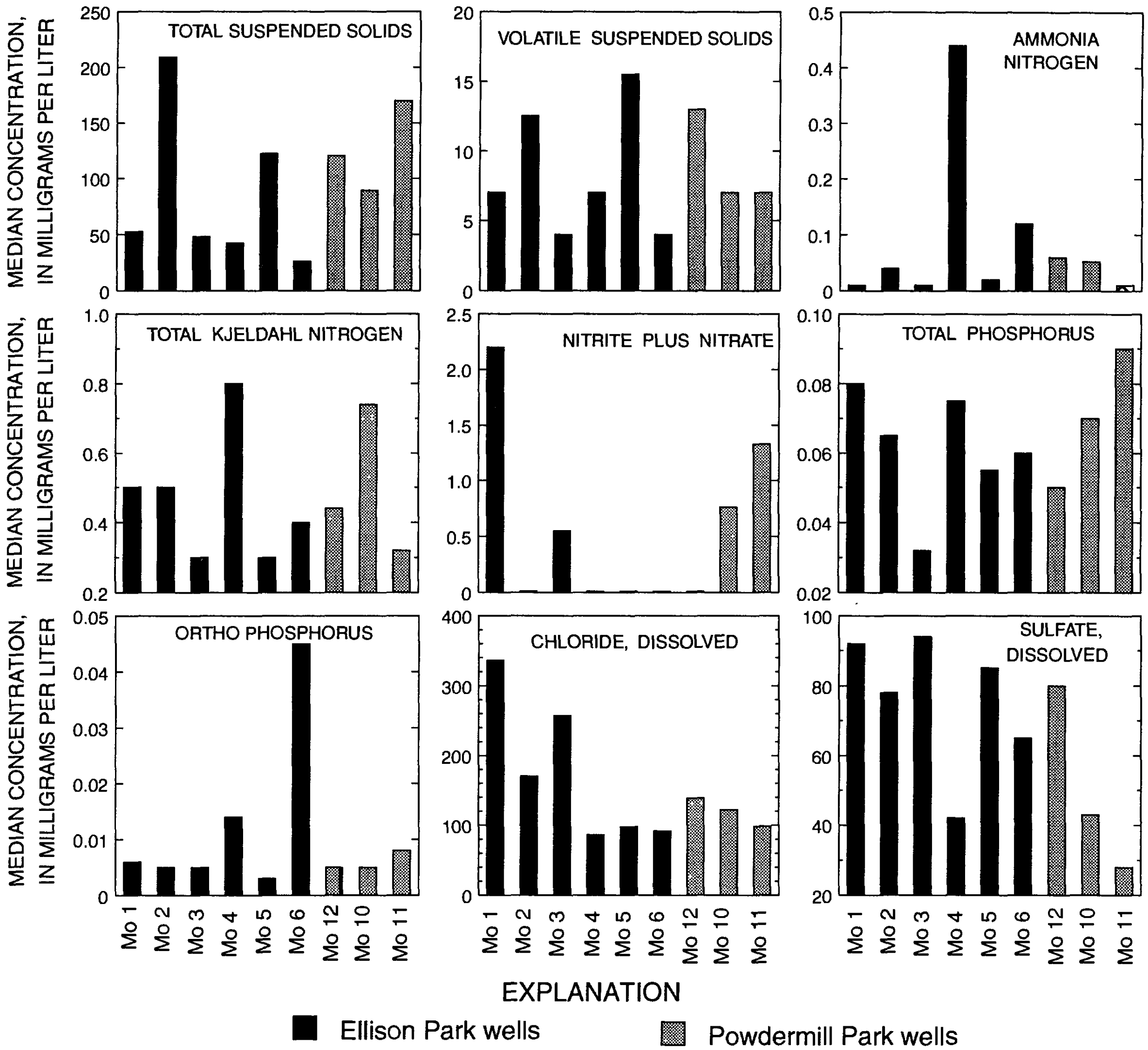


Figure 12. Median concentrations of selected constituents in water from Ellison Park and Powder MIll Park wells, water years 1986-88. (Locations are shown in fig. 2.)

Differences between ground-water quality in Ellison Park wells on the eastern side of Irondequoit Creek and those on the western side are apparent in figure 14. Water from the wells on the eastern side ranged from 40 to 70 percent calcium and 30 to 60 percent sodium, whereas water from the western side was about 90 percent calcium and only 10 percent sodium (fig. 13). Anions in water from the eastern side were about 60 percent chloride and sulfate and 40 percent bicarbonate, whereas anions in water from the western side ranged from 30 to 55 percent chloride and sulfate and from 45 to 70 percent bicarbonate.

Well Mo 2 (45.0 ft deep), near the east valley wall, has a considerably lower median concentration of dissolved chloride than the two shallower wells on the east side of the creek (figs. 11 and 12), probably because the frequent upward ground-water flow dilutes the chloride from road salt and prevents the dense brine from reaching the lower aquifer (Kappel and Young, 1989). Median concentrations of nutrients (nitrates and phosphates) at wells on the western side of the creek were lowest in the deep well (Mo 5), except for nitrite plus nitrate, which was low in all west side wells. Wells Mo 4 and Mo 6 are shallow (16.0 ft) and, thus, reflect the susceptibility of shallow ground water to surface contamination by fertilizers. In contrast, median concentrations of suspended solids and suspended volatile solids

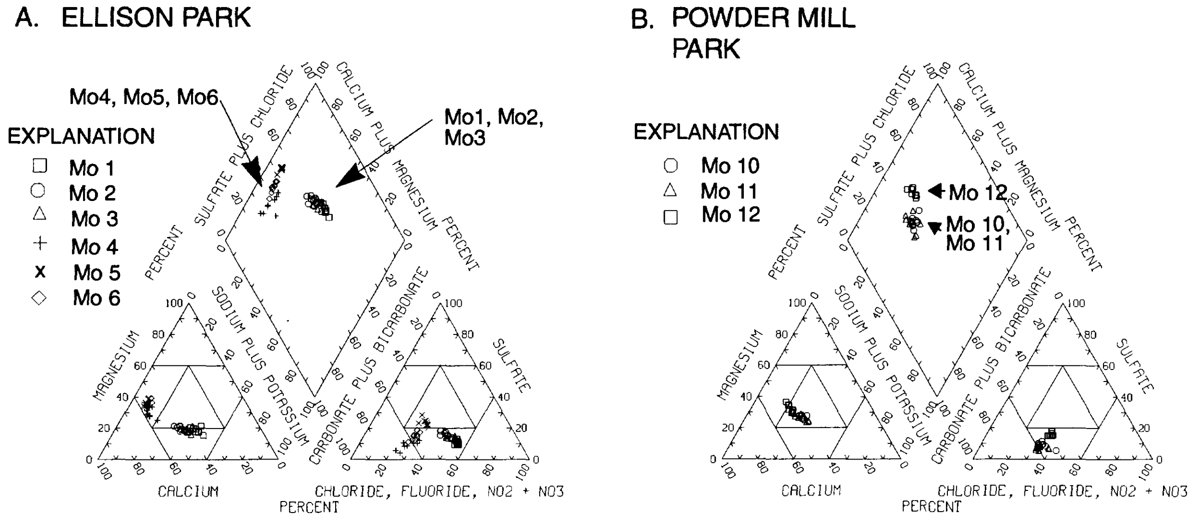


Figure 13. Piper diagrams showing chemical composition of water from: A. Ellison Park wells on east side of Irondequoit Creek (Mo 1, Mo 2, Mo 3) and on west side (Mo 4, Mo 5, Mo 6). B. Powdermill Park wells (Mo 10, Mo 11, Mo 12). (Well locations are shown in fig. 2.)

were higher in the deep wells on both sides of the creek than in the shallow wells. The ions commonly associated with these constituents are derived from the relatively soluble limestone, dolostone, and gypsum in the region.

Median concentrations of dissolved chloride and dissolved sulfate in samples from well Mo 10 and Mo 12 in Powdermill Park were significantly higher than in samples from the shallow well (Mo 11). The water table in this area slopes steeply to the west (Yager and others, 1985), and much of the area east of Powdermill Park has been extensively developed with commercial and residential construction. High concentrations of dissolved chloride and dissolved sulfate in the deeper wells could be partly due to runoff from developed areas and partly to upward flow from the deeper regional flow system (Kappel and Young, 1989). The main source of the chloride and sulfate is probably the Salina shale, which is rich in these constituents. The proximity of well Mo 12 to Park road (within 20 ft) could also contribute to the high chloride concentrations in that well.

The differences in water quality shown in the Powder Mill Park wells (figs. 11, 12, 13) are not surprising, in that (1) well Mo 12 is in the gap of an esker and has a more limited recharge area than the paired wells, and (2) the horizontal velocities in that part of the aquifer exceed the vertical velocities to a greater extent than elsewhere, as indicated by (1) the well logs, (2) small annual head variations, and (3) vertical temperature-profile analyses.

Effects of Atmospheric Deposition

The effect of atmospheric deposition on ground-water chemistry is modified by contact with land surface and the soil matrix. Precipitation flowing across natural and paved surfaces can accumulate a variety of chemical constituents before infiltrating the soil, and some of these can be leached from or adsorbed by the soil matrix as the water percolates through it. Concentrations of selected constituents in bulk precipitation samples from the Mendon Ponds atmospheric deposition site were compared with those from several wells in nearby Powder Mill Park to evaluate the effect of atmospheric deposition on the chemical quality of the water-table aquifer.

Median concentrations of cations in samples from the bulk-deposition collector were low, about 0.1 mg/L, except for calcium, which was about 0.8 mg/L. Median concentrations of calcium, magnesium, and sodium in Powder Mill Park wells were about 2 orders of magnitude greater (31 to 84 mg/L) than in the deposition samples, and that of potassium was more than 1 order of magnitude greater. This indicates that the presence of these cations in atmospheric deposition has little effect on ground-water chemistry. Median concentrations of chloride and sulfate in atmospheric deposition were also lower than in ground water. Median concentrations of nutrients in the bulk-deposition samples were greater than in those from Powder Mill Park wells, however–an indication that a significant amount of nutrients from atmospheric deposition is retained in surface runoff and by the soil during infiltration.

STREAMFLOW

Knowledge of long-term streamflow trends is important to the evaluation of results of water-quality-trend analyses, especially those that focus on seasonal and annual loads of selected chemical constituents. The major snowmelt and spring-runoff period contributes 50 to 75 percent of the annual constituent load transported to Irondequoit Bay (Kappel and others, 1986). Discharge during this period includes the melting snowpack, which has been collecting atmospheric deposition throughout the winter, and nutrients from overfertilization of fields, washoff of animal waste, and soil erosion. Storms that occur during the growing season normally cause less erosion than at other times, and during the fall and early winter, the crop roots that remain in fields to help stabilize soils before the winter snowpack begins to accumulate.

Surface water in the Irondequoit Creek basin was sampled regularly at five sites during water years 1984-88. The samples were composited for chemical analysis on a discharge-weighted basis so that concentrations determined for various mean flows could subsequently be matched with the discharge record for each station to estimate loads transported by Irondequoit Creek and its tributaies on a seasonal and an annual basis. Streamflow records for stations in the Genesee River basin part of Monroe County with longer periods of record were also analyzed to determine whether streamflow for this 5-year period was representative of the normal climatic 5-year period.

Basis of Statistical Analysis

Streamflow, which is variable and reflects climatic conditions, affects constituent concentration. Concentrations of constituents from nonpoint sources generally increase with increased runoff, especially during the first flush of a storm, as does particulate matter. Most dissolved constituents, on the other hand, are derived from ground water or point sources and are diluted by increasing discharge. A nonparametric procedure was used in this study to test for trends in constituent concentrations. Any observed trend in flow-adjusted concentration could be partly due to an upward or downward trend in streamflow over the 1984-88 study period, however.

As an example, Allen Creek near Rochester shows a significant decreasing trend in discharge during water years 1984-88 (fig. 14); this could be largely due to the wet conditions at the beginning of water year 1984 and below-normal discharge throughout the 1988 water year (table 4). Irondequoit Creek at Linden Avenue also shows a negative trend in discharge for the period, but it is not significant at the 90-percent confidence level. Negative trends in concentrations of particulate matter at Allen Creek and possibly at Irondequoit Creek at Blossom Road (the combined flows from Allen Creek and Irondequoit Creek at Linden Avenue), could be partly due to the streamflow trend indicated for at the Allen Creek gage.

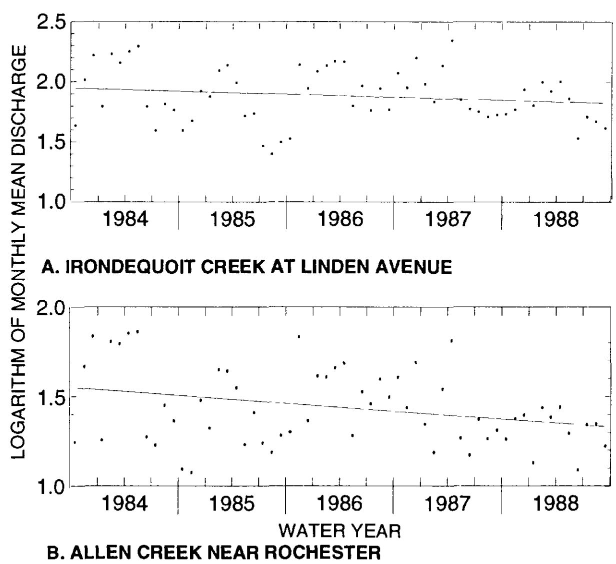


Figure 14. Logarithm of monthly mean discharges and trend slope for water years 1984-88 at two sites in Irondequoit Creek basin, Monroe County, N.Y. (Locations are shown in fig. 2.)

Streamflow variability can also produce significant bias in trends in chemical constituent loads (discharge × concentration) transported by Irondequoit Creek and its tributaries unless the degree of similarity of the study period to a much longer period is known. Therefore, only sites with at least 15 years of record were used to determine the representativeness of streamflow during the 1984-88 study. Flow in Irondequoit Creek basin streams during 1984-88 is compared herein with records from sites with more than 15years of record.

All sites in the adjacent Genesee River basin part of Monroe County have more than 9 years of data, but flows on the main stem of the Genesee River and in Honeoye Creek at Honeoye Falls (fig. 1) are affected by regulation, diversion, and

Table 4. Monthly mean discharge, annual mean discharge, and departures and percent departures from normal at four streamflow-gaging sites in Monroe County, N.Y., water years 1984-88.

[All values except percentages, are in cubic feet per second. Departure refers to departure (+ or -) from the average monthly or annual discharge for the period of record noted for each station. Locations are shown in fig. 2.]

	1984			1985			1986			1987			1988			5-year period		
	Dis-charge	Departure Value	Departure Percent	Dis-charge	Departure Value	Departure Percent	Dis-charge	Departure Value	Departure Percent	Dis-charge	Departure Value	Departure Percent	Dis-charge	Departure Value	Departure Percent	Dis-charge	Departure Value	Departure Percent
A. OATKA CREEK AT GARBUTT — water years 1946-88																		
Monthly Mean																		
Oct.	41.1	-35.4	-46.3	75.7	-0.8	-1.0	40.4	-36.1	-47.2	237	+160	+209	111	+34.5	+45.1		+24.5	+32.0
Nov.	250	+114	+83.8	84.4	-51.6	-37.9	567	+431	+317	170	+34	+25.0	98.8	-37.2	-27.4	234	+98	+72.1
Dec.	453	+224	+97.8	280	+51	+22.3	344	+115	+50.2	523	+294	+128	276	+47	+20.5	375	+146	+63.8
Jan.	136	-81	-37.3	273	+56	+25.8	351	+134	+61.8	242	+25	+11.5	168	-49	-22.6	234	+17	+7.8
Feb.	462	+171	+58.8	431	+140	+48.1	424	+133	+45.7	132	-159	-54.6	235	-56	-19.2	337	+46	+15.8
Mar.	463	-108	-18.9	534	-37	-6.5	576	+5	+0.9	490	-81	-14.2	305	-266	-46.6	474	-97	-17.0
Apr.	683	+177	+35.0	411	-95	-18.8	405	-101	-20.0	622	+116	+22.9	303	-203	-40.1	485	-21	-4.2
May	581	+343	+144	113	-125	-52.5	209	-29	-12.2	139	-99	-41.6	212	-26	-10.9	251	+13	+5.5
June	265	+141	+114	87.6	-36.4	-29.4	147	+23	+18.5	76.2	-47.8	-38.5	70.2	-53.8	-43.4	129	+5	+4.0
July	87.7	+18.0	+25.8	44.5	-25.2	-36.2	85.6	+15.9	+22.8	113	+43.3	+62.1	52.0	-17.7	-25.4	76.7	+7.0	+10.0
Aug.	120	+64.8	+117	32.5	-22.7	-41.1	131	+75.8	+137	71.7	+16.5	+29.9	43.0	-12.2	-22.1	79.6	+24.4	+44.2
Sept.	129	+68.5	+113	38.1	-22.4	-37.0	60.1	-0.4	-0.7	72.5‘	+12.0	+19.8‘	39.0	-21.5	-35.5	67.7	+7.2	+11.9
Annual Mean	305	+91	+42.5	199	-15	-7.0	277	+63	+29.4	242	+28	+13.1	159	-55	-25.7	236	+22	+10.3
B. BLACK CREEK AT CHURCHVILLE — water years 1946-88																		
Monthly Mean																		
Oct.	21.3	-17.8	-45.5	24.6	-14.5	-37.1	12.4	-26.7	-68.3	149	+110	+281	65.5	+26.4	+67.5	54.6	+15.5	+39.6
Nov.	116	40	+52.6	31.2	-44.8	-58.9	270	+194	+25.5	88.5	+12.5	+16.4	82.4	+6.4	+8.4	114	+38	+50.0
Dec.	335	+206	+16.0	105	-24	-18.6	184	+55	+42.6	309	+180	+140	217	+88	+68.2	230	+101	+78.3
Jan.	65.2	-51.8	-44.3	136	-19	-16.2	237	+120	+103	124	+7	+6.0	74.9	-42.1	-36.0	127	+10	+8.5
Feb.	245	+59	+31.7	277	+91	+48.9	237	+51	+27.4	67.5	-118	-63.4	148	-38	-20.4	195	+9	+4.8
Mar.	328	-15	-4.4	308	-35	-10.2	309	-34	-9.9	214	-129	-37.6	151	-192	+56.0	262	-81	-23.6
Apr.	318	+68	+27.2	213	-37	-14.8	256	+6	+2.4	347	+97	+38.8	140	-110	-44.0	255	+5	+2.0
May	258	+140	+119	47.1	-70.9	-60.1	85.9	-32.1	-27.2	60.1	-57.9	-49.1	96.8	-21.2	-18.0	125	+7	+5.9
June	84.6	+29.3	+53.0	32.8	-22.5	-40.7	60.8	+5.5	+9.9	32.9	-22.4	-40.5	14.6	-40.7	-73.6	45.1	-10.2	-18.4
July	24.3	+0.9	+3.8	9.1	-14.3	-61.1	26.2	+2.8	+12.0	38.8	+15.4	+65.8	16.9	-6.5	-27.8	23.1	-0.3	-1.3
Aug.	34.5	+16.1	+87.5	3.1	-15.3	-83.2	34.6	+16.2	+88.0	20.9	+2.5	+13.6	9.9	-8.5	-46.2	20.6	+2.2	+12.0
Sept.	54.4	+29.6	+119	9.2	-15.6	-62.9	24.4	-0.4	-1.6	55.2	+30.4	+123	9.8	-15.0	-60.5	30.6	+5.8	+23.4
Annual Mean	157	+42	+36.5	98.5	-16.5	-14.3	144	+29	+25.2	126	+11	+9.6	85.4	-29.6	-25.7	122	+7	+6.1

Table 4. Monthly mean discharge, annual mean discharge, and departures and percent departures from normal (continued).

	1984			1985			1986			1987			1988			5-year period		
	Dis- charge	Departure Value	Departure Percent	Dis- charge	Departure Value	Departure Percent	Dis- charge	Departure Value	Departure Percent	Dis- charge	Departure Value	Departure Percent	Dis- charge	Departure Value	Departure Percent	Dis- charge	Departure Value	Departure Percent
C. IRONDEQUOIT CREEK AT LINDEN AVENUE — water years 1973-88																		
Monthly Mean																		
Oct.	43.3	-24.3	-35.9	39.3	-28.3	-41.9	33.5	-34.1	-50.4	119	+51.4	+76.0	54.5	-13.1	-19.4	57.9	-9.7	-14.3
Nov.	103	+17.4	+20.3	47.4	-38.2	-44.6	138	+52.4	+61.2	89.7	+4.1	+4.8	59.2	-26.4	-30.8	87.5	+1.9	+2.2
Dec.	165	+51	+44.7	83.7	-30.3	-26.6	88.3	-25.7	-22.5	158	+44	+38.6	86.6	-27.4	-24.0	116	+2	+1.8
Jan.	62.5	-31.0	-33.2	75.6	-17.9	-19.1	122	+28.5	+30.5	96.0	+2.5	+2.7	64.2	-29.3	-31.3	84.1	-9.4	-10.1
Feb.	170	+50	+41.7	124	+4	+3.3	136	+16	+13.3	68.4	-51.6	-43.0	99.5	-20.5	-17.1	120	0	0
Mar.	143	-19	-11.7	138	-24	-14.8	147	-15	-9.3	136	-26	-16.0	83.5	-78.5	-48.5	130	-32	-19.8
Apr.	178	+35	+24.5	98.4	-44.5	-31.2	147	+4	+2.8	221	+78	+54.5	101	-42	-29.4	149	+6	+4.2
May	197	+103	+110	58.2	-35.8	-38.1	63.3	-30.7	-32.7	71.3	-22.7	-24.1	73.2	-20.8	-22.1	91.4	-2.6	-2.8
June	62.4	-3.7	-5.6	55.0	-11.1	-16.8	92.6	+26.5	+40.1	60.4	-5.7	-8.6	33.9	-32.2	-48.7	60.9	-5.2	-7.9
July	39.3	-8.6	-18.0	29.2	-18.7	-39.0	58.2	+10.3	+21.5	56.7	+8.8	+18.4	51.5	+3.6	+7.5	47.0	-0.9	-1.9
Aug.	65.4	+12.6	+23.9	25.0	-27.8	-52.7	87.8	+35	+66.3	51.1	-1.7	-3.2	47.0	-5.8	-11.0	55.3	+2.5	+4.7
Sept.	58.5	+5.2	+9.8	31.7	-21.6	-40.5	58.9	+5.6	+10.5	53.2	-0.1	-0.2	41.1	-12.2	-22.9	48.7	-4.6	-8.6
Annual Mean	107	+15.3	+16.7	66.3	-25.4	-27.7	97.4	+5.7	+6.2	98.6	+6.9	+7.5	66.1	-25.6	-27.9	87.1	-4.6	-5.0
D. ALLEN CREEK NEAR ROCHESTER — water years 1960-88																		
Monthly Mean																		
Oct.	17.1	-9.5	-34.9	12.5	-14.7	-54.0	20.2	-7.0	-25.7	40.4	+13.2	+48.5	18.4	-8.8	-32.4	21.8	-5.4	-19.9
Nov.	46.5	+12.0	+34.8	12.0	-22.5	-65.2	67.7	+33.2	+96.2	27.5	-7.0	-20.3	23.8	-10.7	-31.0	35.5	+1.0	+2.9
Dec.	68.5	+35.6	+108	30.2	-2.7	-8.2	23.2	-9.7	-2.1	49.2	+16.3	+49.5	24.9	-8.0	-24.3	39.2	+6.3	+19.1
Jan.	18.1	-4.1	-18.5	21.1	-1.1	-5.0	40.9	+18.7	+84.2	22.2	0	0	13.5	-8.7	-39.2	23.2	+1.0	+4.5
Feb.	64.1	+28.4	+79.6	44.7	+9.0	+25.2	40.6	+4.9	+13.7	15.4	-20.3	-56.9	27.4	-8.3	-23.2	38.4	+2.7	+7.6
Mar.	62.6	+4.0	+6.9	43.8	-14.4	-24.7	45.6	-12.6	-21.6	34.8	-23.4	-40.2	24.2	-34.0	-58.4	42.1	-16.1	-27.7
Apr.	71.0	+25.4	+55.7	35.4	-10.2	-22.4	48.4	+2.8	+6.1	64.8	+19.2	+42.1	27.7	-17.9	-39.3	49.5	+3.9	+8.6
May	72.2	+38.6	+115	17.7	-15.9	-47.3	19.2	-14.4	-42.9	18.5	-15.1	-44.9	19.7	-13.9	-41.4	29.5	-4.1	-12.2
June	18.8	-10.2	-35.2	25.8	-3.2	-11.0	33.5	+4.5	+15.5	14.9	-14.1	-48.6	12.3	-16.7	-57.6	21.1	-7.9	-27.2
July	16.9	-6.3	-27.2	17.5	-5.7	-24.6	28.9	+5.7	+24.6	23.6	+0.4	+1.7	22.0	-1.2	-5.2	21.8	-1.4	-6.0
Aug.	28.5	+2.7	+10.5	15.4	-10.4	-40.3	39.6	+13.8	+53.5	18.4	-7.4	-28.7	22.2	-3.6	-14.0	24.8	-1.0	-3.9
Sept.	23.2	-1.9	-7.6	19.2	-5.9	-23.5	31.5	+6.4	+25.5	20.5	-4.6	-18.3	16.7	-8.4	-33.5	22.2	-2.9	-6.8
Annual Mean	42.2	+9.8	+30.2	24.5	-7.9	-24.4	36.5	+4.1	+12.7	29.3	-3.1	-9.6	21.1	-11.3	-34.9	30.7	-1.7	-5.2

diurnal fluctuations, and therefore were omitted. Two Genesee River basin sites—Oatka Creek at Garbutt (04230500) and Black Creek at Churchville (04231000) (fig. 1)–have records of more than 30 years of unregulated flow and are well suited for this analysis. Oatka Creek at Garbutt, with 43 years of record (1946-88), was selected as the most representative long-term streamflow site in the Genesee River basin; its record is used here to illustrate long-term trends in the Genesee River basin and for comparison with streamflow in the Irondequoit Creek basin during the 1984-88 study period (fig. 15 and table 4). Black Creek at Churchville, also with 43 years of record (1946-88), has been unregulated since May 1952. Despite differences in basin characteristics (Lumia, 1991, table 10), monthly mean flows at Churchville (fig. 15B) and monthly and annual departures from normal (table 4) during the 1984-88 study period show close agreement with those for Oatka Creek at Garbutt (fig. 15A).

The Irondequoit Creek basin contains only two sites with at least 9 years of continuous record–Irondequoit Creek at Linden Avenue, East Rochester (04232047), with 15 years of record (1974-88), and Allen Creek near Rochester (04232050), with 28 years of record (1961-88). The other three study sites in the basin were not established as continuous-record stations until 1980, during the NURP study. The drainage area above the Linden Avenue gage, on the main stem, includes mixed land use (Zarriello and others, 1985) and, thus, is considered more representative of the rest of the basin than Allen Creek. Diversions from the Erie Canal are included in the records of all sites except Irondequoit Creek near Pittsford, which is upstream from the Canal crossing. Comparison of monthly streamflow at the Linden Avenue gage for water years 1984-88 with 50th-percentile flows, 20th-percentile flows, and 80th-percentile flows for the period of record (fig. 15) reveals that most monthly mean streamflows during the study period were within the normal range.

The 5-year mean for the Linden Avenue gage during the study period was about 5 percent below normal. The 5-year monthly mean streamflows during October and March (-14 percent and -20 percent, respectively) significantly exceeded 10 percent. The 5-year means for all other months were within 5 percent of normal except January (-10 percent), June (-8 percent), and September (-9 percent). The highest annual mean discharge was in 1984 (table 4), nearly 17 percent above normal, and the lowest was in 1988, closely followed by 1985, both nearly 28 percent below normal. The annual mean discharges for 1986 and 1987 were about 6 percent and 8 percent above normal, respectively.

The period of record for Allen Creek near Rochester (28 years, 1961-88) is nearly twice as long as that for Linden Avenue and includes both the 1962-65 drought and the Hurricane Agnes floods of June 1972, which caused record high flows on many streams in New York State. The Allen Creek drainage area is mostly moderate-to high-density residential with some commercial areas (Zarriello and others, 1985) and, thus, is not representative of much of the rest of the Irondequoit Creek basin. The departure of the 5-year mean annual discharges from normal was -5 percent at both the Allen Creek and Linden Avenue sites (table 4), and the departures for the 5-year mean monthly discharges were in the same directions and within 10 percent, except for December (+17 percent), January (-15 percent), June (+19 percent), and August (- 9 percent). The pattern of monthly departure from normal at the Allen Creek gage was similar to that at the Linden Avenue site, except for March and September 1984, November and January of the 1987 water year, and July 1988; the largest absolute difference in departure from normal was 25 percent (+5 and -20) during November 1986 (1987 water year). The departure of the annual means from normal for these two sites was less than 10 percent, except in water year 1984 (14 percent), and in water year 1987, when the direction of the departures was opposite (17 percent). These differences may be due to the longer period of record for Allen Creek than for the Linden Avenue site and (or) the differences in basin characteristics.

Correlation with Records from Long-Term Streamflow-Gaging Sites

The plots of the median, 20th percentile, and 80th percentile of monthly mean discharges for the period of record at Irondequoit Creek at Linden Avenue agree well with those for the Genesee River basin sites, except for the months of August and September, when streamflow in the Irondequoit Creek basin is augmented by diversions from the Erie Canal (fig. 15). The statistical analysis of the Garbutt and Churchville records indicates that the

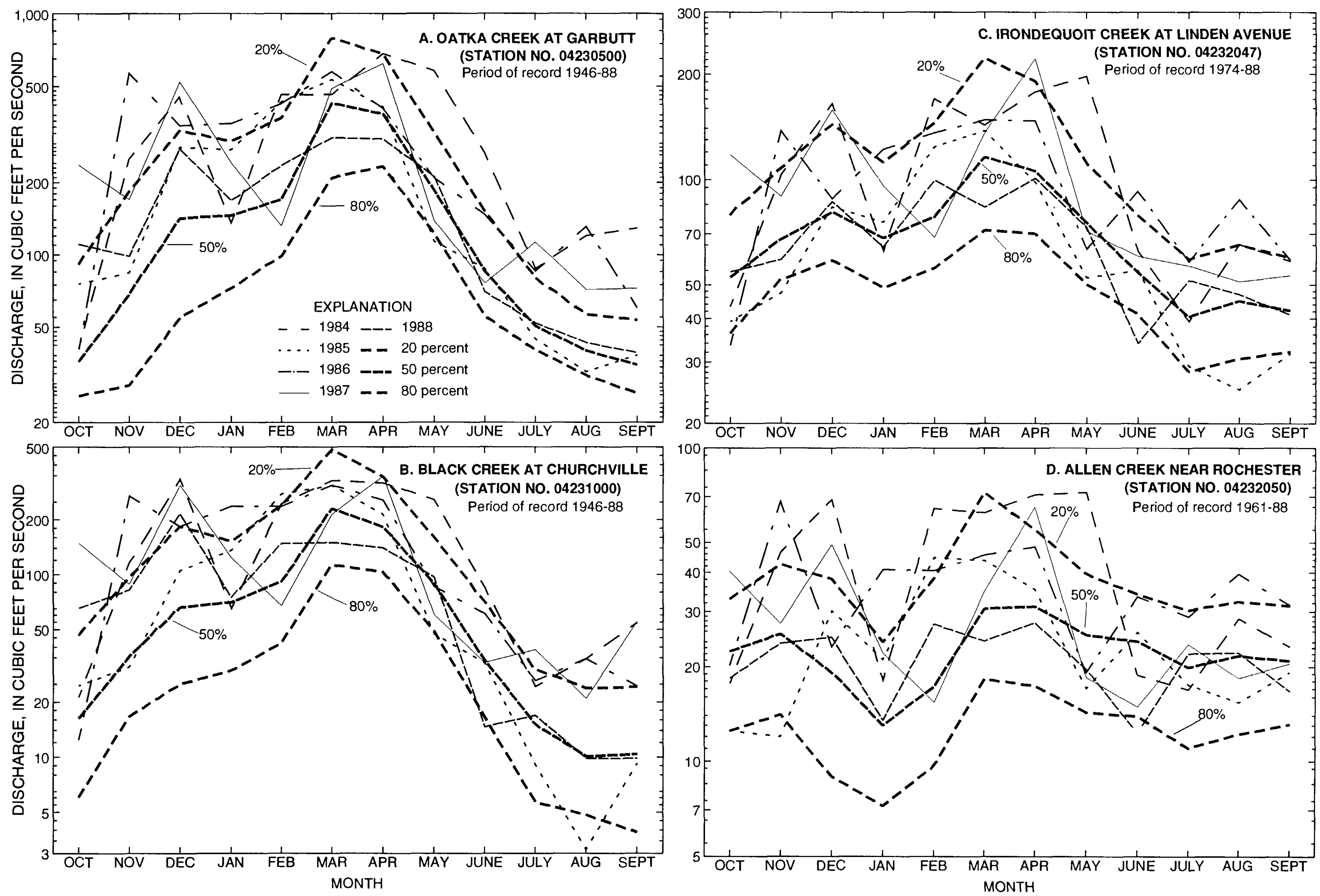


Figure 15. Monthly mean discharge at selected streamflow-gaging stations for water years 1984-88, with 20th, 50th (median), and 80th percentile discharges for period of record. (Locations are shown in fig. 1.)

1984-88 average of the annual mean flows was about 6 to 10 percent above normal (table 4), and flows for the study period are representative of long-term flow, within the accuracy limits of the water-quality statistical analysis. Chemical loads transported to Irondequoit Bay during 1984-88 are considered representative of loads for other 5-year periods if long-term trends in land use and atmospheric deposition continue and no new management practices are implemented.

The average of the mean flows for March was about 20 percent below normal, however, and those for October through December ranged from 35 to 70 percent above normal. The average of the mean flows for January through February and April through July were within 10 percent of normal, whereas those for August and September were 11 to 18 percent above normal. The lowest annual mean discharge (26 percent below normal at both sites) as well as the lowest spring discharge during the study period occurred during water year 1988; the annual mean flows for all other water years except 1985 (7 to 15 percent below normal) were 10 to 45 percent above normal.

A similar analysis made during the 1980-81 NURP study indicated that the annual mean discharge of Oatka Creek at Garbutt was about 25 percent below normal, within 1 percent of the mean annual flow for water year 1988. The 1980-81 annual mean flow for Irondequoit Creek at Linden Avenue was 8 percent lower than the annual mean for water year 1988, whereas that for Allen Creek was 12 percent higher than the annual mean. The sum of the 1980-81 annual mean flows for the two sites, which together represent 92 percent of the Irondequoit Creek at Blossom Road drainage area, is within 3 percent of the sum of the annual means for water year 1988 . Annual discharge for the 1980-81 NURP study then can be considered comparable to that for water year 1988; thus, differences between load estimates for 1988 and those estimated from the Blossom Road record for 1980-81 could reflect land-use changes that occurred in the basin during the interim.

Seasonal Fluctuations

Mean flows for the snowmelt and spring runoff period, and annual mean flows in the Irondequoit Creek basin during water years 1984-88, the NURP study(August 1980 through July 1981), and the period of record are summarized in table 5. Mean spring runoff in the Irondequoit Creek Basin for the 1984-88 study period was representative of the normal spring flows to at least the same degree as the 5-year annual means for normal annual flow. The mean spring flow for the Linden Avenue site was only 1 percent below normal, whereas that at Allen Creek was 6.5 percent below normal. The mean spring flow for Irondequoit Creek at Blossom Road, from which loads to Irondequoit Bay are estimated, was just over 3 percent below normal. This close match supports the use of 1984-88 data to represent normal constituent loading under present land-use conditions, management practices, and atmospheric-deposition rates.

Table 5. Mean annual and mean spring discharges of five streams in the Irondequoit Creek basin, water years 1980-81, 1984-88, and normal values for water years 1973-88.

[Site locations shown in fig. 2; all values are in cubic feet per second.]

Water year	Irondequoit Creek near Pittsford		Thomas Creek at Fairport		Irondequoit Creek at Linden Avenue		Allen Creek near Rochester		Irondequoit Creek at Blossom Road	
	Annual	Spring	Annual	Spring	Annual	Spring	Annual	Spring	Annual	Spring
1980-81	31.1	50.6	13.1	24.1	61.0	98.2	23.9	39.7		170
1984	55.5	84.9	23.9	41.2	107	172	42.2	68.4	161	257
1985	36.8	63.4	13.2	29.6	66.3	123	24.5	42.6	106	198
1986	50.4	72.7	19.1	26.3	97.4	135	36.5	42.1	153	210
1987	47.3	67.0	16.9	25.8	98.6	142	29.3	39.1	143	198
1988	30.3	41.5	10.4	13.4	66.1	85.7	21.1	23.8	98.2	119
1984-88	44.1	65.9	16.7	27.3	87.1	132	30.7	43.2	132	196
Long-term Normal* (1973-88)	e46.3	e66.8	e17.8	e28.2	91.7	133	34.6	46.2	e140	e203

* Estimate based on comparison with records for Irondequoit Creek at Linden Avenue and Allen Creek near Rochester.

Although the mean spring runoff in the Irondequoit Creek basin during the 1980-81 NURP study was from 14 to 26 percent below normal for water years 1973-88, spring discharges were significantly higher at all stations in 1980-81 than in 1988–less than 15 percent at the Linden Avenue site but nearly 50 percent at Allen Creek. An early spring thaw 1981 caused 45 percent of the spring runoff in the Irondequoit Creek basin to occur during the last 13 days of February, whereas spring flows in 1988 were distributed more evenly over a 3-month period. This large difference must be considered in comparisons of loads estimated for the 1980-81 NURP study with those estimated for the 1988 water year.

TRENDS IN CHEMICAL QUALITY OF ATMOSPHERIC DEPOSITION, GROUND WATER, AND STREAMFLOW

Trend analysis of water-quality data is useful in evaluating the effects of changes in land use, air quality, climate, and the stream environment; it also is useful in evaluating the effectiveness of management practices to improve water quality in a given area. The estimated annual chemical loads transported by Irondequoit Creek from nonpoint sources into Irondequoit Bay during the 1980-81 NURP study are as follows: total Kjeldahl nitrogen, more than 200 tons; total phosphorus, 20 tons; total zinc, 88 tons; and total lead, 3.5 tons (Kappel and others, 1986). The nutrient loads promote algal blooms in Irondequoit Bay and thereby can limit the use of the bay as a natural resource and accelerate eutrophication. The large estimated annual dissolved chloride load in Irondequoit Creek, in excess of 16,000 tons (Kappel and others, 1986), is largely due to the use of deicing salts (sodium chloride and calcium chloride) on area roads.

Data Preparation

Trend-analysis programs require consideration of several items: (1) calculation of the stream discharges corresponding to each water sample, (2) variability in constituent concentration as a function of stream discharge, (3) selection of constituents for trend analysis, (4) seasonal variability in concentration, and (5) treatment of data below the laboratory detection limit (censored data). Each of these factors is discussed below.

Discharge Calculations

Because all surface-water-sampling sites were at gaging stations, calculation of discharge for each water sample collected was fairly straightforward. For discrete samples (Genesee River and a few samples from Irondequoit Creek basin sites), the discharge at the time of sampling was used. For composite samples (Irondequoit Creek basin sites), a time-weighted mean discharge was calculated for the period of the composite. For samples collected on days when flow was affected by accumulated ice, the estimated daily discharge was used.

Adjustment for Variation in Discharge

Water-quality data typically are not normally distributed, but a normal distribution is important for parametric tests for trends in water-quality data over time and for fitting various flow-adjustment models used in trend analysis. Transformation of raw data by a common function can be used to produce a more normal distribution of the data set. Log transformations can be used for data with ranges of more than an order of magnitude to produce more resistant and robust results (not greatly affected by individual high values) (Hirsch and others, 1991).

Chemical concentrations are affected by the volume of flow (stream discharge) at the time the sample is collected. Concentrations of constituents in the dissolved phase generally decrease as flow increases, because of dilution, whereas those in the suspended and total phase generally increase with increased flow as particulate matter is washed into the stream by overland runoff. The removal of flow volume as a source of variance from the data makes trend-testing techniques more powerful (greater probability of detecting a trend if one exists) and prevents identification of trends that are only an artifact of trends in the associated discharges (Schertz, 1989).

Variability resulting from differences in flow can be minimized through regression of concentration as a function of flow. All available concentration- and flow-data pairs are used in the regression. The flow-adjusted concentrations (residuals) are then tested for trends.

The USGS has developed statistical and graphical techniques that perform well with the inherent characteristics of water-quality data, and procedures that use these techniques have been incorporated into a software system called EStimate TREND (ESTREND). The statistical methods used in ESTREND overcome common problems inherent in conventional statistical trend techniques in the analysis of water-quality data, such as data that are non-normal or seasonally variable, and censored data (values less than the laboratory detection limit) with less-than values and outliers, all of which adversely affect the performance of conventional statistical techniques. ESTREND uses both parametric and nonparametric tests. A detailed explanation of the ESTREND program is given in Schertz and others (1991).

Selection of Constituents for Trend Analysis

Selection of water-quality constituents for trend testing depends on the criteria to be met. The constituents that met all statistical criteria for this trend analysis were total suspended solids, dissolved chloride, dissolved sulfate, nutrients (nitrogen and phosphorus), and suspended volatile solids. The criteria were (1) at least 5 years of record (Hirsch and others, 1982), (2) random collection of data with respect to hydrologic conditions—that is, samples should be collected without regard for flow or season, and (3) at least 10 observations in the record. These criteria eliminated turbidity, for which only 3 years of record were avaliable for the Irondequoit Creek basin. The remaining constituents were assessed for their effect on Irondequoit Creek and Irondequoit Bay and for consistency with values obtained during the NURP study.

Seasonal Variability of Concentrations

Water-quality data typically show seasonal variability, as seen in monthly and seasonal box plots for nitrite plus nitrate, at two sites, (fig. 16 A, B). Use of the word "season" in trend analysis does not necessarily refer to climatic seasons–it can also reflect sampling frequency. Water-quality data that are collected at a constant sampling frequency during a study constitute a uniform number of values that can be easily compared in a trend test. Generally, the number of seasons used is set to the number of samples that were regularly collected annually during the period (table 6). The selection of seasons becomes more complex, however, when sampling frequencies are inconsistent, as with the Irondequoit Creek basin sites during the 1984-88 study.

Selection of seasons for the Irondequoit Creek basin stations was complicated by the lack of data from October through January of the 1985 water year, except at the downstream (Blossom Road) site. As a result, six seasons were defined for most constituents at the four upstream sites, and four seasons were used for constituents whose concentrations were not determined for all samples. The Blossom Road data had 12 one-month seasons for all constituents except dissolved sulfate, for which the same 6-season definition was used as at the other four sites. Genesee River data had 3 seasons for all constituents because the NASQAN sampling scheme requires only four samples per year, two of which are collected in one season. The dates of each season used in the trend analysis are listed in table 7.

Table 6. Number of seasons used for trend analysis of selected chemical constituents for each site in the Irondequoit Creek basin and the Genesee River, Monroe County, N.Y., 1984-88

[Locations are shown in fig 1.]

Site	Total suspended solids	Volatile suspended Solids	Nitrogen ammonia	Tota Kjeldahl nitrogen	Nitrite plus nitrate	Total phos-phorus	Ortho-phos-phorus	Dissolved chloride	Dis-solved sulfate
Irondequoit Creek Basin									
Pittsford	4	4	6	6	6	6	6	6	6
Thomas Creek	4	4	6	6	6	6	6	6	6
Linden Avenue	4	4	6	6	6	6	6	6	6
Allen Creek	6	6	6	6	6	6	6	6	6
Blossom Road	12	12	12	12	12	12	12	12	6
Genesee River	3	3	3	3	3	3	3	3	3

Table 7.-- Duration of seasons used in trend analysis of water-quality data, Monroe County, N. Y., water years 1984-88

Season number	Dates	Number of days
12 seasons		
1	January 1 - 31	31
2	February 1 - 29	29
3	March 1 - 31	31
4	April 1 - 30	30
5	May 1 - 31	31
6	June 1 - 30	30
7	July 1 - 31	31
8	August 1 - 31	31
9	September 1 - 30	30
10	October 1 - 31	31
11	November 1 - 30	30
12	December 1 - 31	31
6 seasons		
1	March 1 - April 15	46
2	April 16 - May 30	45
3	June 1 - July 15	45
4	July 16 - August 31	46
5	September 1 - December 14	105
6	December 15 - February 29	77
4 seasons		
1	March 1 - May 31	92
2	June 1 - September 30	122
3	October 1 - November 30	61
4	December 1 - February 29	91
3 seasons		
1	March 1 - May 31	92
2	June 1 - September 30	122
3	October 1 - February 29	152

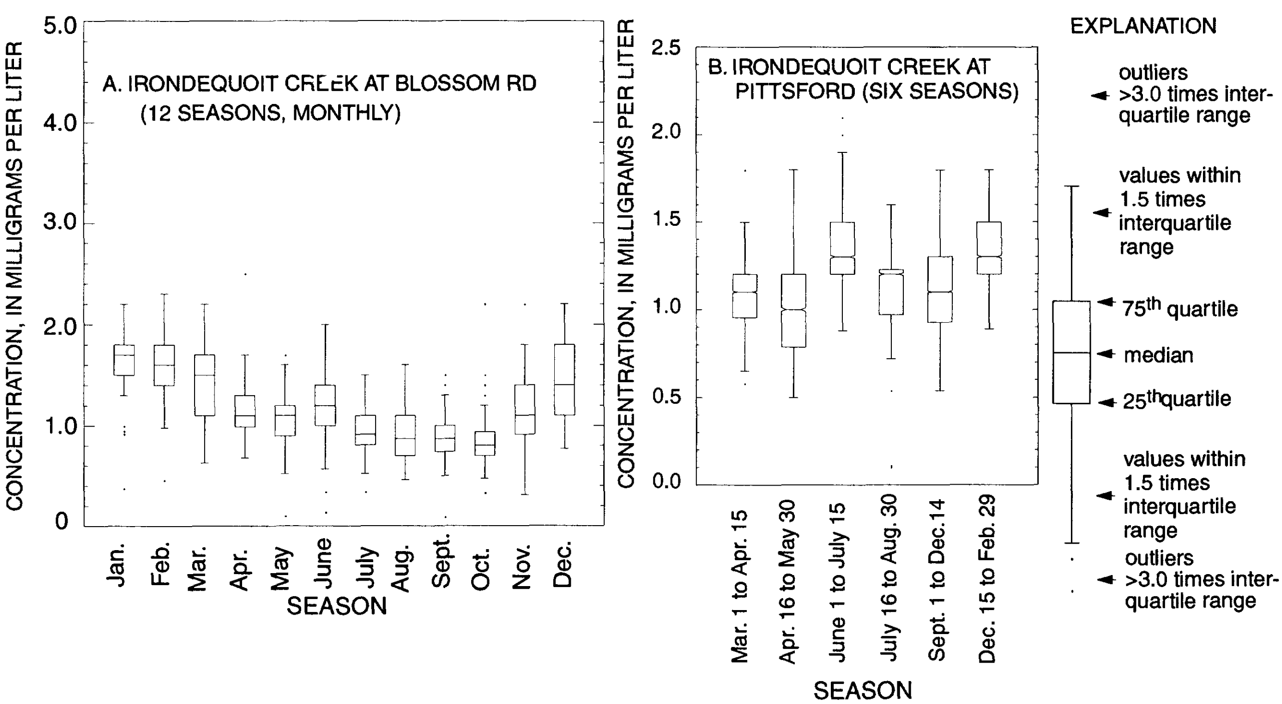


Figure 16. Seasonal distribution of nitrite plus nitrate concentration in (A) Irondequoit Creek at Blossom Road (monthly basis), and (B) Irondequoit Creek at Pittsford (six seasons), water years 1984-88.

Estimation Of Constituent Loads

Data that provided the basis for estimation of constituent loads from the Genesee River into Lake Ontario and from Irondequoit Creek to Irondequoit Bay are given in the companion report (Johnston and Sherwood, 1994). Constituent loads were estimated through a Minimum Varience Unbiased Estimator (MVUE), based on a log linear model (Cohn and others, 1992). A log linear equation was used to calculate constituent concentrations and can be written in the following form:

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

Where:

C is constituent concentration

Q is the discharge;

T is time, in years;

ε is the error (assumed to be independent and normally distributed with a mean and varience of zero);

βs are parameters of the model that must be estimated from the data; and

$\tilde{Q}$ and $\tilde{T}$ are centering variables that simplify the numerical work and have no effect on the load estimates.

The trigonometric functions, sin (sine), and cos (cosine) are associated with cyclical patterns in the data and are used to remove the effects of seasonality. If more cycles are needed, arguments larger than 2π may be used.

The corresponding load L is given by

$$L = KQ\exp(\beta_0 + \beta_1 \ln[Q/\tilde{Q}] + \beta_2\{\ln[Q/\tilde{Q}]\}^2 + \beta_3[T/\tilde{T}] + \beta_4[T/\tilde{T}]^2 + \beta_5 \sin[2\pi T] + \beta_6 \cos[2\pi T] + \varepsilon) \quad (3)$$

Where

K is a conversion factor,

Q is the discharge, and

all other variables are as defined for eq. 1.

Equation 2 defines a load estimator for a given monthly or annual loads.

The precision of the estimated loads can be described in terms of a confidence interval based on the estimated mean and the standard error of prediction (S.E. PRE) calculated by the equation. At the 95-percent confidence interval ($\alpha = 0.05$), the confidence limits are the estimated load $\pm$ 1.96 $\times$ S.E. PRE. The value 1.96 is from a statistical table for a Student's t-distribution at the $\alpha/2$ quantile with a large number of samples (more than 250). If, for example, a monthly load for chloride was 145 tons, and S.E. PRE. was 12 tons, the approximate 95-percent confidence limits would be:

$$145 \pm (1.96 \times 12) = 121.5 \text{ to } 168.5 \text{ tons.}$$

The wider the confidence limits, the more variation and, hence, the less reliable are the load estimates. A more detailed explanation of the MVUE method is given in Cohn and others (1992).

Other Considerations

Three factors to take into account in trend analyses are the variability of chemical concentrations, the effects of atmospheric deposition on stream-water quality, and the effects of ground-water seepage on streamflow and its chemical quality. Each of these factors is exasmined in the following paragraphs.

Areal Variability of Chemical Quality

Statistically significant differences in constituent concentration among the five Irondequoit Creek subbasins were detected through nonparametric statistical tests. An $\alpha = 0.05$ (95-percent confidence level) was used for all tests to denote the maximum probability of falsely detecting significant differences. Boxplots, which include the median and the interquartile range, were used to examine the distribution of the sample population of each constituent from the five subbasins (fig. 17). Because water-quality data do not usually have a normal distribution, the median and interquartile range provide a better measure of the sample population than do the mean and the standard deviation. Tukey's HSD test (honest significant difference) test was used on ranks of the concentration data to reveal differences in median concentration among subbasins.

The major cause of chemical variability among streams, or reaches of streams in the Irondequoit Creek basin, is land use. For example, the median concentration of dissolved chloride at Irondequoit Creek near Pittsford, which is primarily agricultural, was far less (52 mg/L) than that at Allen

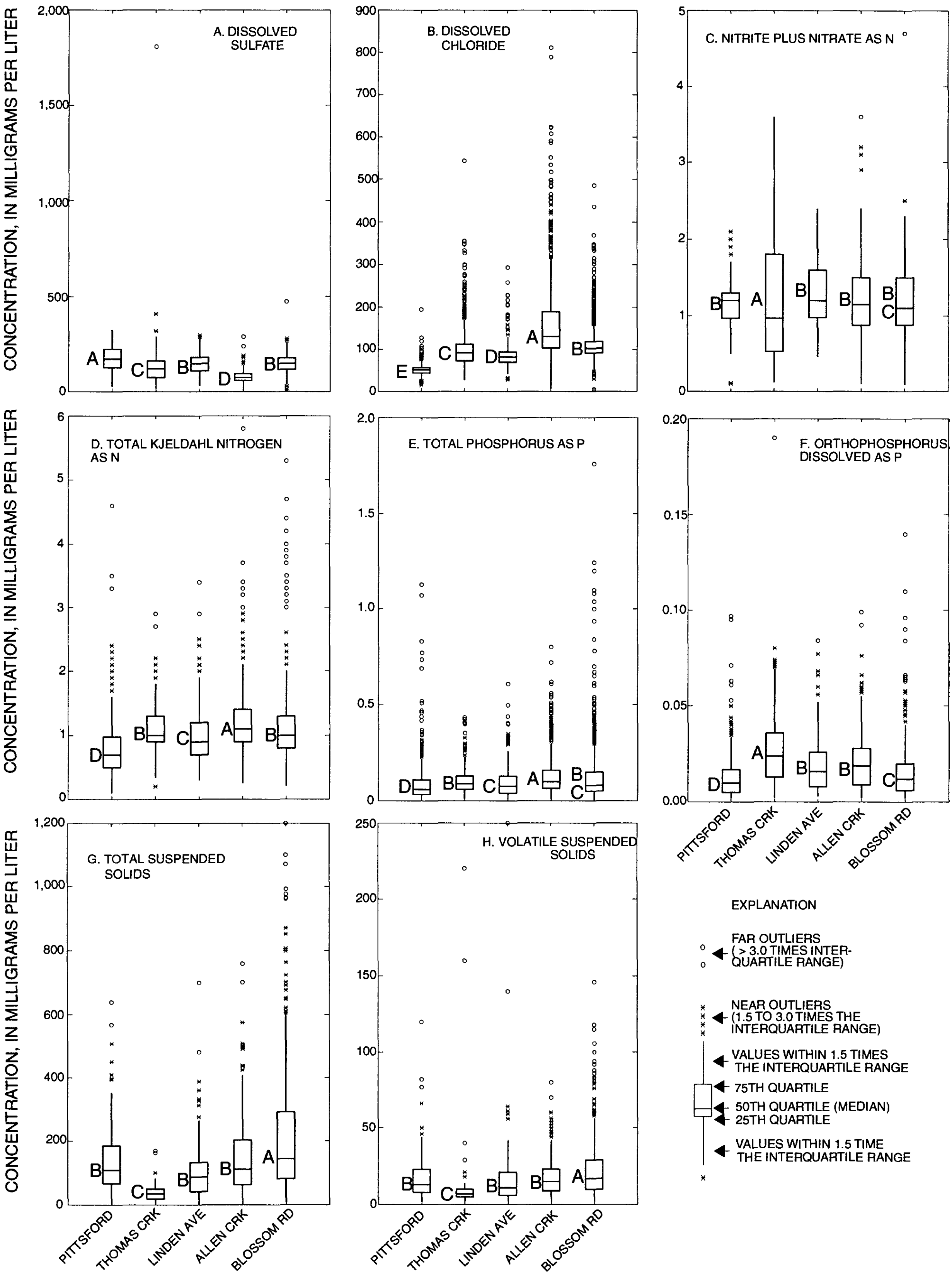


Figure 17. Concentration ranges of selected chemical constituents at the five Irondequoit Creek basin sites, Monroe County, N.Y. (Letters next to boxes indicate statistically significant differences [at 95-percent confidence level] among sites. A is significantly different from B; B is significantly different from C, etc.)

Creek (131 mg/L), which is more residential with commercial and light industrial development.

The 5-year (1984-88) median concentrations of some constituents varied more widely among sites than others (table 13, p. 43). For example, median concentrations of total phosphorus and total Kjeldahl nitrogen were significantly higher statistically at Allen Creek, than at any of the other four sites in the Irondequoit Creek basin, whereas median concentrations of orthophosphorus at Allen Creek was higher than at only three of the other four sites and about the same as at Irondequoit Creek at Linden Avenue (table 8). The median concentration of nitrite plus nitrate at Allen Creek was lower than at all other sites except Thomas Creek. Of the nutrients, total Kjeldahl nitrogen, total phosphorus, and ammonia nitrogen showed the largest number of significant variations among sites. With few exceptions, the median concentrations of each of these three nutrients differed significantly among all five Irondequoit Creek basin sites.

The 5-year median concentrations of dissolved chloride were significantly higher at Allen Creek (131 mg/L) than at the other four sites; the differences are probably directly related to the rate of road-salt application and, to a lesser extent, the rate of sewage and industrial-waste discharge. Median concentrations of dissolved sulfate (75 mg/L) at Allen Creek were lower than at the other four sites, and the highest was at Irondequoit Creek near Pittsford. Sulfate is associated with the dissolution of common soluble minerals that are abundant in both the bedrock and glacial deposits of the region (Young, 1993), as well as in atmospheric deposition, as explained in the following section.)

The 5-year median concentrations of total suspended solids, suspended volatile solids, and turbidity differed considerably among sites in the Irondequoit Creek basin (table 8). Median concentrations of total suspended solids were significantly higher statistically (144 mg/L) at Blossom Road than at the other four sites and were significantly lower (35 mg/L) at Thomas Creek at Fairport than at the other four sites. Volatile solids followed the same pattern–the median at the Blossom Road site (17 mg/L) was significantly higher than at all other sites, and the median at Thomas Creek (7 mg/L) was significantly lower. Turbidity was lowest at Thomas Creek (8.2 nephelometric turbidity units [NTU]) but highest at Allen Creek (22 NTU).

Effects of Atmospheric Deposition

The 1980-81 NURP study concluded that atmospheric deposition contributed 65 percent of the total phosphorus load calculated for Irondequoit Creek, but only 8 percent of the dissolved

Table 8. Median concentrations of selected constituents at five Irondequoit Creek basin sites, Monroe County, N.Y. water years 1984-88.

[Units are milligrams per liter unless otherwise noted. NTU; nephelometric turbidity units. Locations are shown in fig. 1]

Site	Turbidity (NTU)	Total suspended solids	Volatile suspended solids	Ammonia nitrogen as N	Total Kjeldahl nitrogen as N	Nitrite plus nitrate as N	Total phosphorus as P	Orthophosphorusa s P	Chloride, dissolved	Sulfate, dissolved
Pittsford	12	109	13	0.02	0.7	1.2	0.06	0.01	51.9	172
Thomas Creek	8.2	35	7	.03	1.0	1.0	.09	.024	92.2	122
Linden Avenue	17	87	11	.05	.9	1.2	.078	.016	82.4	149
Allen Creek	22	111	15	.03	1.1	1.15	.10	.019	131	75
Blossom Road	18	144	17	.03	1.0	1.1	.08	.012	103	150

chloride load. The total Kjeldahl nitrogen load from atmospheric deposition was 135 percent of the calculated total load for the creek, indicating a net retention in the watershed, and the total lead contribution from atmospheric deposition was 647 percent of the calculated load for the creek (Kappel and others, 1986). The effect of atmospheric deposition on chemical quality of Irondequoit Creek was analyzed through chemical comparison of deposition samples from the bulk collector at Mendon Ponds with surface-water samples from Irondequoit Creek near Pittsford (fig. 18). The Pittsford site was used for this comparison because it is the gaging station closest to the Mendon Ponds site, and its drainage area includes much of Mendon Ponds Park. Median concentrations of all constituents were significantly lower in atmospheric deposition at Pittsford than in streamflow .

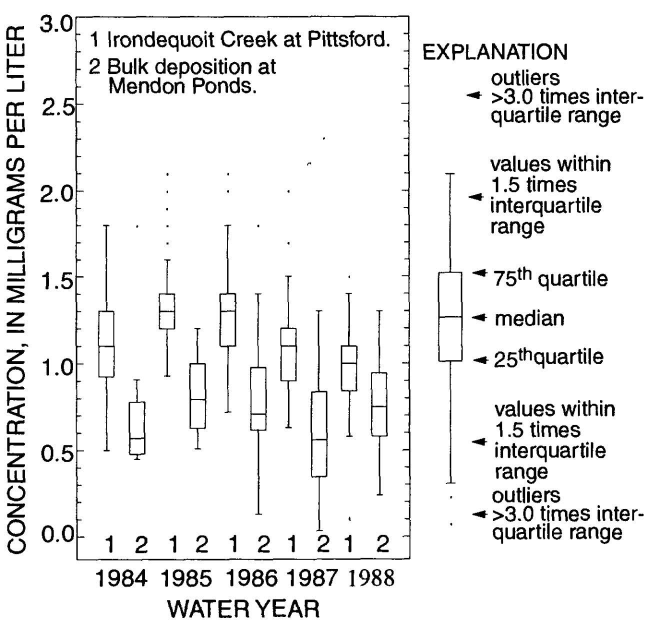


Figure 18. Concentration ranges and medians of nitrite plus nitrate in Irondequoit Creek near Pittsford and in bulk atmospheric deposition at Mendon Ponds, Monroe County, N.Y

Contribution from Ground Water

Ground water forms the base-flow component of streamflow and, thus, affects its chemical quality. Median concentrations of constituents in water samples from Ellison Park wells during 1986-88 were similar to those found by Kappel and Young (1989) in calendar years 1985-86. Median concentrations in ground water from the Powder Mill Park wells were in the same range as those in the Ellison Park wells.

The complexity of the regional ground-water flow pattern at Ellison Park makes the effects of ground water chemistry on streamflow chemistry difficult to judge–in addition to the downvalley component of flow, a cross-valley component flows toward the creek, except during high creek stages, when the gradient can temporarily reverse, allowing some of the streamflow to infiltrate the streambanks as temporary storage or to the water table as recharge (Kappel and Young, 1989). As the creek recedes, the gradient again is toward the stream.

Ground water flowing from the eastern side of the Irondequoit valley has a greater effect on stream chemistry than ground water from the west side because gradients toward the stream on the east side are steeper (fig. 7), particularly during base-flow periods. Median concentrations of NH_4, orthophosphorus, dissolved chloride, and dissolved sulfate in Irondequoit Creek were between those noted in samples from the wells closest to the creek on either side (Mo 3 and Mo 4, fig. 7). Median concentrations of total suspended solids, total Kjeldahl nitrogen, nitrite plus nitrate, and total P in the creek exceeded those at the closest wells, and the median concentrations of volatile suspended solids in Irondequoit Creek exceeded those in any wells on either side. Total suspended solids and nitrite plus nitrate concentrations were greatest near the east valley wall (well Mo 1 or Mo 2), and total P was the same in well Mo 1 as in the stream (table 9). The largest maximum and widest range in concentration for all constituents were found in water samples from Irondequoit Creek rather than in ground water, and the smallest minimum concentration for more than half of the constituents was also in water samples from the creek.

Table 9.--Median, maximum, and minimum concentrations of chemical constituents in ground water at Ellison Park and in Irondequoit Creek at Blossom Road, Monroe County, N.Y.

[Units are in milligrams per liter unless otherwise noted. -- indicates no data. Locations are shown in fig. 2].

Well depth and constituent		Ellison Park wells (1986-88)						Irondequoit Creek
		East			West			
		Mo 1	Mo 2	Mo 3	Mo 4	Mo 5	Mo 6	1984-88
Well Depth (in feet)		26.5	45.0	16.0	16.0	43.0	16.0	--
Solids, total suspended	med	52.5	209	48	42	122	26	144
	max	190	248	65	108	215	44	1200
	min	44	80	9	23	64	9	8
Solids, volatile suspended	med	7	12.5	4	7	15.5	4	17
	max	16	85	7	12	17	24	146
	min	6	6	3	4	8	1	2
Nitrogen ammonia, as N	med	.04	.04	.01	.44	.02	.12	.03
	max	.10	.10	.02	.54	.04	.14	1.1
	min	.02	.02	.01	.35	.01	.07	.005
Total Kjeldahl nitrogen, as N	med	.50	.50	.30	.80	.30	.40	1.0
	max	1.5	.90	.80	1.2	.70	.70	5.3
	min	.30	.10	.10	.60	.10	.30	.21
Nitrite plus nitrate, as N	med	2.2	.01	.55	.01	.01	.01	1.1
	max	2.9	.30	.74	.03	.11	.34	4.7
	min	1.9	.01	.15	.01	.01	.01	.09
Phosphorus, total, as P	med	.080	.065	.032	.075	.055	.060	.080
	max	.165	.190	.235	.155	.245	.575	1.76
	min	.050	.020	.020	.050	.020	.050	.005
Phosphorus, ortho, as P	med	.006	.005	.005	.014	.003	.045	.012
	max	.010	.008	.006	.052	.005	.047	.140
	min	.005	.002	.003	.005	.002	.005	.002
Chloride, dissolved	med	336	170	257	86	97	91	103
	max	340	192	267	108	102	97	486
	min	330	155	251	64	81	84	5
Sulfate, dissolved	med	92	78	94	42	95	65	88
	max	111	100	102	54	120	81	475
	min	77	74	78	18	83	47	10

Trend Analysis

Identification of water-quality trends in Monroe County, especially in the Irondequoit Creek basin, is important to county planners. Rapid development in much of the Irondequoit Creek basin accounted for an 11-percent increase in residential land during 1985-89 and an average 14 percent decrease in agricultural land in the towns of Mendon, Perinton, and Pittsford (Monroe County Department of Planning, written commun., 1992). The combined effects of changing land use and measures to manage water quality in the Irondequoit Creek basin can best be evaluated through an analysis of water-quality trends.

Methods

A trend, as used in this report, is defined as a monotonic (overall) change in the concentration of a chemical constituent in water samples from a specific sampling site over time. Trends, regardless of magnitude, were considered statistically significant for $p \leq 0.10$ (where p is the probability that an apparent trend resulted from chance arrangement of the data rather than an actual change in trend). The methods used for trend analysis depend on the type of data to be analyzed (censored or uncensored) and the continuity of the data. The term "censored data" refers to values reported as less than the laboratory detection limit. Tests commonly used for this purpose are the Seasonal Kendall test (Hirsch and others, 1982) for uncensored data and the Seasonal Kendall test and TOBIT test for censored data. The ESTREND program used in this study includes all of these tests as options and requires a minimum of 5 years of data for trend estimation.

A constant linear relation between concentrations and time cannot be assumed. As an example, a scatter plot of unadjusted concentrations with time by Locally Weighted Scatterplot Smooth (LOWESS) shows a pattern in the data for the 1984-88 study period (fig. 19). The estimated trend line superimposed on this plot illustrates that a trend slope can represent the general relation of the data values at the beginning of the period to those at the end of the period but does not represent all of the variations in the interim.

The Seasonal Kendall test was applied to a time series of actual concentrations and a time series of flow-adjusted concentrations for total suspended solids, total Kjeldahl nitrogen, nitrite plus nitrate, total phosphorus, dissolved chloride, and dissolved sulfate. The results fall into three categories: (1) flow-independent results, with no correlation ($\alpha > 0.10$) between concentration and flow (analysis based on raw concentration values); (2) flow correlation ($\alpha \leq 0.10$) is present, and the flow equation provides a good fit (analysis based on flow-adjusted concentration values); and (3) flow correlation is present, but no significant flow-adjustment could be fit to the data (analysis based on raw concentration values).

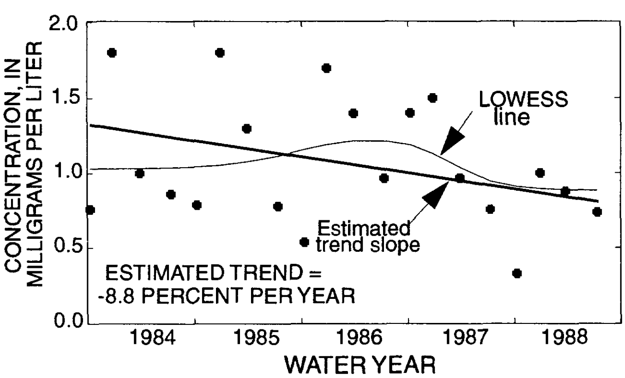


Figure 19. Locally weighted scatterplot smooth (LOWESS) line drawn through seasonally selected nitrite plus nitrate concentrations in Irondequoit Creek at Blossom Road, 1984-88, and the corresponding estimated trend slope.

Censored Data

The Seasonal Kendall test for uncensored data (values at or below the detection limit) is not applicable to constituents for which more than about 5 percent of the concentrations are at or below the detection limit, nor, generally, where the data set contains multiple detection limits (Hirsch and others, 1991). Constituents that are highly censored at one or more reporting limits can be tested for monotonic trend through either (1) the Seasonal Kendall test for censored data, which evaluates the trend in concentrations above the reporting limit but does not account for variability caused by flow, or (2) a regression technique called TOBIT (Cohen, 1976; Cohn, 1988), which uses a maximum-likelihood estimation (MLE) procedure (Cohn, 1988) to estimate the parameters of a regression equation relating concentration to time. The version of TOBIT used in this study does not allow for flow or season-related variability in the data. The Seasonal Kendall test for censored data was used for ammonia nitrogen and orthophosphorus, and the TOBIT test was used for volatile suspended solids. Constituents analyzed for trends in this study are shown in table 10 along with the largest reporting limit used for each constituent during the study period and the percentage of censored data for each constituent at each of the five gaging stations.

Constituent Loads

A primary consideration of water-quality managers is the long residence time of some chemical constituents in the water bodies to which they are transported. Generally, the most efficient and cost-effective way to minimize constituent loads is to control the source. Knowledge of trends in the loads carried by streams and their tributaries enables watershed managers to (1) assess the effectiveness of management practices already in use, (2) project the consequences of failure to implement additional management practices, and (3) evaluate the effect of land-use changes within the watershed on receiving water bodies.

Some of the parameter values from the equation used to calculate concentrations (eq. 1) can be directly related to basin characteristics or to physical processes. For example, the value of β_1, which corresponds to the linear dependence of concentration on flow, may depend on the source of the constituent—negative values indicate a dilution

Table 10. Number of analyses for selected chemical constituents at each Irondequoit Creek site, and percentage of observations below the reporting limit.

[Numbers in parentheses are maximum reporting limits. mg/L, milligrams per liter; total obs, number of observations; % cens, percentage of results below reporting limit. Site locations are shown in fig. 2].

Site	Total suspended solids (12.0 mg/L)		Nitrogen ammonia (0.01 mg/L)		Total Kjeldahl nitrogen (0.25 mg/L)		Nitrite plus nitrate (0.01 mg/L)		Total phosphorus, (0.01 mg/L)		Orthophosphorus (0.01 mg/L)		Dissolved chloride (5.0 mg/L)		Dissolved sulfate (10.0 mg/L)	
	total obs	% cens	total obs	% cens	total obs	% cens	total obs	% cens	total obs	% cens	total obs	% cens	total obs	% ens	total obs	% cens
Pittsford	163	0	431	22.8	424	0.7	442	0	513	2.9	513	20.8	515	0	439	0
Thomas Creek	49	2.4	490	14.8	471	0	501	0	558	0	562	3.3	558	0	475	0
Linden Avenue	75	0	278	8.9	278	0	282	0	279	.4	282	5.9	282	0	281	0
Allen Creek	198	.9	513	18.1	519	.3	527	0	600	0	606	8.2	606	0	526	.3
Blossom Road	349	0	983	20.1	976	0	1013	0	1055	.5	1066	13.2	1069	.2	989	.2

effect, suggesting point sources; near-zero values imply no effect from dilution, as is characteristic of some dissolved constituents; and positive values are generally indicative of sediment-related nonpoint sources. The value of β_3 corresponds to the magnitude of the log-linear component of upward or downward time trends in constituent load. The dependence of concentration on flow (β_1) and the direction and magnitude of trends in loads (β_3) are summarized in table 11.

Irondequoit Creek Basin

The statistical procedures discussed in the preceding "Methods" section were used to evaluate constituent concentrations through time to detect significant trends in chemical quality of streamflow. These trends reflect the net change that has occurred in the quality of water upstream from the sampling point during the time period represented by the data set.

Atmospheric deposition was shown in the 1980-81 NURP study to make a significant contribution to the chemical loads from the Irondequoit Creek basin to Irondequoit Bay (Kappel and others, 1986); ground water, too, could affect the quality of Irondequoit Creek, especially during base-flow periods, when most or all of the flow consists of ground water. Augmentation of flow to Irondequoit Creek and its tributaries from the Erie Canal during low-flow periods also could affect the creek's water quality. Analyses of water samples collected upstream and downstream from flow-augmentation points by the Monroe County Environmental Health Laboratory were evaluated in this study to determine the effect of canal water on Irondequoit Creek; results of the analyses are included as Appendix C.

Atmospheric Deposition

Trend analysis of selected constituents of bulk atmospheric-deposition samples collected at Mendon Ponds Park (table 12) was done through the same techniques as were used for surface water, but only weak trends were detected for the 1984-88 study period; the only constituents for which statistically significant trends were indicated were sulfate and lead. Lead concentrations increased at an average rate of 14 percent per year, and sulfate concentrations increased at an average rate 9 percent per year.

Common ions other than sulfate and chloride showed only minor decreases during the study period, none of which were statistically significant. Chloride showed a slightly increasing trend that was not statistically significant. The only nutrients with enough data for trend analysis were nitrite plus nitrate, ammonia nitrogen, and orthophosphorus, all of which showed virtually no trend during the study period. Statistically significant increasing seasonal trends were noted for nitrite plus nitrate during November, and for ammonia nitrogen during April, however.

Table 11. Equation parameter estimates showing linear dependence of concentration on flow (β_1) and magnitude (β_3), in percent per year, of estimated trends in loads for selected constituents in the Irondequoit Creek basin and Genesee River, Monroe County, N.Y., 1984-88.

[*, Significantly different from zero at the 5-percent confidence level; dashes indicate no data; - for parameter β_1 indicates dilution effect; +/- for parameter β_3 indicates upward or downward trend]

		Constituent								
Site	Equation parameter[1]	Total suspended solids	Volatile suspended solids	Ammonia nitrogen as N	Total Kjeldahl nitrogen as N	Nitrite plus nitrate as N	Total phosphorus as P	Orthophosphorus as P	Dissolved chloride	Dissolved sulfate
Genesee River at Charlotte Docks	b_1	--	--	-1.087*	-0.342	--	0.136	0.193	-0.433*	-0.321*
	b_3	--	--	-8*	-2	--	-6*	-8	3*	0
	R^2 Conc	--	--	61.1	36.1	--	34.1	47.9	65.2	64.0
	R^2 Load	--	--	24.0	67.3	--	71.1	72.4	68.0	88.3
Irondequoit Creek at Pittsford	β_1	0.451	0.316	-.022	.395	-0.141	.654	.612	-.223	-.384
	β_3	+30*	+29*	-15*	+7*	-6*	+29*	+5*	+2*	+1
	R^2 Conc	28.2	18.8	11.6	31.8	34.4	32.1	40.7	50.3	65.7
	R^2 Load	73.9	70.1	49.3	82.6	90.3	74.2	81.0	94.1	75.8
Thomas Creek at Fairport	β_1	.240	-.121	.005	.028	.084	.217	.401	-.280	-.339
	β_3	+11*	+2*	-12*	-2*	-15*	+14*	+10*	0	-2*
	R^2 Conc	14.0	7.3	14.5	18.6	76.8	24.2	46.3	60.8	67.6
	R^2 Load	74.7	49.0	64.1	92.5	94.2	84.5	87.5	94.3	78.2
Irondequoit Creek at Linden Ave.	β_1	1.033	.727	.053	.317	-.057	.679	.616	-.314	-.505
	β_3	+24*	+15	-6*	0	-4*	+20*	+6*	+2*	+1*
	R^2 Conc	51.6	21.9	21.8	35.0	57.4	43.4	56.8	64.3	82.8
	R^2 Load	81.7	56.9	58.5	91.0	94.3	78.3	81.6	92.5	81.7
Allen Creek near Rochester	β_1	.384	.235	.088	.168	.011	.380	.384	-.208	-.275
	β_3	+27*	+32*	-15*	-5*	-7*	+13*	-5*	+3*	-7*
	R^2 Conc	20.8	23.7	9.2	21.4	55.6	29.2	48.9	64.9	46.0
	R^2 Load	74.8	77.2	50.7	89.2	92.2	81.6	85.9	92.2	84.0
Irondequoit Creek at Blossom road	β_1	.730	.497	.052	.322	.039	.683	.519	-.242	-.398
	β_3	+9*	+18*	-21*	+3*	-9*	+21*	-10*	0	-1*
	R^2 Conc	35.5	23.9	12.8	30.3	54.4	42.2	45.3	53.3	63.1
	R^2 Load	78.0	74.2	44.1	86.9	92.0	79.3	77.7	91.9	77.5

[1] β_1 coefficient indicating dependence of concentration on streamflow.

β_3 magnitude and direction of trend in load in percent per year.

R^2 concentration variability explained by the model for logarithm of concentration.

R^2 load variability explained by the model for logarithm of load.

Table 12. Statistical summary and trends of selected constituents of bulk atmospheric deposition at Mendon Ponds, Monroe County, N.Y, 1984-88.

[e, estimated for censored constituents with a log probability regression procedure; --, insuffucient data to calculate value, Units are milligrams per liter unless otherwise noted; µs/cm, microsiemens per centimeter; µg/L, micrograms per liter.]

Water-quality property or constituent	Descriptive statistics: Sample size	Mean	25th percentile	50th percentile (median)	75th percentile	Best-trend results: N	Units per year	Percent per year	P	Trend code
Rainfall (inches)	61	2.71	1.49	2.39	3.60	52	0.00	-0.01	0.620	F
Calcium, dissolved	58	0.85	0.5	0.8	1.0	50	-0.01	-1.08	0.657	
Magnesium, dissolved	57	0.18	0.1	0.1	0.2	48	-0.01	-6.69	0.642	F
Sodium, dissolved	58	e 0.27	--	0.1	0.4	58	-0.02	-8.68	0.324	
Potassium, dissolved	58	e 0.26	--	0.1	0.2	58	-0.01	-3.97	0.669	
Sulfate, dissolved	60	e 5.21	e 2.6	4.0	6.0	60	0.47	9.12	0.084	
Chloride, dissolved	61	e 4.65	0.4	0.8	1.2	61	0.27	5.77	0.560	
Nitrite plus nitrate, dissolved as N	60	0.75	0.52	0.70	0.91	52	-0.0 1	-1.88	0.803	**
Ammonia nitrogen, as N	59	0.57	0.23	0.37	0.70	51	-0.02	-3.52	0.177	
Total Kjeldahl nitrogen, as N	13	1.84	0.8	1.2	1.5	8	--	--	--	
Phosphorus, total as P	36	0.11	0.02	0.05	0.13	30	--	--	--	
Phosphorus, ortho as P	60	e 0.06	--	0.01	0.04	60	0.00	0.00	1.000	
Specific conductance (µs/cm)	55	45.55	30	40	50	47	1.75	3.84	0.785	
pH, standard units	54	4.44	4.1	4.3	4.5	0	--	--	--	
Acidity, total	50	7.29	4.6	6.2	8.8	0	--	--	--	
Lead, total (µg/L)	56	e 6.05	e 2.7	4.7	8.0	56	0.82	13.63	0.026	

[1]TREND CODES: blank, best trend is trend in unadjusted concentrations; F, best trend is trend in flow-adjusted concentrations; **, best trend is in unadjusted concentrations because the flow-adjustment was unsuccessful.

The atmospheric contribution (loads) of selected chemical constituents to the Irondequoit Creek basin, based on data from the Mendon Ponds site, are given in table 13. The most abundant constituents derived from atmospheric deposition during the 1984-88 study were dissolved sulfate and dissolved chloride, with yields of 13.7 ton/mi^2 and 2.9 ton/mi^2, respectively; the least abundant was dissolved lead, with a yield of 0.012 ton/mi^2.

Ground Water

Trends in concentrations of selected constituents of ground water at Powdermill and Ellison Park wells were difficult to characterize because the data were insufficient (less than 3 years) for the analytical techniques described previously. Statistically significant ($\alpha = 0.10$) increasing, decreasing, or unchanging concentrations at each well with respect to time was estimated with the Kendall slope estimator. The results are given in table 14.

Nutrient species at the Ellison Park wells showed either no trend or decreasing trends, except total phosphorus at wells Mo 5 and Mo 6. Common ions at the Ellison Park wells showed few trends, half of which were upward, and half downward. Dissolved magnesium showed a statistically significant downward trend at all Ellison Park wells except Mo 2. None of the constituents showed opposing trends from well to well–all showed either no trend or a downward trend, or no trend and an upward trend.

Nutrient species at the three Powdermill Park wells showed no trends other than a slight upward trend in nitrite plus nitrate at Mo10. Common ions at Mo 10 all showed upward trends, as did dissolved potassium at Mo 11 and Mo 12, and dissolved sodium and chloride at Mo 12. Dissolved magnesium showed a downward trend at Mo 12. Although these trends are indicative of the overall direction of concentration with time, they have not been adjusted for any seasonality that occurs in the data.

Table 13. Annual loads of chemical constituents in bulk atmospheric deposition at Mendon Ponds, Monroe County, N.Y., water years 1984-88.

[Loads are in pounds per square mile; --, insufficient data to estimate annual load; e, estimated load.

Water year	Dis-solved calcium	Dis-solved magne-sium	Dis-solved sodium	Dis-solved potas-sium	Dis-solved sulfate	Dis-solved chloride	Nitrite plus nitrate	Am-monia nitrogen	Total phos-phorus	Ortho-phos-phorus	Acidity	Lead, total recov-erable
1984	3,400	683	1,130	996	24,800	4,650	3,250	2,914	--	288	--	31.4e
1985	3,670	905	892	1,440	26,300	3,740	3,090	3,430	--	457	32,900	17.4e
1986	5,290	871	1,060	562	34,000	8,410	4,680	2,260	252	134	38,300	52.3
1987	2,560	1,180	594	473	25,300	9,120	2,720	1,320	299	119	41,000	25.8e
1988	2,970	670	912	1,430	26,800	2,980	2,800	3,030	791	275	--	28.4

Table14. Direction of statistically significant ($\alpha = 0.10$) estimated trends of selected constituent concentrations in ground water at Ellison Park and Powder Mill Park wells, Monroe County, NY, 1986-88.

[-, decreasing trend; +, increasing trend; o, no trend. Locations are shown in fig. 2]

	Ellison Park Wells								
	East			West			Powder Mill Park		
Constituent	Mo 1	Mo 2	Mo 3	Mo 4	Mo 5	Mo 6	Mo 10	Mo 11	Mo 12
Specific conductance	o	o	o	+	+	o	+	o	o
Ammonia nitrogen as N	-	o	o	-	o	o	o	o	o
Total Kjeldahl nitrogen as N	-	o	o	o	o	o	o	o	o
Nitrite plusnitrate as N	-	-	o	-	o	o	+	o	o
Total phosphorus, as P	o	o	o	o	+	+	o	o	o
Orthophosphorus, as P	o	-	-	o	-	o	o	o	o
Calcium, dissolved	o	o	+	o	+	+	+	o	o
Magnesium, dissolved	-	o	-	-	-	-	+	o	-
Sodium, dissolved	o	o	o	+	o	o	+	o	+
Potassium, dissolved	o	o	o	+	+	o	+	+	+
Chloride, dissolved	o	o	o	o	+	+	+	o	+
Sulfate, dissolved	o	o	-	o	-	o	+	o	o

Surface Water

The statistical procedures discussed in the "Methods " section (p. 38-39) were applied to chemical data collected from the five surface-water sites in the Irondequoit Creek basin to determine the presence and magnitude of trends for nine constituents during the 1984-88 study. Results generally fall into one of the three categories described in the section on the Seasonal Kendall Test (p. 39): flow independent, flow dependent, and flow dependent where no flow equation could be fit to the data.

Most data sets, except for ammonia, volatile suspended solids, and orthophosphorus, were flow dependent, and flow-adjusted concentrations were used in the trend analyses. The best trends for total suspended solids and total phosphorus at Thomas Creek at Fairport were obtained from unadjusted concentrations, however, indicating that these constituents did not appear to be flow dependent at this site. Ammonia nitrogen appeared to be flow dependent at Thomas Creek and at Allen Creek near Rochester, but because no flow-adjustment equation could be fit to the data, unadjusted concentrations were used .

Both overall and seasonal trends were evaluated. Data from the Allen Creek site indicated five constituents with statistically significant monotonic trends over the 1984-88 study period, and data from the two most downstream Irondequoit Creek sites (Linden Ave. and Blossom Road) each indicated two. Data from Irondequoit Creek near Pittsford indicated four constituents with statistically significant trends, and data from Thomas Creek at Fairport indicated three. Volatile suspended solids were evaluated through the TOBIT method because the data set contained too many censored values (20 percent) for a reliable trend analysis by the Seasonal Kendall Trend test. The TOBIT test does not account for seasonal variability in the data.

Results of the seasonal trend analyses differed somewhat from those for the overall trend analyses. All sampled sites showed a few seasonal trends; the tributary streams showed fewer than the mainstem sites. Allen Creek, for instance, showed no statistically significant trends at the 90-percent confidence level ($\alpha = 0.10$), and Thomas Creek at Fairport showed only two. In contrast, The Irondequoit Creek near Pittsford site showed nine statistically significant seasonal trends; the Linden Avenue showed four, and the Blossom Road site showed six.

Overall Trends. Results of the overall trend analysis for the five surface-water sites in the Irondequoit Creek Basin are given in table 15 and figure 20.

Table 15. Statistical summary and results of trend analysis for selected surface-water constituents at five sites in Irondequoit Creek basin, Monroe County, N.Y., water years 1984-88.

[--, insufficient data to calculate value; n, number of observations used in trend analysis; *p*, significance of trend; TREND CODE: blank, best trend is in unadjusted concentrations; F, best trend is in flow-adjusted concentrations; **, best trend is in unadjusted concentrations because flow-adjustment was unsuccessful. Units are milligrams per liter.]

Constituent	Descriptive statistics					Best-trend results				
			percentile							
	Sample size	Mean	25th	50th (median)	75th	n	Units per year	Percent per ear	p	Trend code
A. Irondequoit Creek at Pittsford (04232040)										
Total suspended solids	90	119.16	49	88	150	16	12.99	10.91	0.328	F
Volatile suspended solids	89	e 17.21	6.0	11	25	89	--	--	--	
Ammonia nitrogen, as N	263	0.03	0.01	0.02	0.04	31	0.00	-17.02	0.070	
Total Kjeldahl nitrogen, as N	268	0.72	0.5	0.6	0.9	31	0.05	7.18	0.014	F
Nitrite plus nitrate, as N	271	1.17	0.97	1.20	1.40	31	-0.07	-6.29	0.014	F
Phosphorus, total as P	269	0.08	0.03	0.05	0.09	31	0.01	18.51	0.008	F
Orthophosphorus, as P	279	0.01	--	--	0.02	279	0.00	0.00	0.428	
Chloride, dissolved	272	53.78	48	53	57	31	0.12	0.22	1.000	F
Sulfate, dissolved	270	179.40	130	180	230	31	-4.32	-2.41	0.185	F
B. Thomas Creek at Fairport (04232046)										
Total suspended solids	41	39.21	19	32	51	14	14.42	36.77	0.070	
Volatile suspended solids	41	e 7.98	3.0	6.0	10	41	--	--	--	
Ammonia nitrogen, as N	283	0.04	0.02	0.03	0.05	31	0.00	-11.84	0.335	**
Total Kjeldahl nitrogen, as N	289	1.05	0.9	1.0	1.2	31	0.05	4.78	0.256	F
Nitrite plus nitrate, as N	291	1.16	0.52	0.97	1.70	31	-0.05	-4.52	0.185	F
Phosphorus, total as P	292	0.09	0.05	0.08	0.12	31	0.01	15.97	0.013	
Orthophosphorus, as P	307	0.02	0.01	0.02	0.03	307	0.00	7.21	0.236	
Chloride, dissolved	289	99.69	77	92	110	31	0.24	0.24	0.850	F
Sulfate, dissolved	290	129.24	80	120	160	31	-10.79	-8.35	0.088	F

Table 15. Statistical summary and results of trend analysis for selected surface-water constituents at five sites in Irondequoit Creek basin, Monroe County, N.Y., water years 1984-88 (continued)

	Descriptive statistics					Best-trend results				
			percentile							
Constituent	Sample size	Mean	25th	50th (median)	75th	n	Units per year	Percent per ear	p	Trend code
C. Irondequoit Creek at Linden Avenue (04232047)										
Total suspended solids	66	119.58	42	85	130	15	43.22	36.15	0.035	F
Volatile suspended solids	68	e 22.48	7.0	11	22	68	--	--	--	
Ammonia nitrogen, as N	226	0.05	0.03	0.05	0.07	31	-0.01	-19.53	0.008	
Total Kjeldahl nitrogen, as N	228	0.99	0.7	0.9	1.1	31	0.04	3.75	0.344	F
Nitrite plus nitrate, as N	231	1.27	0.96	1.20	1.60	31	-0.10	-7.66	0.130	F
Phosphorus, total as P	228	0.10	0.04	0.07	0.12	31	0.01	9.16	0.256	F
Orthophosphorus, as P	238	0.02	--	0.02	0.03	238	0.00	0.00	1.000	
Chloride, dissolved	230	86.20	71	83	95	31	-0.25	-0.29	1.000	F
Sulfate, dissolved	230	149.71	110	150	190	31	-3.03	-2.03	0.449	F
D. Allen Creek near Rochester (04232050)										
Total suspended solids	112	117.13	49	89	150	28	8.44	7.21	0.753	F
Volatile suspended solids	114	e 15.87	8.0	13	20	114	3.87	24.10	0.000	
Ammonia nitrogen, as N	307	0.04	0.01	0.03	0.05	31	-0.01	-27.90	0.017	**
Total Kjeldahl nitrogen, as N	312	1.15	0.9	1.1	1.3	31	0.00	0.00	1.000	F
Nitrite plus nitrate, as N	316	1.23	0.88	1.20	1.60	31	-0.08	-6.23	0.037	F
Phosphorus, total as P	314	0.12	0.06	0.09	0.14	31	0.01	9.17	0.058	F
Orthophosphorus, as P	329	0.02	--	0.02	0.02	329	0.00	-1.05	0.182	
Chloride, dissolved	315	158.57	100	120	180	31	3.81	2.40	0.088	F
Sulfate, dissolved	314	80.25	62	77	97	31	-4.06	-5.06	0.088	F
E. Irondequoit Creek at Blossom Road (0423205010)										
Total suspended solids	190	150.84	62	110	190	56	-2.84	-1.88	0.817	F
Volatile suspended solids	191	e 19.46	9.0	14	23	191	3.88	19.85	0.000	
Ammonia nitrogen, as N	546	0.04	0.01	0.02	0.04	60	-0.01	-20.88	0.013	
Total Kjeldahl nitrogen, as N	554	1.05	0.8	1.0	1.2	60	-0.02	-1.92	0.525	F
Nitrite plus nitrate, as N	562	1.17	0.88	1.10	1.50	60	-0.10	-8.80	0.040	F
Phosphorus, total as P	558	0.11	0.05	0.08	0.12	60	0.01	8.49	0.229	F
Orthophosphorus, as P	585	0.01	--	0.01	0.02	585	0.00	-6.79	0.003	
Chloride, dissolved	564	112.24	93	100	120	60	0.50	0.44	0.395	F
Sulfate, dissolved	561	149.4	120.0	150	180	60	-1.35	-0.91	0.705	F

e, parameter is estimated for censored constituents with a log-probability regression procedure

Total suspended-solids concentrations showed relatively large upward trends at Thomas Creek at Fairport and Irondequoit Creek at Linden Avenue–37 and 36 percent per year, respectively, but no detectable trends at Irondequoit Creek near Pittsford or at Allen Creek or Blossom Road (fig. 21A).

Volatile suspended-solids data were analyzed by the TOBIT method for censored data and indicated strong significant upward trends at Allen Creek and at Irondequoit Creek at Blossom Road–24 and 20 percent, respectively–but none at Irondequoit Creek at Pittsford, Thomas Creek at Fairport, or Irondequoit Creek at Linden Avenue (fig. 20B).

The major nutrients that were tested for trends in this study were ammonia nitrogen, total Kjeldahl nitrogen, nitrite plus nitrate, total phosphorus, and

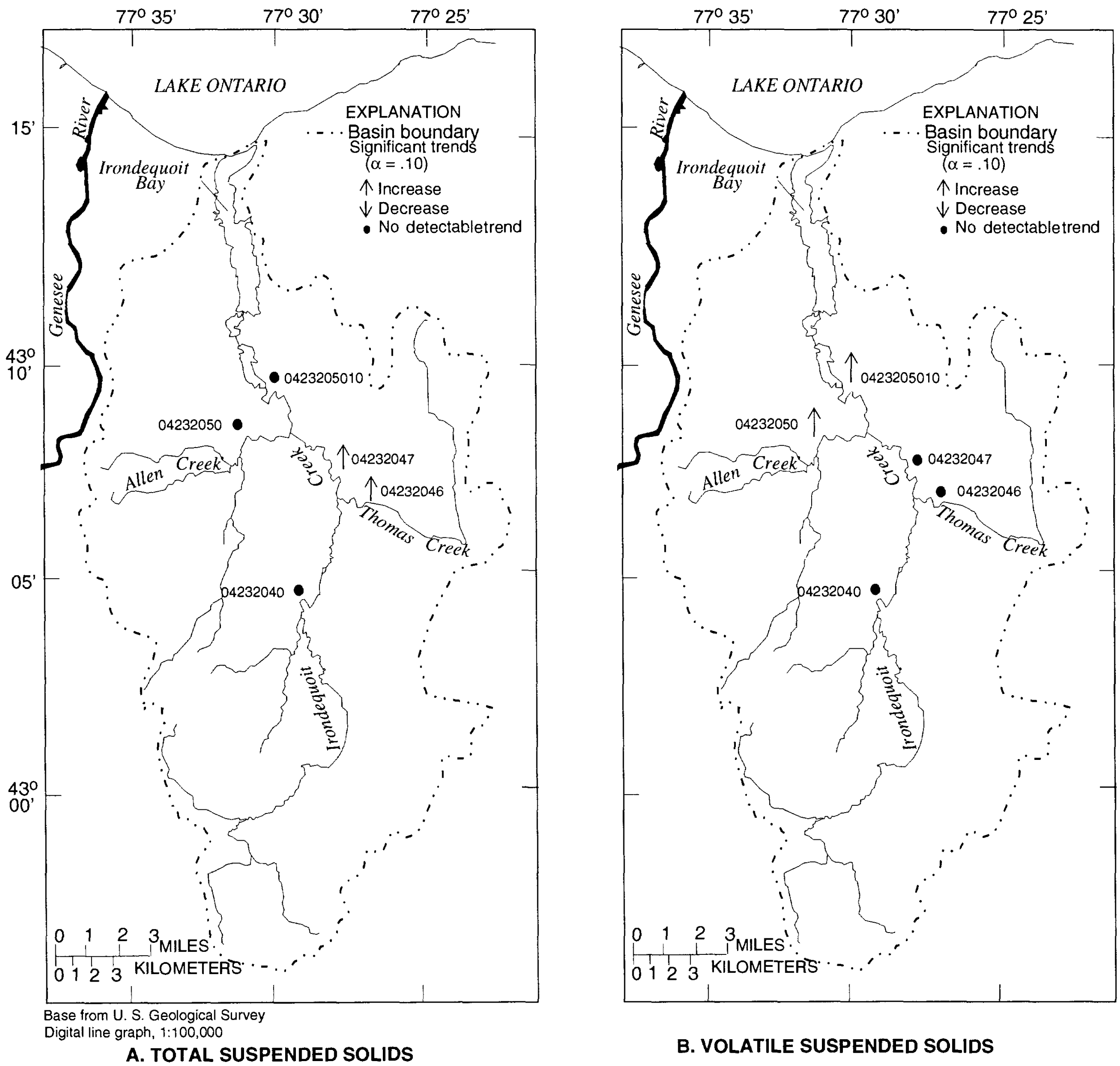
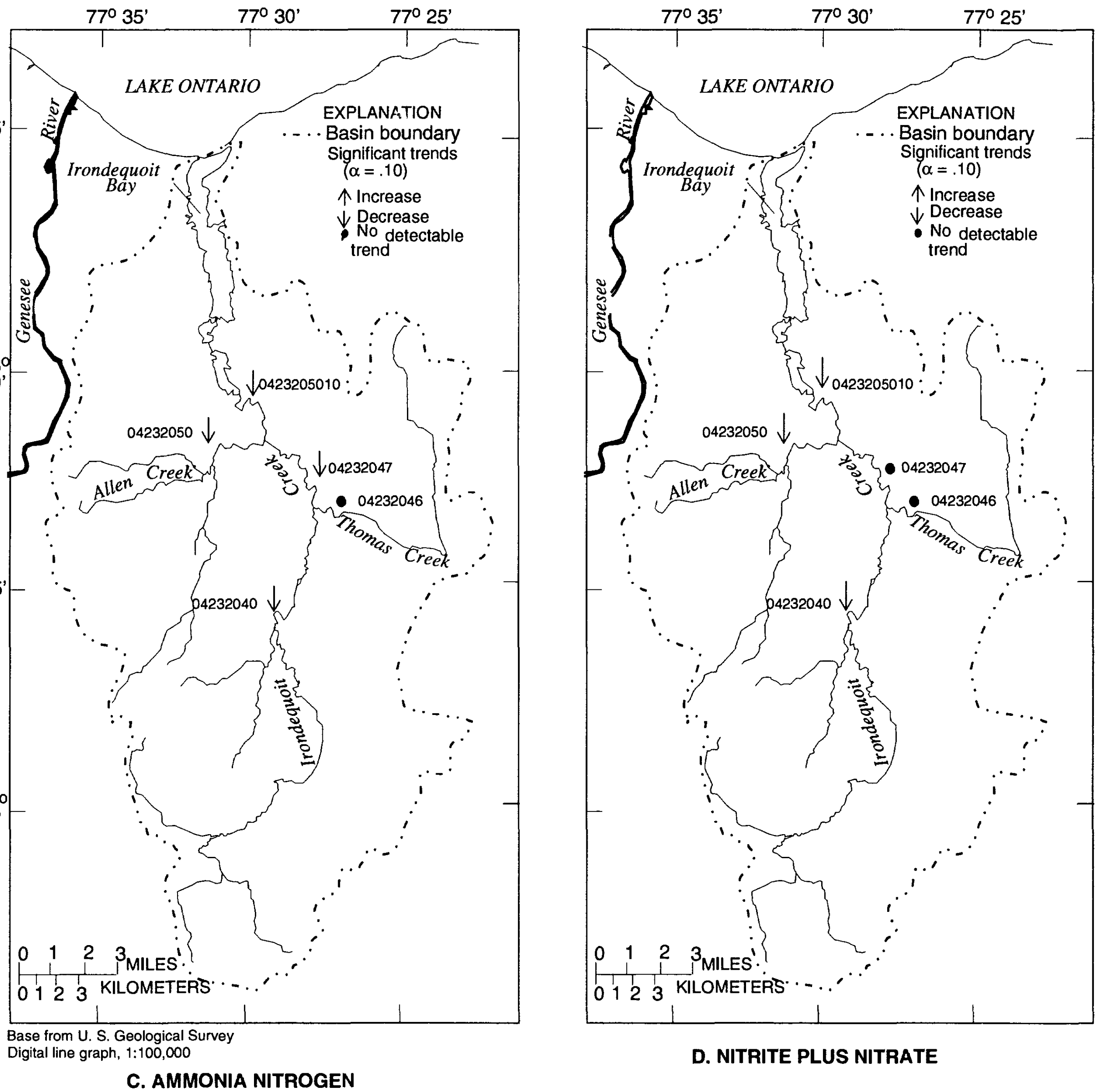


Figure 20. Estimated trends of selected constituents at five surface-water sites in Irondequoit Creek basin, Monroe county, N.Y., water years 1984-88.

orthophosphorus. Ammonia nitrogen (fig. 20C) showed statistically significant ($p < 0.10$) downward trends at four of the five sites; decreases ranged from 17 percent per year at Irondequoit Creek near Pittsford to 28 percent per year at Allen Creek. The only site that did not show a detectable trend in ammonia nitrogen was Thomas Creek at Fairport. Nitrite plus nitrate (fig. 20D) showed downward trends at three of the five sites–6.2 percent per year at Allen Creek to 8.8 percent per year at Blossom Road –but no detectable trends at Irondequoit Creek at Linden Avenue or Thomas Creek at Fairport.

The only statistically significant trend in total Kjeldahl nitrogen was at Irondequoit Creek near Pittsford (7.2 percent per year) (fig. 20E). The predominantly downward trends in ammonia nitrogen and nitrite plus nitrate, which are primarily associated with agriculture and fertilizers, probably



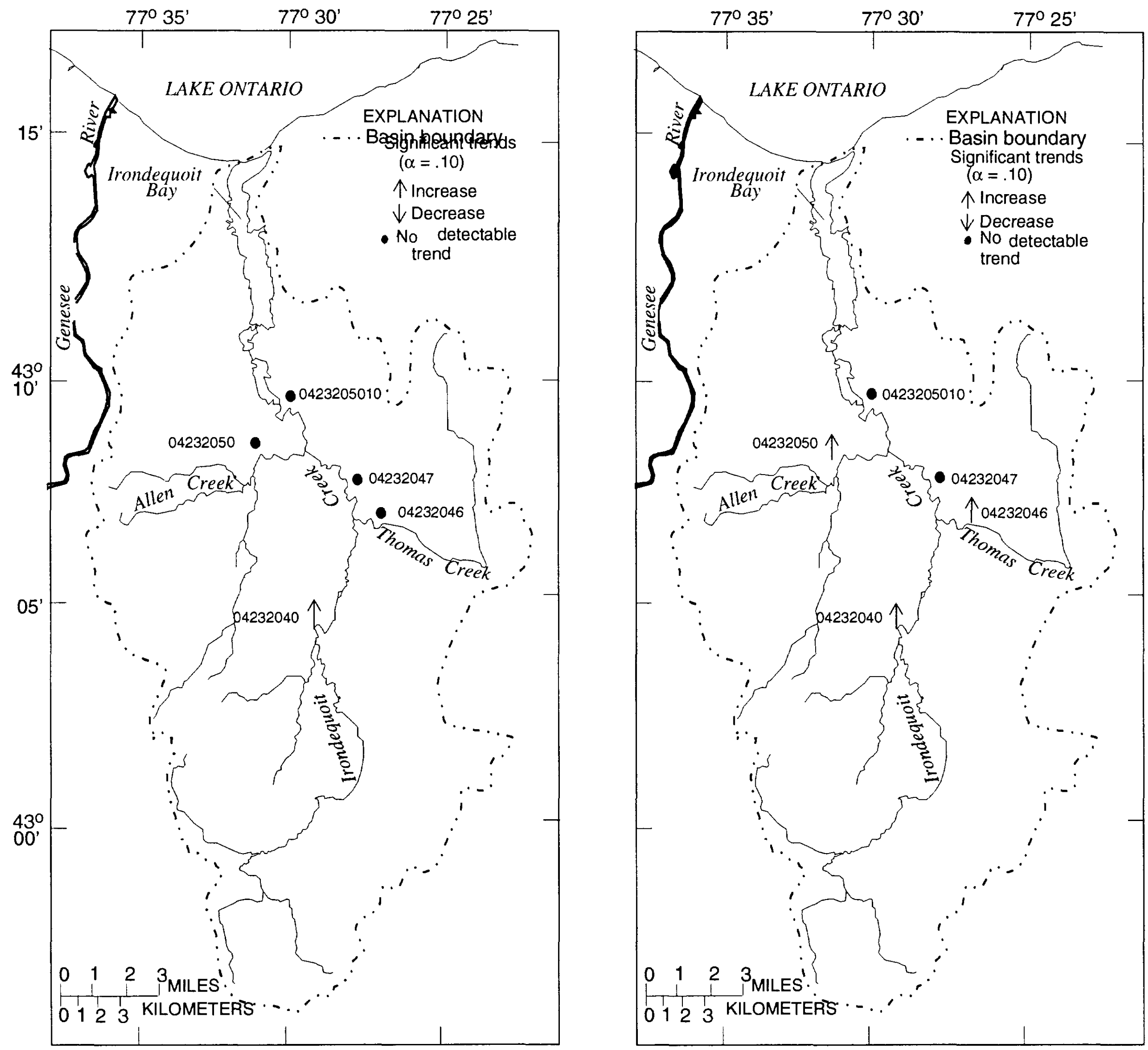
C. AMMONIA NITROGEN

D. NITRITE PLUS NITRATE

Figure 20 (continued.) Estimated trends of selected constituents of surface water at at five sites in Irondequoit Creek basin, Monroe county, N.Y., water years 1984-88.

reflect the conversion of agricultural land to unused or residential land. Total Kjeldahl nitrogen is characteristic of forest soils, where nitrification is unusually slow and is derived mainly from humus carried in overland runoff, and from periphyton detritus abraded from the stream channels. The upward trend in total Kjeldahl nitrogen at Irondequoit Creek near Pittsford (fig. 20E) could result from the clearing of woodlots or unused brushland for housing developments.

Total phosphorus (fig. 20F) is a measure of all forms of phosphorus present in streamflow and results largely from human-derived products, especially sewage and fertilizers. Total phosphorus, unlike nitrogen, showed generally upward trends in much of the basin. Statistically significant increases



Base from U. S. Geological Survey
Digital line graph, 1:100,000

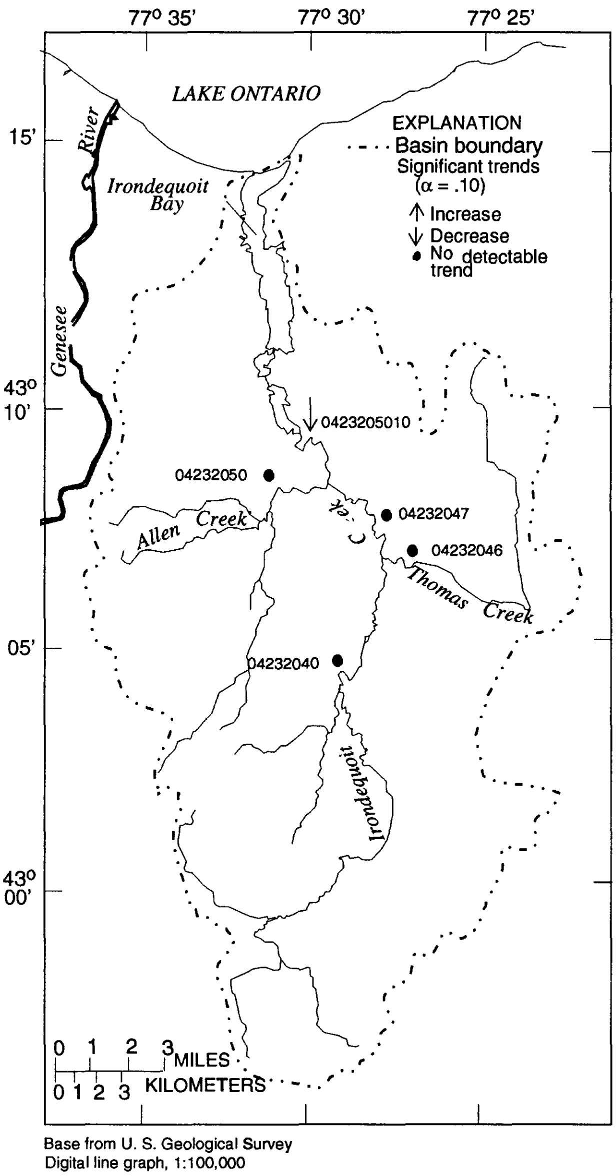
E. TOTAL KJELDAHL NITROGEN

F. TOTAL PHOSPHORUS

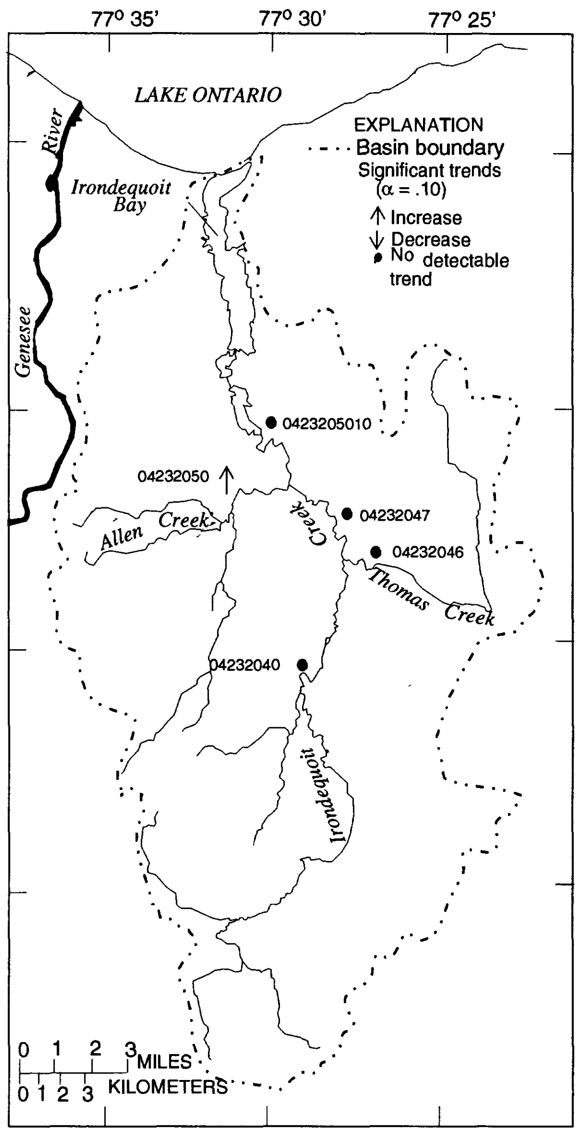
Figure 20 (continued.) Estimated trends of selected constituents of surface water at at five sites in Irondequoit Creek basin, Monroe county, N.Y., water years 1984-88.

were identified at Irondequoit Creek near Pittsford (18.5 percent per year), Thomas Creek at Fairport (16 percent per year), and Allen Creek (9.2 percent per year). Total phosphorus showed no significant trend at the Irondequoit Creek gages at Linden Avenue or Blossom Road. Orthophosphorus (fig. 20G), which is derived primarily from fertilizers, showed only a small downward trend at Irondequoit Creek at Blossom road (-6.8 percent) and no detectable trends at the remaining four sites.

Chloride (fig. 20H) is present in all natural waters but generally in low concentrations (Hem, 1985, p.118). Concentrations of more than a few milligrams per liter generally are the result of human activities, except in streams that receive ground water from bedrock sources that are high in



G. ORTHOPHOSPHORUS

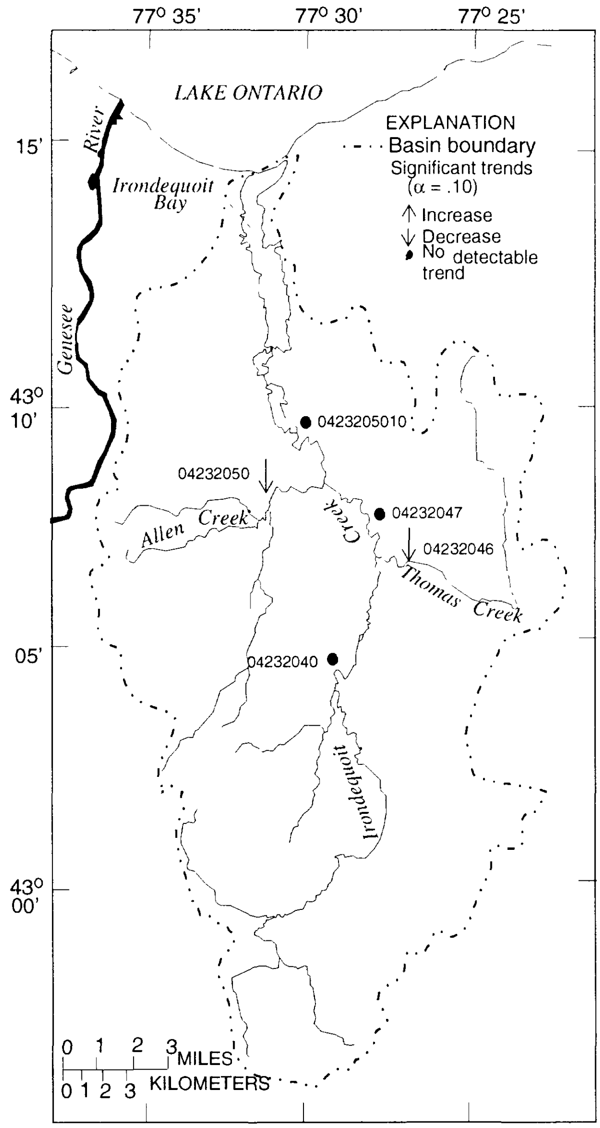


H. DISSOLVED CHLORIDE

Figure 20 (continued.) Estimated trends of selected constituents of surface water at at five sites in Irondequoit Creek basin, Monroe county, N.Y., water years 1984-88.

chloride. Chloride concentrations showed no statistically significant trends in the Irondequoit Creek basin, except at Allen Creek, which showed a a weak (p = 0.09) increasing trend of 2.4 percent per year .

Sulfate (fig. 20 I) occurs naturally streams and is derived from rock weathering, volcanoes, and biochemical processes (Hem, 1985, p. 113).



Base from U. S. Geological Survey
Digital line graph, 1:100,000

I. DISSOLVED SULFATE

Figure 20 (continued.) Estimated trends of selected constituents of surface water at at five sites in Irondequoit Creek basin, Monroe county, N.Y., water years 1984-88.

Human activities such as mining, waste discharge, and fossil-fuel combustion ("acid rain") can also be important sources. Sulfate, like chloride, showed few statistically detectable trends. Two sites—Thomas Creek at Fairport and Allen Creek–showed statistically significant downward trends in dissolved sulfate (-8.4 and -5.1 percent per year, respectively) but both were weak (p = 0 .09). Despite the lack of significant trends at all but two sites, slightly decreasing concentrations of sulfate were indicated at all sites over the study period. Much of the sulfate in the Irondequoit Creek basin is attributable to atmospheric sources; thus, the decrease in streamflow concentrations could reflect a decrease in atmospheric deposition of sulfur.

Seasonal Trends. Results of the Seasonal Kendall test on selected chemical constituents in Irondequoit Creek basin streams indicated very few statistically significant seasonal trends (table 16). Because an α of 0.10 was used, the test significance (p) of a particular seasonal trend is considered to be statistically weak when it is less than, but close to, 0.10. Many of the statistically significant seasonal trends indicated in table 16 are weak. Several constituents at various sites had seasonal trends that paralleled overall trends, where as other constituents that had significant overall trends showed no significant seasonal trends. For example, seven of the nine constituents analyzed in samples from Allen Creek indicated significant overall trends but no significant seasonal trends. Conversely, some of the sites that showed significant seasonal trends showed no overall trends.

Statistically significant seasonal trends were more frequent from June 1 through August 31 (seasons 3 and 4 of the six-season category) than throughout the rest of the year. All statistically significant seasonal trends (p< 0.10) outside this 3-month period have a p value close to 0.10 and, thus, are considered statistically weak, as are all statistically significant seasonal trends for the Blossom Road site.

Only two significant seasonal trends were indicated for the winter period—a weak upward trend in total phosphorus at Irondequoit Creek near Pittsford, and a weak upward trend in total Kjeldahl nitrogen at Blossom Road. Four significant seasonal trends were noted during the snowmelt and spring runoff period (season 1 of 4; seasons 1 and 2 of 6, and seasons 3, 4, and 5 of 12); three of which were

Table 16. Signifance (p) of seasonal trends of selected surface-water constituents in the Irondequoit Creek basin, Monroe County, N.Y., 1984-88.

[Seasonal trend is significant at $\alpha = 0.10$ if p-value is < 0.10. Sign indicates direction of seasonal trend. Dates of seasons are given in table 6. Dashes indicate insufficient data. Site locations are shown in fig. 2].

Constituent	Trend code*	Season** 1	2	3	4	5	6	Chi[2] for all seasons
A. Irondequoit Creek near Pittsford (04232040)								
Total suspended solids[1]	F	-0.735	-0.308	+0.027	-0.734			0.056
Ammonia nitrogen, as N		+.289	-.130	+1.000	-.433	-.086	-.613	.387
Total Kjeldahl nitrogen, as N	F	+1.000	+.086	+.260	+.221	+1.000	+.221	.770
Nitrite plus nitrate, as N	F	-.221	-.221	-.452	-.086	-.086	+1.000	.831
Phosphorus, total as P	F	+1.000	+.221	+.060	+.086	+.462	+.086	.754
Orthophosphorus, as P		--	+1.000	-.556	-.043	-.794	+1.000	--
Chloride, dissolved	F	+.462	-.221	+.452	+1.000	+1.000	-.806	.752
Sulfate, dissolved	F	-.806	-.221	-.452	-.462	+1.000	+.806	.913
B. Thomas Creek at Fairport (04232046)								
Total suspended solids[1]	F	+0.308	+0.308	+0.089	+0.308			0.631
Ammonia nitrogen, as N		-.613	-.806	-.436	+.462	-.130	+.806	.683
Total Kjeldahl nitrogen, as N	F	+.462	+.462	+.707	-.806	+.806	+.806	.984
Nitrite plus nitrate, as N	F	+.806	-.221	-.707	-.221	+1.000	-.806	.859
Phosphorus, total as P		+.221	+.462	+.707	+.806	+.312	+.462	.984
Orthophosphorus, as P		--	-.221	-.707	-.221	+1.000	-.806	--
Chloride, dissolved	F	-.806	+.462	+.707	-.462	+.462	-.806	.874
Sulfate, dissolved	F	+.806	-.221	-.060	+1.000	-.221	+.806	.522
C. Irondequoit Creek at Linden Avenue (04232047)								
Total suspended solids[1]	F	+0.221	+0.221	+0.221	+0.221			1.000
Ammonia nitrogen, as N		+1.000	-.221	-.260	-.086	-.086	+1.000	.688
Total Kjeldahl nitrogen, as N	F	+.462	+.462	+.707	-.806	+.806	+.806	.984
Nitrite plus nitrate, as N	F	-.221	-.806	+.260	-.027	-.221	+1.000	.234
Phosphorus, total as P	F	+.221	+.462	-.452	+1.000	+.221	+.221	.642
Orthophosphorus, as P		-.806	-.462	+.566	-.043	-.221	+1.000	--
Chloride, dissolved	F	-.462	+1.000	+1.000	-.806	+.462	+1.000	.951
Sulfate, dissolved	F	+1.000	+1.000	+.707	-.462	-.221	-.806	.891
D. Allen Creek near Rochester (04232050)								
Total suspended solids[1]	F	+0.308	+0.462	-0.133	-0.133	+0.221	+0.806	0.308
Ammonia nitrogen, as N		-.579	+.794	-.242	-.192	-.130	-.462	.837
Total Kjeldahl nitrogen, as N	F	+.613	+.806	-.707	-.462	-.806	+.462	.902
Nitrite plus nitrate, as N	F	-.221	-.462	+1.000	-.462	-.221	-.806	.940
Phosphorus, total as P	F	+.462	+.462	+.707	-.806	+.462	+.462	.978
Orthophosphorus, as P		+1.000	-.462	-.707	-.613	-.221	-.806	--
Chloride, dissolved	F	+.806	+.806	+.133	-.221	+.221	+.221	.397
Sulfate, dissolved	F	-.806	-.462	-.260	+1.000	-.806	-.462	.971

* F, best trend is in flow-adjusted concentrations; blank, best trend is in unadjusted concentrations.

** 1, March 1 to April 15; 2, April. 16 to May 30; 3, June 1 to July 15; 4, July 16 to Aug 31; 5, September 1 to December 14; 6, December 16 to February 29.

[1] Based on 4 seasons

Table 16. Signifance (*p*) of seasonal trends of selected surface-water constituents in the Irondequoit Creek basin, Monroe County, N.Y., 1984-88. (continued)

Constituent	Trend code*	Season 1	2	3	4	5	6	7	8	9	10	11	12	Chi[2] for all seasons
E. Irondequoit Creek at Blossom Road (0423205010)														
Total suspended solids	F	+0.806	+0.462	+1.000	+0.221	-0.086	-0.462	-0.221	-0.308	-0.308	+0.089	+0.734	+0.806	0.357
Ammonia nitrogen, as N		-.312	-.806	-.312	-.433	+.806	-.312	-.086	+1.000	+1.000	+1.000	-.086	+1.000	.916
Total Kjeldahl nitrogen as N	F	-.806	+.086	-.806	+.806	-.221	-.221	+.462	-.462	+.806	+.806	-.462	-.462	.706
Nitrite plus nitrate as N	F	+1.000	-.462	-.806	-.462	+1.000	+1.000	-.462	-.221	-.806	-.462	-.462	+1.000	.999
Phosphorus, total as P	F	+.221	+.221	+.806	-.462	-.462	+.221	-.221	+.462	+.221	+.806	+.221	-.462	.530
Orthophosphorus, as P		-.806	-.462	-.086	-.086	-.462	-.806	-.806	-.221	-.613	-.221	-.221	-.806	--
Chloride, dissolved	F	+.806	-.462	+.462	+.806	+.221	+1.000	+1.000	+1.000	+.221	+.462	-.806	-.221	.880
Sulfate[1], dissolved	F	+1.000	+1.000	+1.000	+.806	-.462	-.806							.989

* F, best trend is in flow-adjusted concentrations; blank, best trend is in unadjusted concentrations.
[1] Based on 6 seasons.

at the Blossom Road site (table16). Irondequoit Creek near Pittsford showed a weak upward trend in total Kjeldahl nitrogen, and the Blossom Road site showed weak downward trends for total suspended solids during May and for orthophosphorus during March and April.

Significant seasonal trends from June 1 through August 31 were detected for eight constituents. Data from Irondequoit Creek at Pittsford indicate a weak downward trend in nitrite plus nitrate, a moderate downward trend in orthophosphorus from mid-July through August, and an upward trend in total phosphorus from mid-June through August. Data fromIrondequoit Creek at Linden Avenue indicate a weak downward trend for ammonia nitrogen, a strong downward trend in nitrite plus nitrate, and a moderate downward trend in orthophosphorus from mid-July through August. Data from Thomas Creek at Fairport indicate a downward trend in dissolved sulfate from June through mid-July, and data from Irondequoit Creek at Blossom Road indicate a weak downward trend in ammonia nitrogen during July.

Statistically significant seasonal trends from September through mid-December were noted for seven constituents, three of which were at Irondequoit Creek near Pittsford, two at Blossom Road, and one each at Thomas Creek at Fairport and Irondequoit Creek at Linden Avenue. Data from the Pittsford site indicate a strong upward trend in total suspended solids from October through November and weak downward trends for ammonia nitrogen and nitrite plus nitrate from September through mid-December. Data from the Blossom Road site indicate a weak upward trend in suspended solids during October and a weak downward trend in ammonia nitrogen during November. Data from Thomas Creek at Fairport indicate a weak downward trend in suspended solids from October through November, and data from Irondequoit Creek at Linden Avenue indicate a weak downward trend in ammonia nitrogen from September through mid-December.

The upward seasonal trends in suspended solids and total phosphorus in the summer and fall at the Irondequoit Creek at Pittsford site could reflect soil disturbances from construction of housing developments in the upper Irondequoit Creek basin during summer and fall . The downward seasonal trends in ammonia nitrogen, nitrite plus nitrate, and orthophosphorus at the Pittsford site, which are indicated at the Linden Avenue site as well, could result from the loss of active agricultural land in the basin. The weakness of the trends makes a definitive analysis difficult, however.

Comparison with 1980-81 (NURP) Data. A statistical test (Kruskal-Wallis) was used to identify statistically significant differences in median concentrations between the 1980-81 NURP data and individual-year data from 1984-88 study. For purposes of comparison, data from the NURP study were grouped under water year 1981, even though actual dates of data collection were from early July 1980 through August 1981. A summary of the results of this analysis is given in table 17.

Dissolved chloride and total Kjeldahl nitrogen were the two constituents with the greatest number of statistically significant differences in median concentrations between the 1980-81 NURP study and the 1984-88 study. Chloride concentrations increased, while total Kjeldahl nitrogen concentrations decreased.

Information on the application of deicing salt to State highways and expressways in the Irondequoit Creek basin was obtained from Monroe County (Irondequoit Basin Technical Group, 1990). The report indicates that (1) the use of salt on State highways decreased during 1984-88 and was less during 1984-88 than in the 1981 water year, whereas (2) the use of salt on the expressways was greater during 1984-88 than in 1981.

The general increase in median concentrations of dissolved chloride at Thomas Creek, Irondequoit Creek at Linden Avenue, and at Allen Creek (table 17) can be almost entirely accounted for by the increased application of road-deicing salts on expressways in these subbasins. Irondequoit Creek near Pittsford receives drainage from the Towns of Mendon, Perinton, and Pittsford, as well as the Town of Victor in Ontario County, to the southeast. The decreased use of deicing salts on State highways in these towns from 1981 to 1984-87 is apparently offset at this site by the increased use of salt on the expressways (Interstates 90 and 490). The reason for the increase in dissolved chloride concentrations for the 1988 water year is unknown, but, as with Thomas Creek, could be due to increased use of salts on local roads not represented in the Irondequoit Basin Technical Group report.

Dissolved chloride concentrations at the Blossom Road site (whose drainage area contains less than 12 mi^2 in addition to the Linden Avenue plus Allen Creek drainages) were lower in water years 1984 and 1987 than in 1981 but showed no significant difference from 1981 values in water years 1985, 1986, or 1988, unlike those at the Linden Avenue and Allen Creek sites. The reason for this is unknown. Although the total load of dissolved chloride for 1984-88 at Blossom road is greater than the sum of the loads from Allen Creek and Linden Avenue for the same period, the increase is significantly less than would be expect-ed. One explanation could relate to a stratification of dissolved chloride in the water column, similar to

Table 17. Change in median concentrations of selected constituents at five sites in the Irondequoit Creek basin, Monroe County, N.Y., from NURP study (1981) to1984-88 study

[o, no statistically significant difference from 1981; + or - ,concentration significantly higher ot lower than in 1981. Locations are shown in fig. 2.]

Constituent	Water Year 1984	1985	1986	1987	1988
A. Irondequoit Creek near Pittsford					
Dissolved chloride	o	o	o	o	+
Total suspended solids	o	o	o	o	o
Total Kjeldahl nitrogen	o	-	o	o	-
Total phosphorus	-	o	-	o	o
B. Thomas Creek near Pittsford					
Dissolved chloride	+	+	+	+	+
Total suspended solids	o	o	o	o	o
Total Kjeldahl nitrogen	o	-	o	o	-
Total phosphorus	-	o	-	o	-
C. Irondequoit Creek at Linden Ave.					
Dissolved chloride	+	+	+	+	+
Total suspended solids	o	o	o	o	o
Total Kjeldahl nitrogen	-	-	o	o	-
Total phosphorus	-	-	-	o	o
D. Allen Creek near Rochester					
Dissolved chloride	+	+	+	+	+
Total suspended solids	+	+	+	+	o
Total Kjeldahl nitrogen	-	-	-	-	-
Total phosphorus	o	-	o	-	o
E. Irondequoit Creek at Blossom Road					
Dissolved chloride	-	o	o	-	o
Total suspended solids	+	o	o	o	o
Total Kjeldahl nitrogen	-	-	o	-	-
Total phosphorus	-	o	o	o	o

that which occurs in Irondequoit Bay (Bubeck and Burton, 1989) and in the aquifer (Young, 1993). The frequent exchange of water between stream and aquifer, as discussed earlier in relation to wells in Ellison Park, could result in a loss of water containing elevated concentrations of chloride from the stream to the aquifer along the reach between Linden Avenue and Blossom Road, and a gain of water with low chloride concentrations from the upper part of the aquifer. This stratification, if present in the area of low streamflow velocity, where the samples are collected by automatic sampler, could result in the collection of samples that do not represent the highest concentrations present. If so, the calculations of dissolved chloride loads to Irondequoit Bay are conservative.

Total Kjeldahl nitrogen showed significantly lower median concentrations during 1984-88 than in 1981 throughout the Irondequoit Creek basin. This general decrease could be due to the loss of agricultural and forest land in the basin to housing developments.

Total phosphorus, in contrast, showed significantly lower median concentrations in1981 than in 1984-88. Because the main sources of total phosphorus are fertilizers, detergents, and metabolic animal wastes, the general decrease in concentrations of this constituent, again, probably results from the loss of agricultural land.

The only site at which median concentrations of suspended solids increased consistently since the 1981 study was Allen Creek; the source was probably disturbed soil resulting from the construction of housing developments in the East Branch Allen Creek basin.

A comparison of the atmospheric contribution (loads) of selected chemical constituents to the Irondequoit Creek basin between the 1981 study and 1984-88 is based on data collected only at the Mendon Ponds site. Annual precipitation during the 1984-88 study ranged from 25.4 in. to 40.6 in., with a 5-year mean of 32.6 in., about 5 percent below the 1981 value of 34.3 in. (table 18). The most abundant constituents were sulfate (69 ton/mi^2) and dissolved chloride (14.5 ton/mi^2) over the 5-year period. The least abundant was dissolved lead (0.026 ton/mi^2).

Mean annual atmospheric loads of dissolved chloride and total phosphorus were greater during 1984-88 than in 1981, and the mean annual loads of dissolved lead in 1984-88 were less than 25 percent of the annual load for 1981.

Table 18. Atmospheric contribution of selected constituents to Irondequoit Creek basin, Monroe County, N.Y., 1984-88 and 1980-81 based on data collected at Mendon Ponds Park.

[All values are in tons per square mile unless otherwise noted. --, insufficient data to calculate value].

Constituent	Water year					1984-88 mean	1980-81 mean
	1984	1985	1986	1987	1988		
Precipitation (inches)	40.0	25.4	40.6	30.6	26.6	32.6	34.3
Calcium, dissolved	1.70	1.84	2.65	--	1.49	--	--
Magnesium, dissolved	.34	.45	.44	--	.34	--	--
Sodium, dissolved	.56	.45	.53	--	.46	--	--
Potassium, dissolved	.50	.72	.28	--	.72	--	--
Sulfate, dissolved	12.4	13.2	17.0	12.7	e14.6	14.0	--
Chloride, dissolved	2.33	1.87	4.21	4.56	1.49	2.89	2.31
Nitrite plus nitrate as N	1.63	1.55	2.34	1.36	1.40	1.66	--
Ammonia nitrogen as N	1.46	1.72	1.13	e .72	1.51	1.31	--
Total Kjeldahl nitrogen, as N	--	--	--	--	--	--	1.92
Phosphorus, total as P	--	--	.13	e .16	.40	--	.17
Orthophosphorus, as P	.14	.23	.07	e .06	.14	.13	--
Lead, dissolved	e .02	e .01	.03	e .02	.01	.02	.11

e, estimated from partial data

Genesee River

Water samples are collected by the USGS from the Genesee River at Charlotte Docks (fig. 2) as part of the USGS NASQAN Program. Sampling frequency has varied throughout the 20-year period of collection. Samples were collected eight times per year during 1974-81, six times per year during 1982, and quarterly during 1983-94. In 1988, the New York State Department of Environmental Conservation (NYSDEC) also began collecting samples at the Charlotte Docks site and obtained five that year. Results were used with data collected by the USGS for the analysis presented here. Discharges associated with the samples were from station 04232000, Genesee River at Rochester (fig. 2).

Analysis of the long-term water-quality data (10 years or greater) indicated only four constituents to have statistically significant trends during 1974-94. Turbidity, dissolved oxygen, and dissolved chloride showed upward trends, and total phosphorus showed a strongly downward trend. The 1984-88 data indicated that only specific conductance had a statistically significant trend (downward). Long-term trends and 1984-88 trends are given in table 19.

Examples of how locally weighted scatterplot smoothing (LOWESS) and the trend-slope estimator relate to each other are shown in figure 21, which indicates the trends in the dissolved oxygen concentrations in the Genesee River for 1974-88 and 1984-88. The difference in shape of the LOWESS line between the 1984-88 part of the long-term record (Fig. 21A) and in the 1984-88 plot (fig. 21B) is due to the difference in the number of data points used in the weighted smoothing for each plot. The LOWESS analysis, in weighting each segment of the curve, considers a percentage of the total number of observations available. The period-of-record analysis, then, with more than three times the number of total observations, considers observations within a period that is more than three times as long as those considered for the study-period analysis. Also, the estimated trend slope in figure 22B does not agree with the upward trend of 1.8 percent per year shown in figure 21A and table 22 (p. 58) but, rather, shows a downward trend that is not statistically significant and closely matches the 1984-88 part of period-of-record LOWESS curve in figure 22A.

The Genesee River data indicated seasonal trends in some constituents for 1984-88 as well as the period of record (1974-88), as indicated in table 20. Like the overall trends, the seasonal trends for the study period are not reflected in long-term record, nor are overall trends reflected in the

Table 19. Long-term trends in concentrations of selected constituents at Charlotte Docks on the Genesee River, N.Y. and 1984-88 trends, with statistical significance (*p*) of trends.

[* , Statistically significant at α = 0.10.]

Constituent	Long Term			1984-88	
	Period	percent per year	*p*	percent per year	*p*
Turbidity	10/78-6/88	8.99	0.058*	6.31	0.671
Total Kjeldahl nitrogen, as N	5/74-9/88	-1.57	.474	-7.64	.532
Ammonia nitrogen, as N	11/79-7/88	-5.53	.186	-11.35	.643
Phosphorus, total as P	5/74-9/88	-7.95	.000*	-4.46	.623
Oxygen, dissolved	10/74-6/88	1.79	.084*	-.53	.888
Specific conductance	5/74-9/88	-.22	.649	-3.15	.090*
Chloride, dissolved	5/74-9/88	1.98	.095*	-2.16	.322
Sulfate, dissolved	5/74-9/88	-.46	.469	2.37	.888
Calcium, dissolved	5/74-9/88	.02	.975	-.78	.775
Magnesium, dissolved	5/74-9/88	.00	1.00	.00	.417
Sodium, dissolved	5/74-9/88	1.98	.123	-3.34	.203
Copper, dissolved	5/74-9/88	--	--	10.2	.349
Lead, dissolved	5/74-9/88	1.04	.593	--	--
Zinc, dissolved	5/74-9/88	.00	.999	9.53	.643

seasonal record. The direction and statistical significance (*p*) of seasonal trends for 1984-88 and for the period of record are summarized in table 20.

The 1984-88 data indicated downward trends for ammonia from March through September and an upward trend in turbidity from October through February, whereas the period-of-record analysis indicated no statistically significant trends for these constituents. In contrast, the period-of-record data indicated strong downward trends in total phosphorus from March through September and upward trends in dissolved chloride and dissolved sodium from June through September, whereas the 1984-88 data showed no significant seasonal trends for these constituents. No other constituents showed a significant seasonal trend during either period.

Total annual loads of selected constituents from the Genesee River into Lake Ontario (table 21) were estimated from mean daily discharge values for the streamflow-gaging station on the Genesee River at Rochester, and overall trends for the period of record (1974-88) were evaluated. Constituent loads were obtained from the MVUE equation mentioned in the section on trend analysis of constituent loads.

Total Kjeldahl nitrogen and total phosphorus loads had statistically significant downward overall trends (-2 percent and -6 percent per year, respectively) over the period of record (table 17). Dissolved chloride and dissolved sodium both showed upward trends of 3 percent per year, but dissolved sulfate and dissolved calcium showed no overall trend in loads.

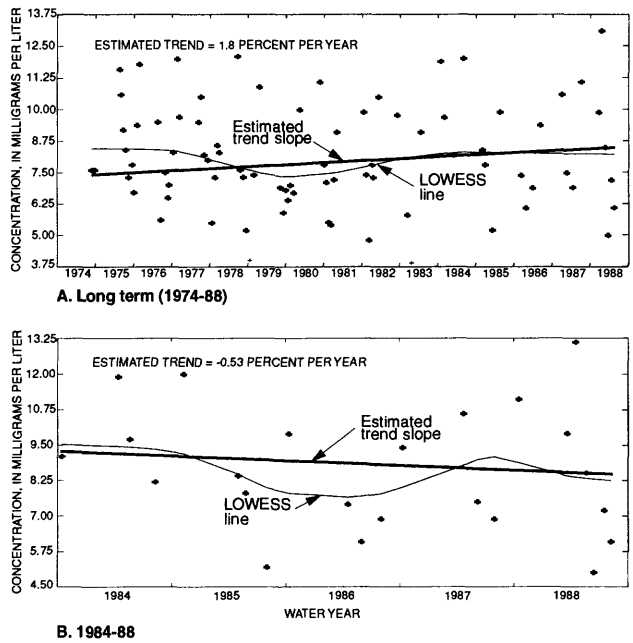


Figure 21. Example of locally weighted scatterplot smoothing (LOWESS) line and estimated trend slope showing changes in pattern of dissolved oxygen concentration at Genesee River at Charlotte Docks, N.Y.; during (A) period of record, (1974-88) and (B) 1984-88 water years.

Table 20. Statistical significance *(p)* of long-term (1974-88) seasonal trends and of seasonal trends for water years 1984-88 for selected constituents in the Genesee River at Charlotte Docks, N.Y.
[*, Statistically significant at $\alpha = 0.10$].

	Seasonal trends					
	March 1 -May 31		June 1 - September 30		October 1 - February 29	
Constituent	long term	1984-88	long term	1984-88	long term	1984-88
Turbidity	+0.152	-0.462	+0.592	+1.000	+0.251	+0.086*
Total Kjeldahl nitrogen, as N	-.235	+.806	-.428	+.806	+.360	+1.000
Ammonia nitrogen, as N	-.466	-.086*	-.602	-.027*	-.368	-.734
Phosphorus, total as P	.000*	-.806	-.003*	-.221	-.760	+.308
Oxygen dissolved	+.304	+1.000	+.150	+1.000	+.756	-.806
Specific conductance	-.322	-.806	+.360	-.221	-.583	-.308
Chloride, dissolved	+.621	+1.000	+.044*	-.221	+.661	-.806
Sulfate, dissolved	-.235	+.806	+.951	-.806	+1.000	+.806
Calcium, dissolved	-.322	+.806	+.360	-.462	+.743	+.806
Magnesium, dissolved	-.488	-.806	+1.000	-.221	+.428	+.734
Sodium, dissolved	+.621	-.806	+.059*	-.221	+.743	-.806

Table 21. Estimated annual loads and associated error of selected constituents, Genesee River at Charlotte Docks, N.Y., 1974-88

[Loads are in thousands of tons. Error when multiplied by 1.96 and added to and subtracted from the estimated load provides the approximate 95-percent confidence limits of the load estimate].

Water year	Calcium, dissolved		Total Kjeldahl nitrogen		Chloride, dissolved		Sulfate, dissolved		Sodium, dissolved		Phosphorus, dissolved	
	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error
1974	205	48.3	1.51	0.35	139	66.3	266	91.2	75.7	32.8	0.76	0.55
1975	227	51.2	1.76	.39	164	72.7	291	94.6	90.5	36.5	.84	.69
1976	257	57.5	2.02	.46	193	83.1	323	103	108	42.4	1.32	1.23
1977	194	26.5	2.15	.32	179	59.1	249	53.8	102	29.9	.82	.37
1978	261	54.3	2.38	.48	211	93.9	326	102	119	47.3	.91	.47
1979	218	53.5	1.70	.42	209	101	287	101	116	51.0	.74	.63
1980	194	34.8	1.82	.33	210	78.7	260	70.4	118	39.9	.41	.20
1981	207	41.0	1.78	.33	245	97.7	281	80.7	136	49.2	.44	.40
1982	248	45.4	2.21	.39	275	110	325	91.1	154	54.9	.56	.29
1983	200	39.3	1.68	.27	248	106	275	81.9	136	51.9	.26	.12
1984	251	45.3	2.20	.40	259	104	312	85.6	146	52.8	.57	.34
1985	182	42.6	1.22	.31	217	102	245	82.0	118	51.3	.34	.30
1986	202	47.7	1.28	.29	226	109	265	91.1	123	54.0	.30	.22
1987	181	33.0	1.30	.24	213	84.3	239	66.2	117	41.8	.27	.14
1988	150	32.2	.94	.20	183	85.0	205	65.6	98.0	41.1	.15	.09

CHEMICAL LOADS TRANSPORTED TO IRONDEQUOIT BAY

The final NURP report (Kappel and others, 1986) contains estimates of constituent loads to Irondequoit Bay during 1980-81; the present study provided similar estimates for 1984-88. Because the constituents transported by Irondequoit Creek to Irondequoit Bay have a residence time in the bay ranging from several months to many years in the bay (Bubeck and Burton, 1989), a minor change in load of some conservative constituents could have a major effect on the bay (Hirsch and others, 1991). Total phosphorus, for example, with a median concentration of 0.08 mg/L at the Blossom Road site and an annual yield of about 0.12 ton/mi^2, has no apparent effect on vegetation in stream channels of the Irondequoit Creek basin, where it is being continually transported, yet is a major factor in the growth of aquatic plants in the bay and, thus, can significantly accelerate the eutrophication process.

Total monthly loads of selected constituents are given by water year for each of the five sites in the Irondequoit Creek basin in appendix B. Total annual loads of selected chemical constituents are listed in table 22 and plotted in figure 22. These loads are those computed for Irondequoit Creek at Blossom Road, multiplied by a drainage-area factor of 1.17, to account for the intervening drainage area between Blossom Road and the bay, as was done in the NURP report (Kappel and others, 1985).

In general, particulate constituents such as total Kjeldahl nitrogen, nitrite plus nitrate, and total phosphorus are transported primarily during periods of high runoff, such as during snowmelt and spring and winter rains; thus, the loads of these constituents are greatest at these times. Even though concentrations of dissolved constituents such as orthophosphorus, ammonia nitrogen, chloride, and sulfate vary with flow to a far lesser degree because they become diluted by large flows, the volume of flow overcomes the effect of dilution and causes these constituents to have large loads during periods of high flow

Typically, the largest loads of most constituents are transported during the snowmelt and spring runoff season, which usually is from February through May. Thaws in late January are not uncommon in the Rochester area, and high flows can continue into early May. The period used to represent the snowmelt and spring-runoff periods in this study was from February 1 through May 31, whereas the comparable period used in the NURP (1980-81) study was January 23 through May 8. Percentages of total annual loads transported by Irondequoit Creek at Blossom Road from February 1 through May 31 are shown in table 22B.

Annual yields (in tons per square mile) are summarized in table 23 and figure 23. Allen Creek, the most urbanized of the subbasins, had the highest annual yields of all nutrients except ammonia nitrogen in 1984-88, and the Thomas Creek subbasin generally had the lowest (table 23, fig 22). Annual yields of nitrogen ammonia were relatively uniform throughout the subbasins and ranged from 0.032 (ton/mi^2)/yr in the Thomas Creek subbasin to 0.052 (ton/mi^2)/yr at the Linden Avenue site. Yields of orthophosphorus were also fairly uniform and ranged from 0.013 ton/mi^2 at Irondequoit Creek near Pittsford to 0.021 ton/mi^2 in the Allen Creek basin. Total Kjeldahl nitrogen was the only constituent to show a distinct difference in yield between the urbanized subbasins (Allen Creek, Linden Avenue, and Blossom Road) and the primarily agricultural subbasins (Pittsford and Thomas Creek at Fairport). The urbanized subbasins had a mean annual yield of 1.1 ton/mi^2, and the agricultural subbasins averaged 0.7 ton/mi^2. Annual yields of nitrite plus nitrate were fairly consistent in four of the five subbasins, ranging from 1.15 (ton/mi^2)/yr at Blossom Road and Pittsford to 1.30 ton/mi^2 at Allen Creek; the annual yield at Thomas Creek was 0.87 ton/mi^2.

Annual yields of dissolved chloride from the Allen Creek subbasin were also significantly higher (161 ton/mi^2) than those from the other watersheds (table 23). The highest annual yields of suspended solids (137 to 170 ton/mi^2) were at the Allen Creek, Pittsford, and Blossom Road sites, and the lowest, by far (24.6 ton/mi^2), was at Thomas Creek. The Thomas Creek basin contains large wetland areas in which filtration and settling of constituents can take place, as well as low stream gradients that prevent the suspension of large particles.

Chemical loads from the NURP study were compared with those calculated for water year 1988 in the current study—the year in which runoff was most similar to that in the NURP (1981) study (table 24). Of the four constituents common to both studies, total Kjeldahl nitrogen was considerably less at all sites in 1988, than in 1981 and total phosphorus was essentially the same. The changes in total suspended solids and dissolved chloride during 1981-88 varied from site to site. Yields of total suspended solids were considerably greater during 1988 at the Thornell Road and Allen Creek sites than in 1981, less at the Linden Avenue site, and about

Table 22. Estimated annual loads of selected constituents transported to Irondequoit Bay, water years 1984-88, and percentage of total annual load transported from February through May (snowmelt and runoff period).

[Annual loads are in tons , runoff is in cubic feet per second]

Water year	Suspended solids	Volatile suspended solids	Sulfate, dissolved	Ammonia nitrogen	Total Kjeldahl nitrogen	Nitrite plus nitrate	Total phosphorus	Orthophosphorus	Chloride, dissolved	Runoff
A. Estimated annual loads (multiplied by a factor of 1.17 to account for drainage area between Blossom Road and mouth)										
1984	35,400	3,050	21,600	10.6	219	249	23.5	3.67	19,000	--
1985	18,100	1,960	16,400	6.06	139	179	12.8	1.68	14,600	--
1986	37,700	4,290	20,100	7.42	245	239	31.2	3.24	18,500	--
1987	32,200	4,030	19,700	5.14	219	193	29.1	2.41	17,800	--
1988	18,500	2,540	15,700	2.42	126	106	19.1	1.18	13,600	--
Mean	28,400	3,170	18,700	6.33	190	193	23.1	2.44	16,700	--
B. Percentage of total annual loads and runoff transported February through May (Spring snowmelt and runoff period)										
1984	68	63	42	51	57	55	62	44	52	53
1985	68	60	41	47	55	53	58	40	51	51
1986	44	41	36	38	40	44	38	24	44	41
1987	46	42	35	36	40	42	39	23	42	40
1988	48	45	37	36	43	44	38	25	45	42
Mean	55	50	38	42	47	48	47	31	47	45

Table 23. Mean annual yield of selected constituents at the five Irondequoit Creek basin sites, Monroe County, N.Y., water years 1984-88.

[All values are in tons per square mile; locations are shown in fig. 2]

Constituent	Pittsford	Thomas Creek	Linden Ave.	Allen Creek	Blossom Road
Suspended solids	137	24.6	85.1	143	170
Volatile Suspended solids	17.6	6.14	14.2	17.4	19.0
Ammonia nitrogen, as N	.033	.032	.052	.044	.038
Total Kjeldahl nitrogen	.76	.65	.91	1.26	1.13
Nitrite plus nitrate, as N	1.15	.87	1.23	1.30	1.15
Phosphorus, total as P	.103	.059	.100	.146	.138
Orthophosphorus, as P	.013	.016	.017	.021	.015
Chloride, dissolved	50.8	62.3	84.2	161	99.7
Sulfate, dissolved	154	60.0	132	72.1	112

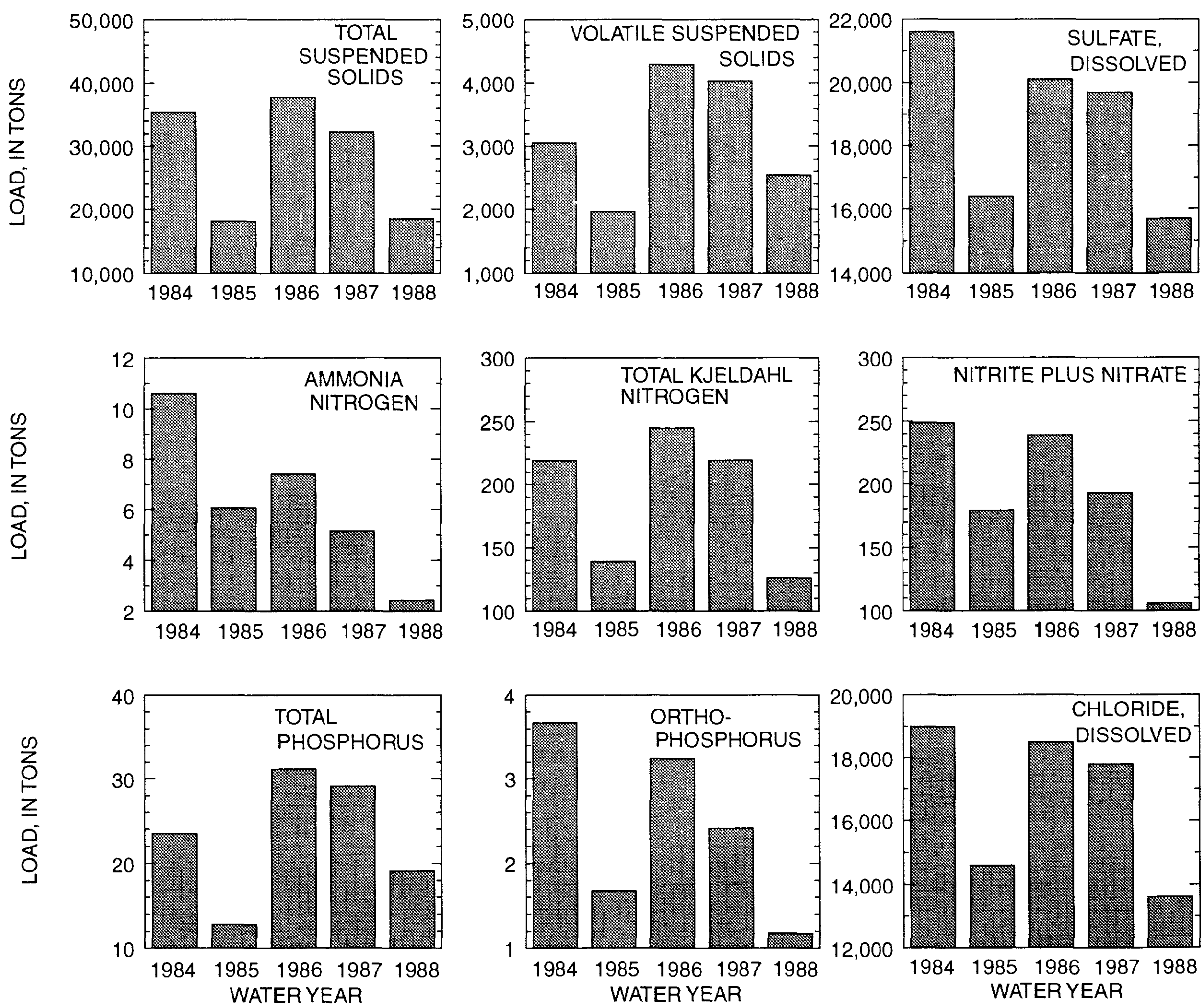


Figure 22. Estimated annual loads of selected constituents transported to Irondequoit Bay, water years 1984-88

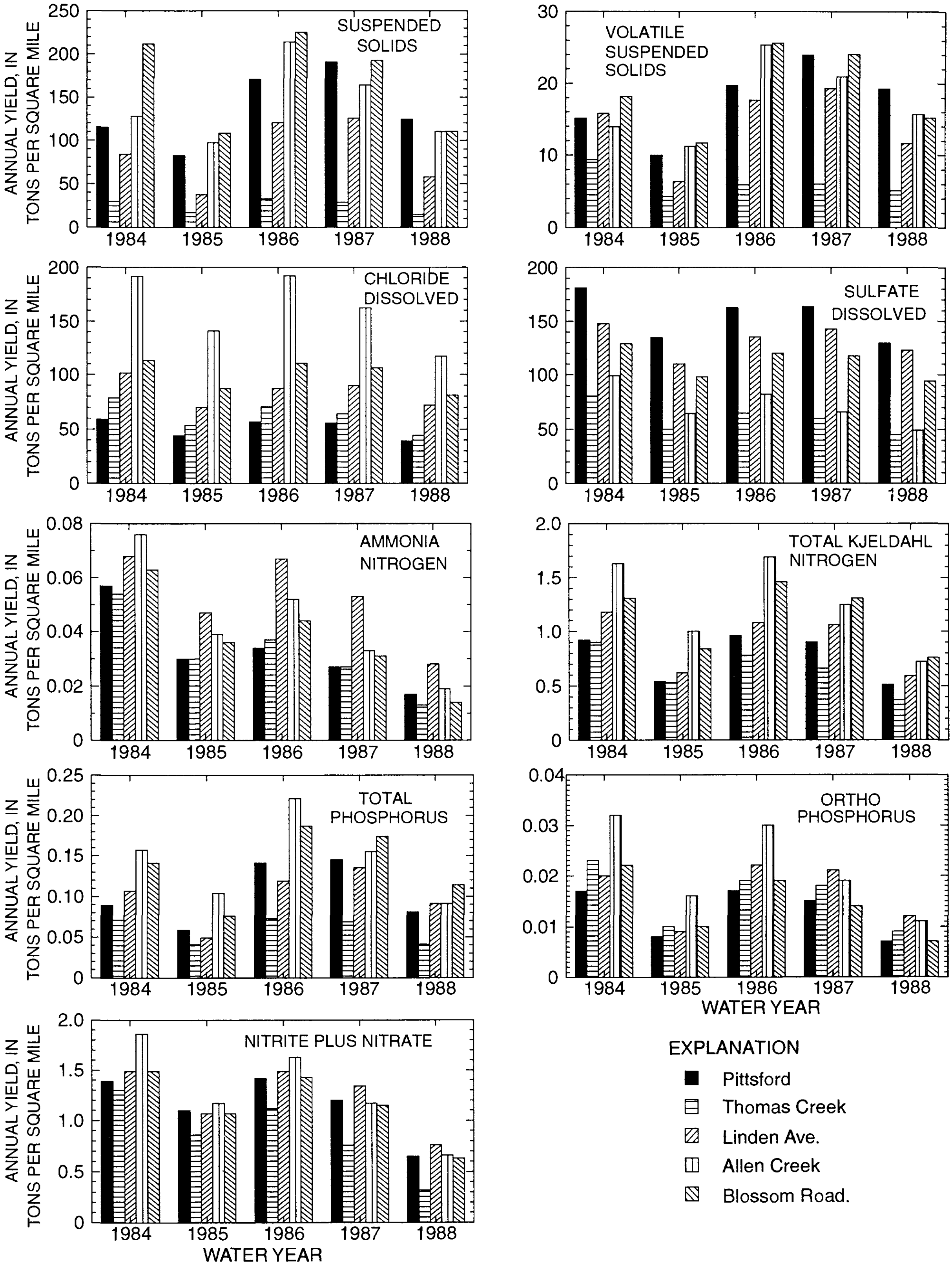


Figure 23. Annual yield of selected constituents from sites in the Irondequoit Creek Basin Monroe County, N.Y., water years 1984-88.

Table 24. Yield of four selected constituents at the five Irondequoit Creek subbasins in 1980-81 study and for water year 1988, with annual runoff for 1981 and 1988.

[1981 values are estimated annual yields; 1988 values are mean yields for water year. Yields are in tons per square mile. Runoff is in cubic feet per second per square mile.]

Station	Total suspended solids		Posphorus, total as P		Total Kjeldahl nitrogen		Chloride, dissolved		Runoff	
	1981	1988	1981	1988	1981	1988	1981	1988	1981	1988
Thornell Road	84.5	124	0.08	0.08	0.72	0.51	35.7	39.1	0.71	0.68
Thomas Creek	14.6	14.8	.06	.04	.57	.37	44.4	44.2	.47	.36
Linden Ave	69.2	58.0	.09	.09	.82	.59	64.6	71.9	.64	.65
Allen Creek	79.3	110	.13	.09	1.22	.72	134	117	.87	.70
Blossom Road	114	111	.12	.11	1.28	.76	97.7	81.0	.80	.69

the same at the Thomas Creek and Blossom Road sites. Dissolved chloride yield was slightly greater in 1988 than in 1981 at the Linden Avenue site; it was about the same at the Thornell Road and Thomas Creek sites, and slightly less at the Allen Creek and Blossom Road sites.

Table 24 can be used to compare loads transported to Irondequoit Bay in 1980-81 with those in 1988. The total constituent load at a given site can be calculated by multiplying the yield by the drainage area at that site; thus, load is directly correlated with yield. Annual loads of total Kjeldahl nitrogen and dissolved chloride to Irondequoit Bay increased slightly after 1981, whereas loads of total suspended solids and total phosphorus did not change significantly.

SUMMARY

The years of systematic collection of water-resources data in Monroe County provide a basis for statistical analysis of long-term trends. Long-term records of unregulated streamflow and precipitation are sufficient to determine the normality of a much shorter period of record, such as the 1984-88 study period analyzed herein.

Precipitation records collected and analyzed by the National Weather Service (NWS, NOAA) indicate that the average water-year total for 1984-88 was nearly 2 in., or about 6 percent, greater than normal. Analyses of bulk atmospheric-deposition samples collected at Mendon Ponds Park show a statistically significant trend in only two constituents over the 5-year study period–dissolved lead concentrations increased 14 percent per year, and dissolved sulfate concentration increased 16 percent per year. Median concentrations of constituents were significantly lower in atmospheric deposition than in streamflow at Irondequoit Creek near Pittsford. Atmospheric loads of constituents to the Irondequoit basin, based on data from Mendon Ponds Park, ranged from 13.7 ton/mi^2 for dissolved sulfate to 0.012 ton/mi^2 for dissolved lead.

Ground-water data indicate that the water-table aquifer and nearby streams in Ellison Park are part of the same shallow aquifer system, whether this is true in Powder Mill Park is unknown. Water-table gradients in the Ellison Park wells indicated frequent reversals in direction of ground-water flow to or from Irondequoit Creek, as well as reversals in the direction of vertical flow in the aquifer system. In contrast, the water table wells Mo 10 and Mo 11 in Powder Mill Park indicate that ground-water flow is well below the nearby Park Creek stream bottom. Most ground-water flow in the underlying confined aquifer monitored at well Mo 12, in the gap of the esker in Powder Mill Park, parallels the esker. Water-temperature profiles made during the study indicate an annual effective downward vertical velocity in the Ellison Park water-table aquifer; the rate ranges from about 0.06 ft/d on the western side of Irondequoit Creek to 0.08 ft/d on the eastern side. An effective downward vertical velocity of 0.08 ft/d was also indicated for the water-table aquifer in Powder Mill Park (wells Mo 10 and Mo 11), and 0.03 ft/d for the confined aquifer in the gap of the esker (well Mo 12).

The complexity of regional ground-water flow at Ellison Park makes the effects of ground-water chemistry on stream chemistry difficult to assess. Water from the area of wells Mo 1, Mo 2, and Mo 3 on the east side of the creek probably affects stream water quality the most. Median concentrations of ammonia nitrogen, orthophosphorus, dissolved chloride, and dissolved sulfate in Irondequoit Creek were between those at the two wells closest to the creek but on opposite sides of it (Mo 3 and Mo 4). Median concentrations of suspended solids, volatile suspended solids, total Kjeldahl nitrogen, nitrite plus nitrate, and total phosphorus were greater in Irondequoit Creek than in the nearest wells; median concentration of total dissolved solids and nitrite plus nitrate were highest in either well Mo 1 or Mo 2; and median concentration of total phosphorus was the same in well Mo 1 as in the stream.

Streamflow during 1984-88 can be considered in the normal range. Annual mean discharges of streams in the Irondequoit Creek basin were below normal in water years 1985 and 1988, above normal in water years 1984 and 1986, and about normal in water year 1987, but the 5-year average streamflow at all gaging stations was well within the normal range. Mean seasonal streamflow in the Irondequoit Creek basin during the winter snowmelt and spring runoff period was estimated to be within 4 percent of normal during the 1984-88 study period, except in the Allen Creek subbasin, where it was 6.5 percent below normal.

Trend analyses of long-term water-quality data from the Genesee River indicated that the only statistically significant trend was a downward trend in specific conductance during 1984-88. A seasonal analysis of 1984-88 data indicates downward trends for ammonia nitrogen during spring and summer and an upward trend for turbidity from October 1 through February 28. The period-of-record analysis indicated strong downward trends in total phosphorus during spring and summer and upward trends in dissolved chloride and dissolved sodium during the summer.

Median concentrations of some constituents during 1984-88 varied more widely among the five Irondequoit Creek basin sites than did others. Median concentrations of total phosphorus, total Kjeldahl nitrogen, and dissolved chloride were significantly greater at Allen Creek than at the other four sites. Total Kjeldahl nitrogen, total phosphorus, and ammonia nitrogen, were the nutrients that showed the greatest number of significant differences among sites. Median concentrations of each of these constituents differed significantly among most of the five sites.

Land use is the major cause of areal variability in stream-water quality in the Irondequoit Creek basin, but road-deicing salts cause local variations in chloride concentrations.

The study showed upward trends in suspended solids, volatile suspended solids, total Kjeldahl nitrogen, total phosphorus, orthophosphorus, and dissolved chloride of 2.4 to 36 percent per year at most sites and downward trends in ammonia nitrogen, nitrite plus nitrate, orthophosphorus, and dissolved sulfate of 4.2 to 28 percent per year.

The average annual load of total suspended solids transported to Irondequoit Bay during 1984-88 was about 28,400 ton/yr, of which volatile solids constituted about 3,200 tons, or about 11 percent. Nutrients were transported to the bay at an average rate of 190 ton/yr as total Kjeldahl nitrogen; 193 ton/yr as nitrite plus nitrate; 6.3 ton/yr as ammonia nitrogen; 23 ton/yr as total phosphorus; and at 2.4 ton/yr as orthophosphorus. Dissolved chloride was transported to the bay at an average rate of about 16,700 ton/yr, and dissolved sulfate was transported at a rate of 18,700 ton/yr.

The highest annual yields of all nutrients, except for ammonia nitrogen during the 1984-88 study, were from the Allen Creek subbasin; the lowest yields were mostly from the Thomas Creek subbasin. Annual yields of ammonia nitrogen and orthophosphorus were relatively uniform among the subbasins and ranged from 0.032 to 0.052 ton/mi^2 and 0.013 to 0.021 ton/mi^2 respectivly. Total Kjeldahl nitrogen was the only constituent to show a distinct difference in mean annual yield between the urbanized subbasins (1.1 ton/mi^2 for Allen Creek, Linden Avenue, and Blossom Road, combined) and the primarily agricultural subbasins (0.7 ton/mi^2 for Irondequoit Creek near Pittsford and Thomas Creek at Fairport, combined). The highest annual yields of dissolved chloride (161 ton/mi^2) were from the Allen Creek subbasin.

Although the 1981 annual mean discharge of Irondequoit Creek was in the lower quartile range, as opposed to the mean annual discharge for 1984-88, yields of total phosphorus, and total Kjeldahl nitrogen during 1984-88 were slightly less than in 1980-81. Yields of dissolved chloride and suspended solids, by contrast, were consistently higher during 1984-88 than during 1981. Irondequoit Creek transported greater annual mean loads of total suspended solids and total phosphorus and smaller loads of total Kjeldahl nitrogen, during 1984-88 than during 1981. Chloride loads, based on yields at the Blossom Road site, were about the same in both periods.

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APPENDIXES

APPENDIX A. Laboratory Analysis: Laboratory quality- asssurance/quality-control programs between the Monroe County Environmental Health Laboratory (MCEHL) and agencies other than USGS

Quality-Assurance/Quality-Control (QA/QC) protocols were developed to ensure that laboratory analyses of water samples by MCEHL are accurate and free of analytical bias. The protocols entail two procedures: (1) analysis of split samples, and (2) participation in the USGS Standard Reference Water Sample (SRWS) program. The first procedure was done by splitting the samples into eight parts, four of which were analyzed by the MCEHL and four by the USGS National Water Quality Laboratory. Analytical results from the two laboratories for each constituent were then compared through a t-test and tested for bias. Of the samples collected in November 1987 and June 1989, only the mean concentrations of nitrite plus nitrate samples collected in November differed significantly and showed a significantly high bias. Mean concentrations of orthophosphorus in samples collected in June 1989 by MCEHL were significantly different from those collectedby the USGS but did not show a significantly high bias. Analytical results for two selected constituents in samples collected by the USGS and the MCEHL are shown in figure A1.

MCEHL is required to participate in a SRWS program as a part of the USGS quality-assurance program for cooperating laboratories, Under this program, the USGS National Water Quality Laboratory (NWQL) submits reference samples (major constituents, trace constituents, and nutrients) twice yearly to laboratories that analyze water samples as part of a cooperative program. The analytical results from all participating laboratories are sent to the NWQL and statistical analysis to determine the "most probable value" (MPV) for each constituent. Results from each laboratory are then compared against the MPV and rated by increments of standard deviation from the MPV. During the 5-year period of this study (1984-88), the MCEHL rated good to excellent (less than 1.0 standard deviation from the MPV) for major ions and nutrients.

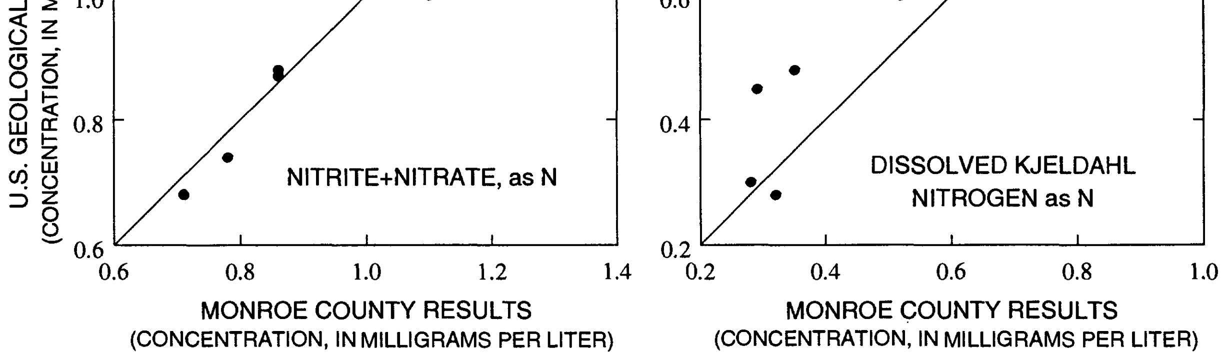

Figure A1. Analytical results obtained for two nutrients by the U.S. Geological Survey National Water Quality Laboratory and Monroe County Environmental Health Laboratory for split samples collected in November 1987 and June 1989.

A detailed explanation of the QA/QC procedures and results is given in the companion report (Johnston and Sherwood, 1994). Additional data on QA/QC programs in which MCEHL participates, either internally or with agencies of the State of New York, were statistically analyzed to further ensure that data used for the analysis of trends and calculation of chemical loads in this report were accurate and free from analytical bias. The types and frequency of QA/QC procedures used by MCEHL are summarized in table A1.

To satisfy the compliance requirements of the Public Health Law and State Sanitary Code, MCEHL is required to participate in the New York State Department of Health's Environmental Laboratory Approval Program (ELAP). Prior to 1987, the New York State ELAP was conducted twice yearly and included limited nutrient analyses, as well as chloride and sulfate. The proficiency program, from 1987 to present, is conducted four times per year–twice for potable samples and twice for nonpotable samples. Only results from the nonpotable samples and environmental samples were of concern for this report.

MCEHL has its own external quality-control program. The laboratory receives synthetic concentrate samples from the U.S. Environmental Protection Agency (USEPA), for which the value of each constituent is known. Blind field duplicate and blind laboratory split environmental samples are also used as external quality-control checks.

The MCEHL has an internal quality-control program in which the analysts use standard stock solutions and environmental samples to make reference standards, spikes, and duplicates.

Each method is calibrated daily by running blanks and one or more sets of standards of known concentrations ranging from low to high. Accuracy of laboratory equipment is closely monitored. Laboratory instruments are maintained and calibrated according to manufacturers' instructions.

All quality-control data are tabulated in a monthly report. Any quality-assurance and (or) quality-control problems and remedial actions taken are discussed in the monthly reports. A summary of the analytical methods used for selected chemical constituents is given in table A-2.

Table A1. Type and frequency of quality-assurance/ quality-control procedures used by Monroe County Environmental Health Laboratory.

Type of procedure or instrument calibration	Frequency
Procedure	**Frequency**
Method standards	1 in 20 to 1 in 50
Duplicate samples	1 in 10
Spiked samples	1 in 20 to 1 in 50
Blind external reference samples1	1 in 10
Blind laboratory split samples	1 in 20
Blind field duplicate samples	1 in 20
U.S. Geological Survey Standard Water Reference Sample program	twice yearly
New York State Health Department Environmental Laboratory Approval Program	quarterly
Instrument Calibrations	
Field instruments	each use
Analytical balances (National Bureau of Standards standards)	once daily
Ovens/water baths (National Bureau of Standards thermometers)	twice daily
pH meters (standard buffers)	each use
Conductivity meters (KCl standards)	each use
Turbidimeter (formazin standards)	each use
Turbidimeter (formazin standards)	twice yearly
Atomic absorption spectrophotometer	
(standards)	each use
(instrument specifications)	twice yearly
Total organic carbon analyzer	
(standards)	each use
(instrument specifications	quarterly
Gas chromatograph	
(standards)	each use
(instrument specifications)	quarterly

Table A2. Analytical methods used by Monroe County Environmental Health Laboratory for selected chemical constituents.
[USGS, U.S. Geological Survey. EPA, U.S. Environmental Protection Agency. ASTM, Association of Testing and Materials. SM, Standard Methods. ELAP,

Analyte	Method			Comments
	Description	Reference[1]	Code-ELAP*	
Ammonia nitrogen	Phenate	USGS I-2523-78 USGS I-4523-85	2034	Method used 1980-88
Total Kjeldahl nitrogen	Block digestion/salicyclate hypochlorite	USGS I-2552-78 EPA-1979(351.2) (ASTM D3590-89(B)	No reference 2230 2223	Method used 1980-84 Method used 1984-present
Nitrite plus nitrate	Cadmium reduction, diazotization	EPA 1979 (353.2)	2281	Method used 1980-88
Total phosphate	Persulfate digestion, molybdenum blue by ascorbic acid (automated)	SM17(4500P.F) See also SM 15+16	9057	Method used 1980-81
	same as above (manual)	SM17(4500 P-E) See also SM 15+16	9058	Method used 1981-present
Orthophosphate	--- --- --- --- Same as for total phosphate ---- --- --- ---			
Chloride	Colorimetric ferricyanide (automated)	SM 17(4500-CL-C) See also SM 15+16	9023 2112	Method used 1980-84
	Mercuric nitrate	SM 17(4500-CL-C See also SM 15+16	9022	Method used 1985-present
Sulfate	Colorimetric, complexo -metric methythymol blue (automated)	USGS I-2822-77	No reference	Method used 1980-88

[1] USGS - Methods for the determination of inorganic sudstances in water and fluvial sediments: U.S. Geological Survey Techniques of Water Resources Investigations, Book 5, Chapter A1.

SM 17 - Standard Methods for the Examination of Water and Wastewater, 17th edition.

EPA - Methods for Chemical Analysis of Water and Waste March, 1979.

* ELAP- Environmental Laboratory Approval Program (New York State Health Department).

APPENDIX B. Monthly Constituent Loads and Associated Error for the Five Study Sites in the Irondequoit Creek Basin, Monroe County, N.Y., Water Years 1984-88.

Table B1. Monthly, chemical loads and associated error for the five study sites in the Irondequoit Creek basin, Monroe County, N.Y., water years 1984-88

[Loads are in tons. Error when multiplied by 1.96 and added to and subtracted from the estimated load, provides the 95-percent confidence limits of the load estimate. Site locations are shown in fig 2.]

A. Irondequoit Creek at Pittsford, N.Y.

WATER YEAR 1984

Month	Total suspended solids		Volatile suspended solids		Ammonia nitrogen as N		Total phosphorus, as P		Ortho-phosphorus, as P		Total Kjeldahl nitrogen as N		Nitrite plus nitrate, as N		Chloride, dissolved		Sulfate, dissolved	
	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error
OCT	75.0	21.6	15.7	4.30	0.09	0.02	0.06	0.01	0.021	0.003	0.97	0.12	2.06	0.12	104	4.79	450	28.2
NOV	399	117	66.6	17.7	.20	.05	.31	.08	.090	.017	3.86	.51	5.10	.32	241	11.2	804	49.9
DEC	655	233	95.2	29.6	.27	.09	.48	.18	.112	.029	4.32	.68	7.47	.53	297	14.9	863	56.3
JAN	172	46.9	27.4	7.15	.11	.04	.08	.02	.016	.002	1.22	.15	4.35	.28	192	8.3	544	35.9
FEB	711	248	85.1	26.1	.27	.09	.42	.15	.062	.016	3.76	.60	7.63	.55	309	14.2	724	48.1
MAR	595	178	69.7	18.6	.26	.07	.35	.10	.047	.010	3.58	.49	6.24	.38	287	12.7	709	42.3
APR	765	210	87.2	21.6	.34	.09	.52	.14	.071	.014	5.09	.63	6.97	.41	306	13.4	806	46.7
MAY	1018	308	114	31.3	.48	.14	.95	.27	.140	.030	8.49	1.15	8.50	.54	324	14.7	936	55.8
JUN	173	43.0	24.5	5.70	.15	.03	.15	.03	.027	.004	2.42	.27	3.40	.19	140	6.01	531	30.9
JUL	88.4	22.5	14.5	3.53	.10	.02	.09	.02	.019	.003	1.43	.16	2.56	.15	105	4.58	443	26.2
AUG	241	73.1	37.4	10.2	.15	.04	.29	.08	.073	.014	3.17	.44	4.01	.25	167	7.86	631	39.1
SEP	217	65.4	35.3	9.46	.12	.03	.24	.07	.066	.013	2.52	.34	3.59	.22	155	7.06	589	35.4
TOTAL	5110	1566	673	185	2.54	.69	3.93	1.14	.744	.154	40.8	5.54	61.9	3.94	2617	120	8030	495

WATER YEAR 1985

Month	Total suspended solids		Volatile suspended solids		Ammonia nitrogen as N		Total phosphorus, as P		Ortho-phosphorus, as P		Total Kjeldahl nitrogen as N		Nitrite plus nitrate, as N		Chloride, dissolved		Sulfate, dissolved	
	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error
OCT	138	33.4	24.2	5.61	0.08	0.02	0.12	0.02	0.033	0.004	1.55	0.16	2.91	0.16	132	5.53	516	29.2
NOV	141	36.9	23.7	6.00	.07	.02	.10	.02	.024	.003	1.34	.14	3.06	.17	134	5.72	490	28.2
DEC	414	148	55.4	16.9	.12	.03	.28	.10	.047	.011	2.50	.37	5.88	.38	221	10.4	648	39.2
JAN	326	113	42.6	13.2	.10	.03	.20	.07	.030	.007	1.82	.29	5.51	.36	202	9.53	553	35.1
FEB	781	361	78.8	31.6	.20	.09	.56	.26	.059	.020	3.23	.66	6.71	.55	241	12.7	548	37.1
MAR	750	203	80.2	19.8	.20	.05	.45	.11	.047	.008	3.97	.48	7.17	.41	306	12.9	714	40.6
APR	521	167	56.0	15.7	.17	.04	.35	.11	.036	.008	3.03	.40	5.18	.31	221	9.85	593	34.3
MAY	176	45.4	22.2	5.46	.10	.02	.13	.02	.016	.002	1.55	.17	3.16	.17	127	5.36	441	25.1
JUN	218	60.0	27.8	7.02	.11	.02	.20	.05	.028	.005	2.57	.32	3.50	.20	135	5.90	492	28.4
JUL	67.3	20.3	10.7	3.14	.07	.02	.07	.01	.012	.002	.92	.11	2.13	.12	80.5	3.62	346	21.1
AUG	45.2	15.7	8.00	2.74	.06	.01	.05	.01	.010	.002	.54	.07	1.72	.11	64.7	3.14	292	19.3
SEP	76.3	22.8	13.4	3.87	.06	.01	.08	.02	.018	.003	.79	.09	2.03	.12	83.0	3.69	352	21.0
TOTAL	3653	1228	443	131	1.33	.34	2.60	.80	.361	.075	23.8	3.26	49.0	3.06	1947	88.4	5985	358

Appendix B. Monthly Constituent Loads and Associated Error for the Five Study Sites in the Irondequoit Creek Basin, Monroe County, N.y., Water Years 1984-88--(continued)

A. Irondequoit Creek at Pittsford, N.Y. (continued)

WATER YEAR 1986

Month	Total suspended solids		Volatile suspended solids		Ammonia nitrogen as N		Total phosphorus, as P		Ortho-phosphorus, as P		Total Kjeldahl nitrogen as N		Nitrite plus nitrate, as N		Chloride, dissolved		Sulfate, dissolved	
	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error
OCT	72.0	23.7	12.8	4.14	0.05	0.01	0.06	0.01	0.01	0.00	0.68	0.08	1.92	0.12	81.4	3.74	340	21.2
NOV	915	256	122	31.9	.16	.04	.84	.19	.15	.02	6.36	.78	7.37	.43	302	13.5	883	52.3
DEC	487	135	66.2	17.1	.09	.02	.34	.08	.05	.01	2.90	.36	5.90	.34	231	10.3	673	39.9
JAN	907	408	97.2	38.2	.14	.06	.67	.30	.07	.02	3.30	.65	7.51	.60	252	13.5	607	40.9
FEB	990	323	104	30.3	.15	.04	.62	.19	.06	.01	4.02	.59	7.73	.51	299	13.7	660	41.3
MAR	1302	419	128	36.7	.21	.06	.89	.28	.07	.02	5.20	.74	8.00	.51	334	15.1	740	43.5
APR	1239	461	120	38.4	.23	.08	1.02	.40	.08	.02	5.37	.82	6.91	.47	283	13.2	707	42.2
MAY	363	92.8	42.9	10.2	.11	.02	.28	.06	.03	.00	2.63	.31	3.86	.21	162	6.83	526	29.6
JUN	304	77.8	38.8	9.20	.10	.02	.29	.06	.03	.01	3.05	.36	3.60	.20	147	6.34	527	30.1
JUL	215	59.2	30.9	7.84	.08	.02	.24	.06	.03	.01	2.38	.30	3.05	.17	127	5.54	490	28.3
AUG	467	170	63.7	20.4	.11	.03	.62	.20	.10	.02	4.28	.69	4.13	.27	173	8.42	612	38.0
SEP	316	140	46.8	18.0	.07	.02	.38	.16	.07	.02	2.32	.45	2.86	.19	126	6.42	468	29.4
TOTAL	7575	2565	874	262	1.50	.43	6.25	2.00	.75	.17	42.5	6.11	62.8	4.03	2519	117	7233	437

WATER YEAR 1987

Month	Total suspended solids		Volatile suspended solids		Ammonia nitrogen as N		Total phosphorus, as P		Ortho-phosphorus, as P		Total Kjeldahl nitrogen as N		Nitrite plus nitrate, as N		Chloride, dissolved		Sulfate, dissolved	
	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error
OCT	714	209	106	28.5	0.11	0.03	0.76	0.19	0.13	.02	5.19	0.67	4.98	0.30	237	10.9	781	47.6
NOV	624	216	89.6	27.1	.09	.02	.52	.16	.07	.02	3.55	.49	4.60	.28	213	9.65	674	40.0
DEC	1380	440	178	51.3	.14	.04	1.09	.33	.13	.03	5.91	.82	8.18	.50	336	15.3	895	53.3
JAN	677	206	87.7	24.3	.08	.02	.39	.10	.04	.01	2.64	.34	5.93	.36	250	11.3	645	39.1
FEB	382	111	49.6	13.7	.06	.01	.19	.04	.02	.00	1.54	.18	3.88	.23	184	7.90	468	28.1
MAR	1259	424	137	40.5	.14	.04	.77	.26	.06	.01	4.30	.60	6.13	.39	298	13.4	686	40.0
APR	2223	671	228	61.7	.25	.07	1.65	.47	.11	.02	7.69	1.01	7.66	.48	358	16.3	853	50.4
MAY	414	98.4	53.7	12.0	.09	.02	.29	.05	.02	.00	2.43	.26	3.18	.17	157	6.52	522	29.5
JUN	245	62.9	35.9	8.66	.07	.02	.21	.04	.02	.00	2.05	.24	2.44	.14	116	5.02	448	25.7
JUL	226	60.2	35.9	8.89	.07	.01	.22	.05	.03	.00	2.07	.25	2.35	.13	116	4.94	464	26.3
AUG	143	40.7	26.3	7.16	.05	.01	.15	.03	.02	.00	1.15	.13	1.84	.10	93.2	3.88	398	22.4
SEP	193	56.2	36.5	10.0	.05	.01	.19	.04	.03	.00	1.32	.16	1.90	.10	104	4.47	428	24.5
TOTAL	8482	2595	1063	294	1.20	.30	6.44	1.75	.68	.13	39.8	5.14	53.1	3.19	2461	109	7261	427

Appendix B. Monthly Constituent Loads and Associated Error for the Five Study Sites in the Irondequoit Creek Basin, Monroe County, N.y., Water Years 1984-88--(continued)

A. Irondequoit Creek at Pittsford, N.Y. (continued)

WATER YEAR 1988

Month	Total suspended solids		Volatile suspended solids		Ammonia nitrogen as N		Total phosphorus, as P		Ortho-phosphorus, as P		Total Kjeldahl nitrogen as N		Nitrite plus nitrate, as N		Chloride, dissolved		Sulfate, dissolved	
	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error
OCT	224	64.8	43.1	11.9	0.05	0.01	0.19	0.04	0.03	0.00	1.43	0.16	1.99	0.12	117	5.16	467	27.8
NOV	321	126	56.3	19.5	.05	.01	.22	.07	.03	.01	1.55	.24	2.27	.14	130	6.20	472	29.5
DEC	627	198	102	30.1	.06	.01	.37	.08	.04	.01	2.43	.30	3.86	.23	209	9.36	644	38.5
JAN	420	150	65.7	21.8	.05	.01	.20	.05	.02	.00	1.37	.19	3.16	.20	167	7.84	483	30.4
FEB	696	221	99.3	29.8	.07	.02	.32	.07	.02	.00	2.20	.28	3.64	.22	217	9.88	554	34.8
MAR	618	217	85.9	27.6	.07	.02	.31	.09	.02	.00	1.97	.27	2.84	.17	188	8.71	509	31.3
APR	978	388	128	44.6	.10	.03	.58	.21	.04	.01	3.08	.47	3.14	.21	204	9.96	581	36.6
MAY	774	289	109	37.2	.10	.03	.57	.19	.04	.01	3.47	.56	2.72	.18	165	8.42	559	36.8
JUN	122	46.6	23.0	8.48	.05	.01	.09	.02	.01	.00	.80	.10	1.91	.08	70.2	3.54	313	21.4
JUL	449	251	75.6	37.2	.07	.02	.50	.26	.05	.02	2.80	.66	1.80	.14	110	6.42	445	31.6
AUG	157	60.5	35.1	12.9	.04	.01	.14	.04	.02	.00	.98	.13	1.24	.08	82.6	3.87	379	23.6
SEP	127	51.6	31.3	12.3	.04	.01	.11	.02	.02	.00	.71	.09	1.06	.07	74.9	3.60	351	22.7
TOTAL	5514	2065	854	294	.74	.19	3.61	1.14	.33	.07	22.8	3.44	28.9	1.83	1735	83.0	5759	365

B. Thomas Creek ar Fairport, N.Y.

WATER YEAR 1984

Month	Total suspended solids		Volatile suspended solids		Ammonia nitrogen as N		Total phosphorus, as P		Ortho-phosphorus, as P		Total Kjeldahl nitrogen as N		Nitrite plus nitrate, as N		Chloride, dissolved		Sulfate, dissolved	
	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error
OCT	9.46	4.09	8.52	5.08	0.02	0.01	0.03	0.01	0.011	0.002	0.44	0.03	0.29	0.03	58.6	4.07	123	9.91
NOV	63.4	25.6	32.6	18.5	.12	.03	.15	.02	.061	.011	2.20	.18	2.50	.26	225	15.8	293	24.0
DEC	100	37.8	45.2	23.8	.27	.09	.30	.05	.125	.027	4.00	.34	8.21	.91	385	25.9	373	31.7
JAN	12.2	5.32	9.72	5.61	.05	.01	.04	.01	.009	.001	.87	.07	2.05	.20	141	9.19	111	9.12
FEB	90.7	33.6	31.0	15.6	.32	.14	.31	.07	.102	.028	3.67	.37	8.55	1.11	353	26.1	230	21.8
MAR	92.5	29.6	26.8	12.1	.19	.07	.22	.04	.056	.013	2.91	.24	4.46	.49	280	19.1	182	14.7
APR	141	39.3	34.5	14.2	.20	.06	.27	.04	.069	.011	3.74	.27	4.53	.43	296	19.0	213	15.8
MAY	231	70.2	42.3	18.5	.24	.08	.48	.08	.148	.031	5.01	.39	4.56	.46	276	17.7	286	22.6
JUN	26.4	8.04	8.60	3.69	.03	.01	.06	.01	.013	.002	.77	.06	.54	.05	59.3	3.92	101	7.30
JUL	16.4	4.97	6.22	2.70	.02	.01	.04	.01	.011	.002	.48	.04	.34	.03	40.1	2.60	97.6	7.16
AUG	38.5	12.6	11.5	5.23	.03	.01	.08	.01	.026	.004	.80	.06	.61	.06	63.0	4.24	142	11.0
SEP	28.7	8.92	10.6	4.65	.03	.01	.06	.01	.023	.003	.71	.05	.49	.05	66.8	4.27	137	10.1
TOTAL	850.4	280.0	267.7	129.6	1.55	.52	2.03	.33	.653	.136	25.61	2.09	37.13	4.08	2243	151.8	2290	185

Appendix B. Monthly Constituent Loads and Associated Error for the Five Study Sites in the Irondequoit Creek Basin, Monroe County, N.y., Water Years 1984-88--(continued)

B. Thomas Creek at Fairport, N.Y. (continued)

WATER YEAR 1985

Month	Total suspended solids		Volatile suspended solids		Ammonia nitrogen as N		Total phosphorus, as P		Ortho-phosphorus, as P		Total Kjeldahl nitrogen as N		Nitrite plus nitrate, as N		Chloride, dissolved		Sulfate, dissolved	
	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error
OCT	11.7	3.88	6.54	3.07	0.03	0.01	0.04	0.01	0.012	0.002	0.47	0.03	0.34	0.03	59.8	3.69	112	8.15
NOV	21.5	7.48	9.94	4.85	.05	.01	.06	.01	.018	.003	.86	.06	1.03	.10	110	7.14	143	10.6
DEC	26.0	11.4	9.72	5.54	.07	.03	.07	.02	.022	.006	1.15	.12	2.72	.39	144	11.0	131	10.8
JAN	32.6	13.1	11.5	6.25	.09	.03	.09	.02	.024	.006	1.48	.13	3.92	.46	188	12.9	133	11.1
FEB	69.8	28.9	14.9	8.42	.18	.08	.21	.05	.058	.017	2.37	.25	5.31	.73	234	19.1	141	13.2
MAR	112	33.5	23.4	10.2	.19	.05	.24	.03	.054	.009	3.31	.23	5.83	.54	330	20.4	184	13.3
APR	72.4	22.4	14.4	6.40	.10	.03	.14	.02	.029	.006	1.95	.15	2.46	.26	181	12.0	121	9.00
MAY	65.0	22.1	11.0	5.16	.06	.02	.12	.02	.027	.005	1.51	.13	1.39	.16	110	7.91	105	8.03
JUN	37.7	10.9	7.89	3.28	.03	.01	.08	.01	.017	.003	.91	.06	.65	.06	65.6	4.13	101	7.01
JUL	14.0	4.14	4.19	1.86	.02	.01	.04	.01	.010	.001	.41	.03	.28	.02	34.9	2.20	82.7	5.99
AUG	8.29	2.81	3.14	1.59	.02	.01	.03	.01	.009	.001	.27	.02	.19	.02	27.6	1.83	75.2	5.99
SEP	14.2	4.62	4.82	2.25	.02	.01	.04	.01	.013	.002	.93	.03	.26	.03	41.2	2.71	90.5	6.79
TOTAL	485.5	165.3	121.4	58.9	.85	.27	1.17	.19	.292	.060	15.1	1.24	24.4	2.79	1527	105.0	1420	110.0

WATER YEAR 1986

Month	Total suspended solids		Volatile suspended solids		Ammonia nitrogen as N		Total phosphorus, as P		Ortho-phosphorus, as P		Total Kjeldahl nitrogen as N		Nitrite plus nitrate, as N		Chloride, dissolved		Sulfate, dissolved	
	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error
OCT	10.9	3.86	4.58	2.36	0.02	0.01	0.04	0.01	0.012	0.002	0.40	0.03	0.28	0.03	51.5	3.35	95.2	7.20
NOV	113	40.2	24.5	12.7	.13	.04	.27	.04	.097	.017	2.81	.21	3.38	.33	256	17.1	281	21.6
DEC	66.5	24.2	17.0	8.96	.11	.03	.16	.06	.049	.009	2.16	.16	4.08	.39	239	15.4	202	15.5
JAN	72.4	31.6	14.8	8.89	.17	.08	.24	.06	.071	.021	2.58	.27	7.00	.98	261	20.5	166	15.2
FEB	70.1	26.3	14.4	7.74	.12	.04	.17	.03	.037	.007	2.28	.18	4.87	.50	258	17.6	138	10.9
MAR	118	40.9	19.5	9.76	.17	.05	.27	.04	.058	.011	3.09	.24	4.94	.49	304	19.7	165	12.4
APR	125	42.5	17.8	8.60	.12	.04	.26	.04	.054	.011	2.72	.21	3.05	.31	223	14.5	144	10.8
MAY	41.7	14.0	7.62	3.56	.04	.01	.09	.01	.016	.003	1.02	.08	.79	.08	85.4	5.42	84.5	6.04
JUN	152	54.5	18.3	9.01	.07	.02	.27	.04	.068	.012	2.41	.18	1.65	.16	133	8.73	178	13.4
JUL	69.6	21.5	11.7	5.12	.03	.01	.13	.02	.033	.005	1.17	.08	.76	.07	78.1	4.77	145	10.1
AUG	68.3	23.3	12.2	5.57	.03	.01	.14	.02	.041	.007	1.06	.08	.71	.07	76.1	4.88	151	11.3
SEP	21.1	8.06	5.78	2.90	.02	.01	.06	.01	.018	.004	.46	.04	.27	.03	46.5	3.42	94.2	7.31
TOTAL	928.0	331.0	168.3	85.2	1.05	.33	2.09	.32	.555	.109	22.17	1.76	31.79	3.43	2011	135.3	1844	142.0

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Appendix B. Monthly Constituent Loads and Associated Error for the Five Study Sites in the Irondequoit Creek Basin, Monroe County, N.y., Water Years 1984-88--(continued)

B. Thomas Creek at Fairport, N.Y. (continued)

WATER YEAR 1987

Month	Total suspended solids		Volatile suspended solids		Ammonia nitrogen as N		Total phosphorus, as P		Ortho-phosphorus, as P		Total Kjeldahl nitrogen as N		Nitrite plus nitrate, as N		Chloride, dissolved		Sulfate, dissolved	
	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error
OCT	123	44.8	23.5	11.9	0.08	0.02	0.28	0.04	0.103	0.019	2.13	0.16	1.37	0.14	176	11.5	251	19.6
NOV	50.5	18.3	13.8	7.10	.06	.02	.13	.02	.039	.007	1.36	.11	1.45	.16	153	10.5	171	13.2
DEC	125	44.2	27.7	14.4	.15	.04	.32	.05	.101	.018	3.38	.25	5.76	.54	340	21.7	274	20.8
JAN	36.1	14.4	10.7	5.99	.06	.02	.10	.02	.022	.004	1.38	.11	2.91	.31	185	12.4	119	9.30
FEB	14.9	6.20	5.49	3.27	.04	.01	.05	.01	.008	.001	.70	.05	1.18	.11	114	7.48	69.7	5.23
MAR	104	37.0	19.3	9.90	.12	.04	.25	.04	.050	.010	2.59	.20	3.57	.38	273	18.3	148	11.2
APR	209	70.3	29.7	14.4	.16	.04	.45	.06	.095	.016	3.96	.28	3.82	.36	310	19.8	194	14.2
MAY	42.6	13.7	9.06	4.17	.03	.01	.09	.01	.016	.002	.98	.07	.63	.06	87.4	5.49	84.9	5.90
JUN	19.3	5.98	5.23	2.40	.02	.01	.06	.01	.010	.001	.49	.03	.24	.02	42.5	2.63	71.4	5.00
JUL	29.6	8.64	7.56	3.17	.02	.01	.08	.01	.017	.002	.57	.04	.28	.02	46.2	2.80	98.5	6.78
AUG	38.4	11.4	10.2	4.22	.02	.01	.09	.01	.025	.004	.64	.04	.33	.03	55.2	3.30	119	8.29
SEP	24.9	7.10	8.94	3.74	.02	.01	.07	.01	.020	.003	.51	.03	.23	.02	53.8	3.28	108	7.55
TOTAL	816.9	281.9	171.2	84.70	.78	.21	1.96	.27	.506	.087	18.70	1.39	21.79	2.16	1837	119.2	1707	127.1

WATER YEAR 1988

Month	Total suspended solids		Volatile suspended solids		Ammonia nitrogen as N		Total phosphorus, as P		Ortho-phosphorus, as P		Total Kjeldahl nitrogen as N		Nitrite plus nitrate, as N		Chloride, dissolved		Sulfate, dissolved	
	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error
OCT	25.9	8.13	10.3	4.59	0.02	.01	0.08	0.01	0.022	0.003	0.61	0.04	0.28	0.03	73.1	4.46	122	9.03
NOV	29.8	12.6	11.7	6.32	.03	.01	.09	.02	.026	.006	.83	.08	.67	.10	106	7.88	131	10.7
DEC	43.4	16.6	16.6	8.89	.05	.01	.12	.02	.031	.006	1.34	.11	1.70	.18	178	11.9	154	11.8
JAN	20.0	8.88	8.55	5.27	.03	.01	.06	.01	.012	.002	.79	.07	1.20	.14	123	9.13	87.4	7.06
FEB	58.4	23.5	18.1	10.3	.06	.02	.15	.02	.029	.006	1.68	.14	2.16	.23	221	15.6	124	9.98
MAR	43.9	19.3	13.2	7.75	.04	.01	.11	.02	.020	.005	1.14	.10	.97	.11	150	10.6	92.8	7.41
APR	66.1	29.2	16.4	9.70	.05	.02	.17	.03	.032	.009	1.41	.13	.96	.13	145	11.1	102	8.47
MAY	46.0	17.2	13.6	7.41	.02	.01	.10	.01	.018	.003	.99	.07	.44	.04	92.5	5.92	94.1	6.96
JUN	15.2	5.95	6.32	3.62	.01	.01	.05	.01	.009	.001	.40	.03	.14	.01	38.1	2.52	70.1	5.40
JUL	27.0	11.0	9.88	5.62	.01	.01	.08	.01	.017	.003	.49	.04	.17	.02	43.4	2.91	100	7.56
AUG	29.8	13.7	11.9	7.14	.01	.01	.09	.01	.024	.005	.50	.04	.17	.02	47.1	3.39	112	8.58
SEP	15.5	6.27	9.33	5.48	.01	.01	.06	.01	.015	.002	.35	.02	.11	.01	42.2	2.85	96.5	7.37
TOTAL	420.9	172.2	145.8	82.1	.37	.11	1.16	.18	.257	.051	10.5	.87	8.98	1.00	1260	88.4	1286	100.4

Appendix B. Monthly Constituent Loads and Associated Error for the Five Study Sites in the Irondequoit Creek Basin, Monroe County, N.y., Water Years 1984-88--(continued)

C. Irondequoit Creek at Linden Avenue near Rochester, N.Y.

WATER YEAR 1984

Month	Total suspended solids		Volatile suspended solids		Ammonia nitrogen as N		Total phosphorus, as P		Ortho-phosphorus, as P		Total Kjeldahl nitrogen as N		Nitrite plus nitrate, as N		Chloride, dissolved		Sulfate, dissolved	
	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error
OCT	111	36.0	36.6	19.1	0.17	0.04	0.24	0.04	0.057	0.008	2.90	0.22	3.43	0.20	358	19.2	804	40.1
NOV	413	135	106	56.1	.24	.05	.74	.14	.168	.025	8.07	.63	10.3	.58	772	39.8	1288	61.5
DEC	1332	578	221	148	.64	.17	1.46	.40	.294	.060	14.6	1.42	20.4	1.30	1224	67.3	1617	80.7
JAN	69.5	23.9	19.0	10.3	.42	.09	.17	.03	.041	.006	3.35	.24	9.61	.59	807	46.1	1060	56.6
FEB	967	439	140	99.0	1.16	.36	1.42	.44	.240	.056	13.0	1.39	22.0	1.50	1425	81.5	1389	70.8
MAR	617	249	107	66.6	.50	.12	.86	.22	.118	.023	11.4	1.06	17.2	.99	1220	60.6	1330	60.2
APR	824	256	158	77.8	.61	.13	1.04	.21	.135	.021	15.3	1.20	17.1	.92	1171	56.9	1432	64.0
MAY	2237	911	360	221	1.29	.35	2.52	.70	.382	.082	21.6	1.98	17.2	1.03	1037	53.7	1456	68.4
JUN	196	50.8	55.2	23.5	.39	.08	.41	.07	.098	.013	4.88	.35	6.19	.33	425	20.8	831	37.5
JUL	125	34.9	37.6	17.0	.21	.04	.21	.04	.066	.009	2.93	.21	4.35	.24	280	14.4	686	32.9
AUG	521	160	129	64.4	.32	.07	.45	.10	.149	.026	4.43	.53	6.26	.37	379	20.0	936	44.9
SEP	397	129	96.9	50.1	.33	.07	.39	.09	.111	.020	5.08	.42	4.68	.27	353	18.0	870	40.6
TOTAL	7808	3004	1467	853	6.28	1.57	9.91	2.48	1.86	.350	110	9.67	139	8.29	9451	498.3	13700	658.4

WATER YEAR 1985

Month	Total suspended solids		Volatile suspended solids		Ammonia nitrogen as N		Total phosphorus, as P		Ortho-phosphorus, as P		Total Kjeldahl nitrogen as N		Nitrite plus nitrate, as N		Chloride, dissolved		Sulfate, dissolved	
	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error
OCT	124	35.0	33.1	15.1	0.18	0.04	0.21	0.04	0.049	0.007	2.60	0.18	3.50	0.19	308	16.0	731	35.4
NOV	120	34.0	29.2	13.6	.14	.03	.21	.04	.046	.006	2.87	.20	5.38	.30	405	21.1	807	39.3
DEC	393	171	64.7	43.0	.42	.12	.45	.13	.098	.021	6.06	.58	12.5	.79	741	40.4	1112	54.0
JAN	286	129	46.4	33.7	.57	.14	.36	.10	.078	.018	5.04	.51	12.3	.79	796	44.2	1046	53.4
FEB	1003	516	111	92.4	.85	.28	1.12	.41	.167	.045	9.41	1.25	16.4	1.24	948	56.3	1002	51.0
MAR	515	158	84.8	41.9	.55	.12	.76	.15	.115	.018	10.5	.79	19.1	1.01	1202	57.2	1330	58.0
APR	349	133	61.2	35.0	.34	.07	.43	.10	.056	.010	7.24	.61	10.8	.62	741	37.2	1025	46.8
MAY	120	33.2	28.3	12.9	.32	.06	.21	.04	.033	.005	3.54	.25	5.33	.29	411	21.0	755	35.9
JUN	222	63.1	51.2	24.1	.38	.08	.39	.07	.089	.013	4.28	.33	5.78	.31	362	17.7	740	33.4
JUL	92.7	32.8	23.2	13.0	.18	.04	.14	.03	.041	.006	1.95	.16	3.37	.21	209	12.1	554	30.3
AUG	97.0	35.7	23.3	13.7	.16	.04	.10	.02	.028	.005	1.67	.15	2.49	.17	172	11.1	519	31.6
SEP	143	45.2	33.6	17.5	.21	.05	.15	.03	.038	.006	2.16	.18	2.64	.16	211	12.0	597	32.0
TOTAL	3466	1386	590.2	356.0	4.32	1.06	4.52	1.15	.840	.160	57.3	5.17	99.6	6.09	6505	346.5	10220	501.1

Appendix B. Monthly Constituent Loads and Associated Error for the Five Study Sites in the Irondequoit Creek Basin, Monroe County, N.y., Water Years 1984-88--(continued)

C. Irondequoit Creek at Linden Avenue near Rochester, N.Y. (continued)

WATER YEAR 1986

Month	Total suspended solids		Volatile suspended solids		Ammonia nitrogen as N		Total phosphorus, as P		Ortho-phosphorus, as P		Total Kjeldahl nitrogen as N		Nitrite plus nitrate, as N		Chloride, dissolved		Sulfate, dissolved	
	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error
OCT	126	40.5	28.1	14.7	0.17	0.04	0.19	0.04	0.041	0.006	2.14	0.17	3.05	0.19	257	15.0	640	35.0
NOV	1445	418	227	109	.40	.08	1.56	.30	.315	.048	12.7	.97	15.2	.84	824	41.7	1367	63.8
DEC	436	139	73.8	38.6	.35	.07	.51	.10	.107	.017	6.41	.49	12.9	.72	753	38.6	1182	56.5
JAN	1528	830	146.5	126	1.23	.44	1.33	.50	.220	.062	10.2	1.32	19.0	1.42	1008	60.4	1198	62.3
FEB	720	275	93.2	57.0	.86	.21	.99	.25	.160	.030	9.42	.86	19.2	1.17	1123	60.0	1199	58.1
MAR	1048	392	131	77.9	.61	.15	1.19	.30	.150	.028	12.1	1.09	19.5	1.14	1159	57.9	1292	58.0
APR	1468	683	176	122	.56	.15	1.20	.36	.125	.027	13.0	1.28	14.7	.87	900	45.5	1199	54.7
MAY	257	81.3	50.8	26.3	.38	.08	.38	.08	.056	.009	4.75	.36	6.20	.34	456	23.0	826	38.6
JUN	807	233	151	71.9	.58	.12	1.16	.23	.238	.037	8.78	.68	9.25	.51	515	25.6	978	44.5
JUL	501	149	104	51.3	.29	.06	.56	.11	.153	.024	5.31	.41	6.41	.35	348	17.4	827	38.2
AUG	1787	756	294	187	.41	.10	1.13	.31	.303	.063	9.94	.95	8.43	.52	433	23.0	1051	50.1
SEP	1029	543	160	128	.33	.08	.80	.29	.161	.043	5.57	.64	4.43	.29	317	17.6	801	39.1
TOTAL	11152	4540	1637	1010	6.18	1.59	11.0	2.85	2.028	.396	100.4	9.25	138.2	8.38	8093	425.7	12562	598.8

WATER YEAR 1987

Month	Total suspended solids		Volatile suspended solids		Ammonia nitrogen as N		Total phosphorus, as P		Ortho-phosphorus, as P		Total Kjeldahl nitrogen as N		Nitrite plus nitrate, as N		Chloride, dissolved		Sulfate, dissolved	
	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error
OCT	2227	732	351	184	0.50	0.12	2.09	0.45	0.401	0.068	12.5	1.03	9.56	0.56	638	33.4	1287	62.2
NOV	793	294	126	71.3	.24	.05	.91	.20	.159	.027	7.07	.60	9.51	.56	608	31.5	1109	52.2
DEC	2196	854	272	164	.59	.13	1.92	.47	.312	.058	14.1	1.22	20.3	1.16	1095	56.1	1562	73.7
JAN	430	160	66.3	38.8	.64	.15	.62	.14	.108	.019	6.39	.52	14.5	.87	973	53.0	1252	63.0
FEB	131	44.2	24.3	13.3	.36	.08	.29	.05	.046	.007	3.44	.26	9.25	.53	743	39.4	921	45.6
MAR	893	345	121	71.0	.51	.13	1.23	.30	.143	.027	10.4	.88	16.8	.95	1147	56.3	1307	58.0
APR	2848	963	347	182	.72	.16	2.59	.58	.228	.038	20.6	1.73	19.7	1.12	1230	60.9	1513	67.5
MAY	305	79.9	64.8	28.1	.34	.06	.51	.08	.061	.008	5.27	.35	6.19	.33	517	25.5	924	42.4
JUN	354	92.8	80.1	35.1	.32	.06	.66	.11	.115	.016	4.68	.32	5.39	.28	392	19.0	821	37.1
JUL	485	132	111	49.6	.23	.05	.68	.12	.150	.022	4.90	.35	5.46	.29	352	17.3	850	38.7
AUG	491	135	114	51.8	.20	.04	.48	.08	.108	.016	4.36	.31	4.28	.23	311	15.2	849	38.6
SEP	504	142	114	52.9	.23	.05	.56	.10	.103	.015	4.24	.31	3.54	.19	324	16.2	857	39.7
TOTAL	11657	3973	1792	942.4	4.88	1.08	12.53	2.70	1.93	.322	98.1	7.87	124.4	7.07	8329	423.8	13253	618.5

Appendix B. Monthly Constituent Loads and Associated Error for the Five Study Sites in the Irondequoit Creek Basin, Monroe County, N.y., Water Years 1984-88--(continued)

C. Irondequoit Creek at Linden Avenue near Rochester, N.Y. (continued)

WATER YEAR 1988

Month	Total suspended solids		Volatile suspended solids		Ammonia nitrogen as N		Total phosphorus, as P		Ortho-phosphorus, as P		Total Kjeldahl nitrogen as N		Nitrite plus nitrate, as N		Chloride, dissolved		Sulfate, dissolved	
	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error
OCT	446	135	97.5	48.5	0.18	0.04	0.67	0.12	0.106	0.016	4.11	0.30	3.88	0.22	383	19.9	902	43.7
NOV	410	169	75.7	48.8	.13	.03	.62	.15	.087	.016	3.97	.36	5.30	.34	458	25.8	911	46.8
DEC	513	190	91.7	54.1	.25	.06	.75	.15	.109	.018	5.90	.48	9.89	.60	778	43.0	1239	63.2
JAN	220	93.7	39.8	27.0	.34	.08	.44	.10	.061	.012	3.66	.33	8.10	.54	744	45.1	1035	58.0
FEB	344	130	62.2	37.7	.40	.09	.81	.16	.097	.016	5.84	.48	11.1	.70	1027	59.3	1192	63.8
MAR	342	148	61.7	42.2	.20	.04	.65	.15	.057	.010	5.31	.48	8.22	.49	839	45.3	1080	54.1
APR	710	352	115	85.3	.22	.06	.99	.28	.073	.016	7.32	.74	7.62	.49	756	42.1	1092	55.3
MAY	417	153	93.3	54.9	.26	.06	.84	.18	.080	.014	5.46	.46	5.03	.31	537	30.8	966	51.4
JUN	128	54.0	33.8	22.4	.15	.04	.35	.07	.045	.007	2.03	.18	2.38	.16	260	16.3	608	35.6
JUL	932	570	183	171	.16	.04	1.13	.41	.189	.053	4.78	.60	3.77	.28	313	19.5	777	43.9
AUG	597	283	141	104	.14	.04	.68	.18	.111	.023	3.94	.40	2.93	.19	296	17.6	822	44.9
SEP	326	139	85.4	57.6	.13	.03	.51	.10	.071	.012	2.86	.25	2.12	.14	279	17.0	779	44.2
TOTAL	5386	2417	1080	754.0	2.56	.61	8.44	2.06	1.085	.212	55.2	5.06	70.4	4.44	6669	381.6	11401	604.9

D. Allen Creek near Rochester, N.Y.

WATER YEAR 1984

Month	Total suspended solids		Volatile suspended solids		Ammonia nitrogen as N		Total phosphorus, as P		Ortho-phosphorus, as P		Total Kjeldahl nitrogen as N		Nitrite plus nitrate, as N		Chloride, dissolved		Sulfate, dissolved	
	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error
OCT	54.8	20.7	7.16	2.26	0.09	0.03	0.11	0.02	0.033	0.005	1.32	0.13	1.27	0.10	144	11.7	147	10.2
NOV	204	80.7	22.1	6.89	.18	.06	.34	.08	.113	.022	4.00	.42	4.56	.36	418	34.5	291	20.8
DEC	505	238	54.5	19.0	.25	.10	.64	.17	.188	.045	6.51	.79	9.24	.85	841	74.0	395	30.5
JAN	92.5	32.7	15.6	4.48	.08	.02	.10	.02	.021	.003	1.32	.11	2.76	.19	454	33.0	161	10.6
FEB	725	329	80.4	25.8	.38	.17	.73	.21	.130	.034	5.67	.76	8.60	.86	1082	94.5	312	25.2
MAR	504	236	42.6	13.6	.29	.12	.52	.15	.072	.019	6.00	.73	7.45	.67	850	69.3	307	22.2
APR	483	187	45.4	13.0	.26	.09	.54	.13	.066	.014	7.28	.73	7.37	.56	715	54.6	336	22.1
MAY	672	284	71.2	21.9	.35	.13	.85	.22	.136	.033	8.57	.96	7.33	.62	561	46.0	359	25.4
JUN	106	29.9	14.0	3.26	.10	.02	.14	.02	.034	.004	1.69	.13	1.86	.12	174	12.1	153	9.22
JUL	109	34.5	12.9	3.38	.09	.02	.14	.02	.040	.006	1.50	.13	1.62	.11	149	10.9	150	9.31
AUG	234	78.1	29.7	8.03	.12	.04	.33	.06	.072	.012	2.85	.26	2.26	.16	209	15.8	206	13.1
SEP	164	63.9	22.7	6.91	.10	.03	.28	.06	.051	.011	2.22	.24	1.56	.12	167	13.1	161	10.5
TOTAL	3852.9	1616	418.2	128.5	2.28	.84	4.71	1.16	.957	.210	48.9	5.38	55.9	4.70	5764	469.6	2976	209.2

Appendix B. Monthly Constituent Loads and Associated Error for the Five Study Sites in the Irondequoit Creek Basin, Monroe County, N.y., Water Years 1984-88--(continued)

D. Allen Creek near Rochester, N.Y. (continued)

WATER YEAR 1985

Month	Total suspended solids		Volatile suspended solids		Ammonia nitrogen as N		Total phosphorus, as P		Ortho-phosphorus, as P		Total Kjeldahl nitrogen as N		Nitrite plus nitrate, as N		Chloride, dissolved		Sulfate, dissolved	
	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error
OCT	51.0	16.5	6.49	1.77	0.05	0.01	0.10	0.01	0.021	0.003	1.02	0.08	0.98	0.06	124	9.05	113	7.12
NOV	43.6	15.0	4.97	1.42	.04	.01	.07	.01	.017	.002	.92	.08	1.26	.09	157	12.1	110	7.33
DEC	294	159	39.8	16.5	.09	.04	.31	.09	.059	.015	3.11	.40	4.76	.45	553	51.4	210	15.3
JAN	227	139	32.4	14.7	.08	.04	.23	.08	.040	.013	2.09	.33	3.48	.38	487	46.0	154	12.4
FEB	746	435	70.0	29.8	.23	.14	.68	.26	.087	.029	4.46	.79	5.96	.77	748	84.2	197	19.1
MAR	465	170	46.5	13.0	.18	.06	.43	.10	.046	.009	4.70	.50	5.85	.46	772	60.7	233	15.6
APR	292	130	28.1	8.92	.11	.04	.28	.08	.027	.007	3.78	.43	4.00	.34	466	39.5	190	12.8
MAY	116	33.9	15.5	3.75	.06	.02	.13	.02	.016	.002	1.85	.14	1.89	.12	213	14.7	133	7.91
JUN	250	79.2	33.3	8.45	.12	.04	.30	.05	.054	.008	2.88	.25	2.71	.18	245	17.4	180	10.8
JUL	158	43.8	19.2	4.40	.08	.02	.19	.03	.040	.005	1.75	.13	1.76	.11	170	11.6	149	8.73
AUG	129	36.5	16.8	3.95	.05	.01	.17	.02	.028	.004	1.46	.11	1.23	.08	139	9.7	130	7.83
SEP	157	43.1	23.0	5.18	.07	.02	.24	.04	.035	.005	1.90	.15	1.32	.08	160	11.3	139	8.39
TOTAL	2929	1301	336.0	112.0	1.18	.45	3.11	.79	.470	.103	29.9	3.40	35.2	3.12	4236	367.7	1939	133.3

WATER YEAR 1986

Month	Total suspended solids		Volatile suspended solids		Ammonia nitrogen as N		Total phosphorus, as P		Ortho-phosphorus, as P		Total Kjeldahl nitrogen as N		Nitrite plus nitrate, as N		Chloride, dissolved		Sulfate, dissolved	
	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error
OCT	141	40.8	18.8	4.45	0.08	0.02	0.23	0.04	0.039	0.006	2.05	0.17	1.65	0.11	200	14.3	149	9.05
NOV	731	253	77.9	20.2	.22	.07	.99	.22	.191	.037	8.05	.78	7.40	.53	689	51.2	352	23.1
DEC	199	75.8	26.8	8.02	.06	.02	.21	.04	.039	.007	2.39	.23	3.38	.24	437	33.0	172	11.3
JAN	1138	873	131	69.4	.18	.12	.98	.46	.128	.055	4.91	1.00	6.62	.97	826	101	207	21.3
FEB	678	271	89.7	27.8	.17	.06	.55	.13	.058	.013	4.13	.48	5.64	.49	882	75.2	201	14.7
MAR	692	271	68.5	20.7	.17	.06	.57	.14	.050	.011	5.22	.59	5.99	.51	830	69.9	224	15.7
APR	634	313	58.2	20.3	.13	.06	.57	.18	.044	.012	5.86	.76	5.13	.48	571	49.9	218	16.1
MAY	190	75.7	25.5	8.09	.06	.02	.20	.05	.019	.004	2.20	.23	1.96	.15	227	17.4	129	8.32
JUN	462	143	63.4	15.9	.14	.04	.49	.09	.072	.011	4.08	.36	3.36	.23	314	22.8	204	12.5
JUL	454	164	54.9	15.5	.11	.04	.48	.10	.084	.016	3.38	.33	2.72	.20	254	19.0	193	12.2
AUG	676	239	85.1	23.1	.13	.04	.75	.15	.112	.021	4.77	.46	3.14	.32	305	23.2	235	15.1
SEP	446	184	61.8	19.0	.11	.04	.63	.17	.080	.019	3.60	.42	2.03	.17	233	19.4	176	12.0
TOTAL	6443	2905	761.3	252.5	1.55	.60	6.65	1.76	.914	.211	50.6	5.81	49.0	4.32	5768	496.9	2458	171.3

Appendix B. Monthly Constituent Loads and Associated Error for the Five Study Sites in the Irondequoit Creek Basin, Monroe County, N.y., Water Years 1984-88--(continued)

D. Allen Creek near Rochester, N.Y. (continued)

WATER YEAR 1987

Month	Total suspended solids		Volatile suspended solids		Ammonia nitrogen as N		Total phosphorus, as P		Ortho-phosphorus, as P		Total Kjeldahl nitrogen as N		Nitrite plus nitrate, as N		Chloride, dissolved		Sulfate, dissolved	
	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error
OCT	508	161	69.3	17.5	0.14	0.04	0.74	0.14	0.103	0.017	4.79	0.44	2.99	0.20	345	25.2	225	14.2
NOV	255	92.0	31.4	8.89	.06	.02	.29	.06	.047	.008	2.78	.27	2.85	.22	354	27.6	175	11.2
DEC	759	337	94.3	30.7	.11	.04	.72	.18	.109	.026	5.72	.66	6.53	.54	786	63.6	269	19.1
JAN	352	168	61.5	23.1	.06	.02	.27	.07	.031	.007	2.22	.25	3.32	.27	609	50.1	152	10.4
FEB	175	58.1	28.0	7.76	.05	.01	.13	.02	.012	.002	1.20	.10	1.90	.13	429	31.5	102	6.50
MAR	570	239	65.0	21.3	.11	.04	.42	.11	.034	.008	3.65	.40	4.12	.34	692	58.0	176	12.0
APR	1020	388	99.2	28.2	.16	.06	.79	.18	.054	.011	7.56	.80	6.20	.51	763	63.9	257	17.8
MAY	185	56.2	26.5	6.64	.05	.01	.17	.03	.014	.002	1.92	.16	1.64	.11	223	15.8	120	7.26
JUN	172	51.8	24.3	6.04	.05	.01	.16	.03	.023	.003	1.42	.12	1.26	.08	155	11.1	108	6.60
JUL	423	180	52.4	17.4	.08	.03	.39	.10	.065	.015	2.54	.30	1.94	.17	204	17.0	151	10.2
AUG	268	106	36.2	11.1	.05	.02	.27	.06	.036	.008	1.77	.19	1.20	.09	154	11.9	125	7.95
SEP	254	85.5	40.0	10.9	.06	.02	.31	.06	.036	.006	1.94	.19	1.10	.08	161	12.2	123	7.79
TOTAL	4939	1922	628.0	189.6	.98	.33	4.66	1.04	.564	.113	37.5	3.86	35.1	2.74	4874	388.1	1983	131.1

WATER YEAR 1988

Month	Total suspended solids		Volatile suspended solids		Ammonia nitrogen as N		Total phosphorus, as P		Ortho-phosphorus, as P		Total Kjeldahl nitrogen as N		Nitrite plus nitrate, as N		Chloride, dissolved		Sulfate, dissolved	
	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error
OCT	182	64.4	26.9	7.87	0.05	0.02	0.24	0.05	0.031	0.005	1.68	0.16	1.12	0.08	173	12.7	120	7.56
NOV	288	175	33.7	15.2	.05	.02	.28	.10	.043	.013	2.19	.33	2.09	.24	283	29.2	137	10.8
DEC	307	141	47.4	17.1	.04	.01	.24	.06	.033	.006	2.26	.24	2.80	.22	467	37.8	159	10.7
JAN	192	94.3	35.8	14.3	.03	.01	.13	.03	.014	.003	1.07	.12	1.61	.14	380	32.7	97.6	6.92
FEB	435	159	69.8	20.6	.08	.02	.28	.05	.024	.004	2.22	.22	2.81	.21	646	51.1	142	9.79
MAR	318	156	35.7	13.2	.05	.02	.21	.06	.015	.004	2.09	.27	2.14	.19	435	37.1	123	8.95
APR	357	206	38.1	15.8	.05	.02	.25	.08	.016	.005	2.49	.36	2.08	.22	345	33.9	126	9.74
MAY	232	102	34.9	12.3	.04	.02	.19	.05	.016	.004	1.83	.20	1.38	.11	209	17.4	113	7.96
JUN	129	46.9	19.2	5.77	.03	.01	.11	.02	.015	.003	.94	.09	.80	.06	121	9.63	87.1	6.01
JUL	380	177	50.0	18.1	.06	.02	.31	.09	.050	.012	1.93	.24	1.36	.12	173	15.5	132	9.82
AUG	324	124	50.1	15.8	.05	.02	.30	.06	.037	.007	1.84	.19	1.07	.08	164	13.2	131	8.89
SEP	173	63.6	29.6	9.00	.04	.01	.19	.03	.022	.003	1.21	.11	.68	.05	125	9.83	101	6.79
TOTAL	3317	1510	471.2	165.0	.57	.20	2.73	.69	.316	.070	21.7	2.53	19.9	1.71	3520	300.0	1469	103.9

Appendix B. Monthly Constituent Loads and Associated Error for the Five Study Sites in the Irondequoit Creek Basin, Monroe County, N.y., Water Years 1984-88--(continued)

E. Irondequoit Creek at Blossom Road near Rochester, N.Y. (continued)

WATER YEAR 1984

Month	Total suspended solids		Volatile suspended solids		Ammonia nitrogen as N		Total phosphorus, as P		Ortho-phosphorus, as P		Total Kjeldahl nitrogen as N		Nitrite plus nitrate, as N		Chloride, dissolved		Sulfate, dissolved	
	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error
OCT	498	146	49.3	13.2	0.32	0.08	0.35	0.06	0.102	0.015	4.30	0.35	4.98	0.30	561	28.5	1040	50.1
NOV	1758	554	148	41.6	.70	.19	1.28	.25	.318	.055	14.2	1.23	15.8	.99	1311	69.2	1801	89.1
DEC	2795	1054	245	77.6	1.24	.44	2.78	.78	.520	.118	22.7	2.31	29.7	2.01	2061	113	2144	108
JAN	474	121	64.8	15.5	.42	.10	.36	.05	.083	.011	6.4	.48	13.4	.76	1297	63.3	1244	58.6
FEB	5490	2120	424	134	1.20	.48	3.23	.99	.386	.097	24.0	2.69	34.5	2.61	2607	147	1863	97.5
MAR	3762	1292	284	81.4	.90	.30	1.92	.49	.193	.040	20.9	2.02	26.4	1.76	2143	112	1838	89.5
APR	3915	1100	329	81.9	1.02	.28	2.16	.42	.217	.037	25.4	2.10	26.9	1.63	1912	97.3	1992	94.6
MAY	7520	2432	612	168	1.48	.46	5.06	1.22	.590	.126	36.2	3.28	30.2	1.94	1767	92.2	2130	104
JUN	1229	314	130	29.9	.45	.12	.84	.14	.175	.025	9.51	.76	9.64	.57	728	36.4	1138	53.5
JUL	503	136	56.4	13.4	.32	.08	.44	.07	.121	.018	5.02	.41	5.65	.33	495	24.5	893	41.6
AUG	1290	375	141	36.4	.54	.15	.95	.18	.256	.044	10.4	.92	9.06	.57	708	36.8	1253	60.3
SEP	1059	330	123	33.2	.44	.12	.72	.14	.180	.032	7.93	.72	7.08	.45	624	32.2	1135	54.2
TOTAL	30294	9975	2607	726.3	9.02	2.80	20.1	4.78	3.14	.618	186.8	17.3	213.4	14.0	16215	852.1	18470	300.8

WATER YEAR 1985

Month	Total suspended solids		Volatile suspended solids		Ammonia nitrogen as N		Total phosphorus, as P		Ortho-phosphorus, as P		Total Kjeldahl nitrogen as N		Nitrite plus nitrate, as N		Chloride, dissolved		Sulfate, dissolved	
	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error
OCT	401	95.1	51.0	11.4	0.27	0.06	0.33	0.05	0.081	0.011	4.24	0.30	4.96	0.27	535	25.2	968	43.4
NOV	330	82.8	43.2	10.1	.27	.07	.33	.05	.075	.010	4.86	.36	6.89	.39	688	33.4	1049	48.3
DEC	1066	424	137	46.1	.58	.19	1.07	.29	.184	.040	12.5	1.29	18.7	1.32	1404	76.3	1493	71.1
JAN	1051	396	144	45.2	.55	.17	.96	.25	.155	.035	11.7	1.20	19.6	1.32	1564	80.7	1383	66.5
FEB	4373	1982	374	141	.81	.36	2.82	.98	.242	.070	19.3	2.61	25.9	2.26	1945	122	1390	76.9
MAR	3537	928	347	80.0	.76	.20	1.82	.33	.172	.028	23.4	1.87	29.6	1.73	2359	116	1898	87.0
APR	2006	695	208	58.0	.55	.17	1.22	.30	.102	.020	16.1	1.46	18.1	1.17	1399	73.6	1482	70.0
MAY	582	139	82.5	18.2	.30	.07	.46	.07	.056	.008	6.70	.50	7.86	.44	664	32.1	969	44.4
JUN	1065	301	132	32.5	.35	.09	.84	.15	.139	.023	8.79	.75	8.51	.52	650	32.7	1002	47.0
JUL	357	81.1	49.6	10.5	.25	.06	.39	.06	.085	.012	4.26	.32	4.82	.27	442	21.4	794	36.6
AUG	216	55.4	34.2	8.19	.22	.06	.26	.04	.057	.008	2.95	.24	3.40	.20	351	17.9	699	34.0
SEP	470	126	70.9	17.0	.26	.07	.42	.07	.085	.013	4.73	.39	4.56	.27	458	22.9	867	40.8
TOTAL	15453	5306	1673	478.5	5.18	1.57	10.9	2.62	1.43	.277	119.5	11.3	152.9	10.2	12459	653.9	13994	666.1

Appendix B. Monthly Constituent Loads and Associated Error for the Five Study Sites in the Irondequoit Creek Basin, Monroe County, N.y., Water Years 1984-88--(continued)

E. Irondequoit Creek at Blossom Road near Rochester, N.Y. (continued)

WATER YEAR 1986

Month	Total suspended solids		Volatile suspended solids		Ammonia nitrogen as N		Total phosphorus, as P		Ortho-phosphorus, as P		Total Kjeldahl nitrogen as N		Nitrite plus nitrate, as N		Chloride, dissolved		Sulfate, dissolved	
	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error
OCT	402	107	57.9	14.0	0.22	0.05	0.38	0.06	0.070	0.010	4.31	0.33	4.64	0.26	510	24.9	902	41.6
NOV	3193	939	347	89.0	.74	.21	2.91	.56	.422	.072	24.8	2.09	22.2	1.35	1628	83.5	1989	95.4
DEC	825	247	122	31.6	.42	.11	.92	.17	.139	.024	11.6	.98	15.6	.92	1294	63.8	1438	67.3
JAN	3697	1774	435	175	.83	.38	3.86	1.40	.331	.100	21.9	2.96	28.9	2.54	2026	127	1525	81.7
FEB	3735	1304	424	124	.63	.21	2.43	.61	.203	.043	21.4	2.20	27.6	1.93	2223	122	1560	79.3
MAR	4782	1658	465	137	.71	.24	3.06	.78	.188	.041	25.7	2.60	28.1	1.95	2258	122	1757	86.0
APR	4496	1798	454	148	.74	.28	3.65	1.14	.187	.046	26.7	2.85	23.5	1.69	1697	93.2	1693	83.4
MAY	1136	355	160	42.7	.31	.08	.93	.18	.082	.015	10.2	.89	9.55	.58	792	39.2	1092	50.7
JUN	3416	936	406	98.0	.51	.14	2.73	.51	.320	.053	20.6	1.76	14.9	.92	1038	53.3	1427	68.2
JUL	1648	474	207	51.4	.37	.10	1.52	.29	.237	.041	12.5	1.09	9.56	.58	765	38.4	1204	56.2
AUG	2966	1011	356	101	.54	.16	2.75	.66	.396	.081	19.1	1.85	12.5	.83	942	49.8	1489	71.7
SEP	1907	924	232	90.4	.33	.11	1.59	.52	.195	.053	10.2	1.28	6.89	.54	643	37.2	1086	54.8
TOTAL	32204	11527	3667	1101	6.34	2.09	26.7	6.88	2.77	.579	209.1	20.9	204.0	14.1	15817	855.4	17162	836.2

WATER YEAR 1987

Month	Total suspended solids		Volatile suspended solids		Ammonia nitrogen as N		Total phosphorus, as P		Ortho-phosphorus, as P		Total Kjeldahl nitrogen as N		Nitrite plus nitrate, as N		Chloride, dissolved		Sulfate, dissolved	
	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error
OCT	4603	1410	530	143	0.57	0.16	3.60	0.74	0.426	0.077	23.3	2.07	14.7	0.92	1263	65.1	1824	87.7
NOV	1270	399	172	46.3	.33	.09	1.41	.31	.163	.030	12.7	1.14	11.8	.76	1109	57.4	1454	68.7
DEC	3126	1013	412	111	.70	.21	4.02	.95	.373	.074	28.1	2.51	27.9	1.72	2152	109	2092	99.2
JAN	1363	425	233	63.3	.37	.10	1.35	.26	.127	.022	14.1	1.19	19.1	1.15	1789	89.0	1482	68.9
FEB	799	200	132	30.7	.20	.05	.61	.09	.050	.007	7.67	.60	11.3	.66	1317	66.0	1053	50.3
MAR	3411	1086	392	107	.40	.12	2.23	.50	.119	.024	20.0	1.80	20.5	1.33	2040	106	1619	76.2
APR	7259	2207	749	195	.74	.23	5.89	1.30	.229	.043	37.5	3.38	28.0	1.83	2228	119	2046	99.2
MAY	1110	254	171	36.0	.23	.06	1.01	.14	.065	.009	10.0	.73	8.33	.46	820	39.2	1119	50.8
JUN	1107	259	160	33.9	.20	.05	1.11	.17	.106	.015	8.48	.65	6.47	.36	643	31.2	982	45.1
JUL	1573	538	200	56.2	.24	.07	1.62	.36	.179	.034	10.5	.98	7.05	.44	689	34.8	1098	51.0
AUG	859	248	129	31.7	.20	.05	.98	.18	.114	.019	7.22	.61	5.01	.30	564	27.6	1003	45.8
SEP	1067	293	163	39.4	.19	.05	1.03	.18	.108	.017	7.37	.61	4.78	.28	589	29.4	1043	48.7
TOTAL	27548	8333	3443	892.8	4.39	1.25	24.9	5.18	2.06	.370	186.9	16.3	165.0	10.2	15202	774.0	16815	791.8

Appendix B. Monthly Constituent Loads and Associated Error for the Five Study Sites in the Irondequoit Creek Basin, Monroe County, N.y., Water Years 1984-88--(continued)

E. Irondequoit Creek at Blossom Road near Rochester, N.Y. (continued)

WATER YEAR 1988

Month	Total suspended solids		Volatile suspended solids		Ammonia nitrogen as N		Total phosphorus, as P		Ortho-phosphorus, as P		Total Kjeldahl nitrogen as N		Nitrite plus nitrate, as N		Chloride, dissolved		Sulfate, dissolved	
	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error	Load	Error
OCT	1010	300	146	38.0	0.17	0.04	0.98	0.17	0.096	0.016	7.03	0.58	4.89	0.28	658	32.1	1098	50.7
NOV	798	358	109	40.7	.16	.06	1.07	.32	.085	.021	7.10	.87	6.06	.48	758	43.9	1058	53.0
DEC	1828	588	273	77.1	.32	.10	2.49	.53	.177	.033	17.0	1.55	15.8	1.02	1639	86.2	1670	80.4
JAN	945	325	165	49.1	.19	.05	1.02	.21	.068	.012	8.67	.80	10.6	.68	1362	70.8	1182	56.6
FEB	2146	586	302	74.4	.22	.06	1.59	.27	.082	.013	13.2	1.10	13.9	.85	1836	94.6	1380	67.6
MAR	1834	672	220	66.7	.18	.05	1.39	.34	.051	.010	11.0	1.09	10.0	.65	1418	74.1	1260	61.3
APR	2223	902	261	83.9	.20	.07	1.91	.54	.060	.014	13.1	1.35	9.65	.68	1205	66.8	1298	64.2
MAY	1350	398	194	50.0	.15	.04	1.35	.25	.060	.010	9.11	.78	6.12	.37	771	39.5	1073	51.7
JUN	443	128	68.4	17.7	.09	.02	.62	.10	.040	.006	3.49	.30	2.66	.16	401	21.0	675	33.6
JUL	1521	653	180	64.6	.14	.04	1.78	.48	.135	.032	7.86	.92	4.26	.32	558	32.2	926	48.2
AUG	1061	391	149	46.8	.13	.04	1.27	.28	.097	.019	6.46	.64	3.55	.23	532	28.5	964	47.8
SEP	659	181	104	26.1	.10	.03	.81	.13	.059	.009	4.38	.36	2.59	.16	461	23.9	871	42.9
TOTAL	15819	5482	2170	635.0	2.07	.60	16.29	3.64	1.01	.195	108.5	10.3	90.2	5.90	11598	613.6	13455	657.8

APPENDIX C. Concentrations of selected constituents in Erie Canal discharges to local streams, Monroe County, N.Y., 1984-88

Table C1. Concentrations of selected constituents in Erie Canal discharges to local streams.

[Dashes indicate no data; NTU, nephelometric turbidity units; mg/L milligrams per liter.]

DATE	Discharge in cubic feet per second	Turbidity (NTU)	Total suspended solids (mg/L)	Volatile suspended solids (mg/L)	Ammonia nitrogen, dissolved (mg/L as N)	Total Kjeldahl nitrogen (mg/L as N)	Nitrite plus nitrate (mg/L as N)	Total phosphorus (mg/L as P)	Orthophophorus (mg/L as P)	Chloride, dissolved (mg/L)	Sulfate, dissolved (mg/L)
430526077315201 - East Branch Allen Creek above siphon at Rochester											
DEC 1984											
28	2.6	--	12	<5	0.090	0.90	1.80	0.050	0.030	140	50
JUL 1985											
17	0.60	--	--	--	0.130	0.60	0.650	0.090	<0.005	110	52
JUN 1987											
10	0.74	4.1	14	<5	<0.010	0.96	0.900	0.110	0.050	110	73
NOV											
20	0.95	5.3	9	<5	0.020	0.55	0.080	0.030	0.004	120	67
JUN 1988											
08	0.63	5.1	7	<5	<0.010	1.1	0.740	0.080	0.025	98	54
21	0.21	6.6	8	--	0.020	0.77	0.090	0.060	0.019	95	64
28	--	7.9	11	<5	0.090	0.83	0.080	0.065	0.016	100	58
JUL											
07	--	3.8	6	<3	0.030	0.90	0.010	0.045	0.010	100	69
14	0.22	3.6	6	<3	0.010	1.4	0.090	0.055	0.017	94	48
22	--	11	16	3	0.030	0.74	0.880	0.105	0.058	84	25
28	--	6.1	9	<2	<0.010	0.74	0.390	0.075	0.037	110	52
AUG											
04	--	7.6	12	<2	0.020	0.53	0.050	0.050	0.011	92	55
12	--	11	10	2	0.090	0.74	0.060	0.070	0.019	81	40
25	--	8.6	15	<5	<0.010	0.64	0.200	0.150	0.037	94	54
SEP											
01	--	5.4	10	<2	<0.010	0.40	0.380	0.060	0.030	130	64
08	--	7.5	12	2	0.040	0.92	0.150	0.045	0.013	110	70
15	--	11	16	3	0.030	0.51	0.080	0.065	0.012	99	59
22	--	6.8	9	2	<0.010	0.66	0.120	0.085	0.028	110	64
29	0.08	4.2	5	<1	0.010	0.47	0.080	0.055	0.018	100	61
430526077315202 - East Branch Allen Creek below siphon at Rochester											
DEC 1984											
28	9.9	--	--	--	0.060	0.60	1.20	0.050	0.020	150	110
APR 1985											
15	8.6	--	--	--	0.040	0.50	0.800	0.060	<0.005	140	120
JUL											
17	3.0	--	--	--	0.200	0.60	0.790	0.100	<0.005	120	72
JUN 1987											
10	2.5	7.8	40	5	0.120	0.94	0.870	0.440	0.035	84	86
NOV											
20	2.7	11	18	<5	0.140	0.69	0.450	0.055	0.008	120	89
JUN 1988											
08	1.2	8.0	20	<5	<0.010	0.90	0.710	0.140	0.016	82	67
21	2.6	13	34	--	0.080	0.91	0.590	0.065	0.006	62	100
28	--	15	20	5	0.110	0.79	0.570	0.065	0.022	77	22
JUL											
07	--	21	47	5	0.010	0.84	0.220	0.060	0.005	67	93
14	2.3	31	81	7	0.040	0.70	0.160	0.160	0.014	57	71
22	--	29	70	9	0.120	0.84	0.590	0.075	0.045	63	77
28	--	30	46	5	0.050	0.84	0.600	0.110	0.019	84	66
AUG											
04	--	16	40	9	<0.010	0.57	0.390	0.140	0.012	74	86
12	--	24	54	6	<0.010	0.99	0.160	0.050	0.005	53	85
28	2.5	17	39	5	0.070	0.80	0.280	0.070	0.022	78	60
SEP											
01	--	17	35	<5	0.080	0.70	0.420	0.085	0.025	110	78
08	--	15	27	4	0.080	0.77	0.460	0.050	0.025	85	92
15	--	14	30	4	0.100	0.72	0.340	0.070	0.009	92	86

Table C1. Concentrations of selected constituents in Erie Canal discharges to local streams (continued)

DATE	Discharge in cubic feet per second	Turbidity (NTU)	Total suspended solids (mg/L)	Volatile suspended solids (mg/L)	Ammonia nitrogen, dissolved (mg/L as N)	Total Kjeldahl nitrogen (mg/L as N)	Nitrite plus nitrate (mg/L as N)	Total phosphorus (mg/L as P)	Orthophophorus (mg/L as P)	Chloride, dissolved (mg/L)	Sulfate, dissolved (mg/L)
430526077315203 - East Branch Allen Creek siphon at Rochester											
NOV 1987											
20	1.7	13	20	<5	0.240	0.76	0.660	0.00	0.011	120	88
JUN 1988											
08	0.59	13	30	<5	<0.010	1.0	0.630	0.150	0.005	63	78
21	--	17	32	--	0.090	0.93	0.650	0.090	0.007	62	100
28	--	9.2	26	7	0.190	1.1	0.590	0.090	0.022	75	22
JUL											
07	--	24	65	6	0.010	0.90	0.240	0.070	0.004	62	91
14	2.1	25	50	5	0.050	0.61	0.180	0.070	0.013	53	62
22	--	30	61	8	0.170	0.88	0.450	0.080	0.040	53	91
28	--	25	45	10	0.040	0.84	0.550	0.050	0.023	91	66
AUG											
04	--	15	26	5	<0.010	0.53	0.440	0.125	0.024	65	92
12	--	17	35	6	<0.010	0.78	0.150	0.045	0.005	52	50
25	--	16	38	4	0.080	0.78	0.290	0.040	0.020	77	60
SEP											
01	--	17	33	3	0.110	0.54	0.360	0.080	0.024	110	88
08	--	16	27	4	0.060	0.80	0.490	0.065	0.014	80	92
15	--	15	31	4	0.120	0.86	0.350	0.065	0.009	91	88
22	--	14	22	2	0.080	0.75	0.390	0.040	0.024	100	79
29	--	18	30	3	0.050	0.68	0.380	0.050	0.010	91	73
430557077344402 - Allen Creek below siphon at Rochester											
JUL 1985											
17	10	--	--	--	0.180	0.40	0.420	0.100	<0.005	100	74
NOV											
08	6.6	--	--	--	0.020	1.2	0.880	0.130	0.036	140	85
MAY 1986											
08	2.1	--	23	<5	0.080	1.2	0.730	0.060	<0.005	140	94
28	6.5	--	32	<5	0.080	1.1	0.830	0.060	0.012	130	79
OCT											
22	12	13	15	<5	0.010	0.80	0.660	0.070	0.017	91	61
JUN 1987											
10	5.2	10	21	<5	0.100	1.0	0.660	0.065	0.020	130	84
NOV											
20	6.8	14	23	<5	0.210	0.71	0.540	0.060	0.010	110	95
MAY 1988											
11	4.0	8.2	14	<5	0.030	1.5	0.450	0.075	0.004	120	65
JUN											
08	4.4	7.8	18	<5	0.060	1.0	0.550	0.135	0.005	110	61
21	4.0	16	27	--	0.100	0.88	0.610	0.080	0.003	88	98
28	--	17	39	8	0.090	1.1	0.430	0.060	0.009	97	78
JUL											
07	--	18	47	6	<0.010	0.91	0.210	0.065	0.003	77	96
14	4.2	3.3	115	10	0.060	0.89	0.190	0.080	0.008	59	62
22	--	17	35	7	0.110	0.97	0.400	0.060	0.013	83	51
28	--	18	29	<2	0.080	0.91	0.460	0.045	0.012	100	61
AUG											
04	--	11	29	4	0.040	0.91	0.410	0.100	0.006	89	93
12	--	24	52	7	0.090	1.0	0.110	0.055	0.004	55	82
25	8.9	15	26	4	0.040	0.90	0.250	0.025	0.010	75	65
SEP											
01	7.1	16	28	4	0.090	0.82	0.240	0.070	0.013	160	110
08	--	13	22	4	0.100	1.1	0.460	0.085	0.004	97	85
15	--	13	24	4	0.100	0.91	0.280	0.050	0.006	88	82
22	--	13	21	2	0.110	0.79	0.360	0.030	0.018	110	76
28	--	15	24	2	0.070	0.78	0.270	0.030	0.005	94	63

Table C1. Concentrations of selected constituents in Erie Canal discharges to local streams (continued)

DATE	Discharge in cubic feet per second	Turbidity (NTU)	Total suspended solids (mg/L)	Volatile suspended solids (mg/L)	Ammonia nitrogen, dissolved (mg/L as N)	Total Kjeldahl nitrogen (mg/L as N)	Nitrite plus nitrate (mg/L as N)	Total phosphorus (mg/L as P)	Orthophorus (mg/L as P)	Chloride, dissolved (mg/L)	Sulfate, dissolved (mg/L)
					430557077344403 - Allen Creek siphon at Rochester						
MAY 1986											
08	1.0	--	30	<5	0.100	1.0	1.10	0.070	<0.005	86	95
OCT											
22	8.7	15	19	<5	0.090	0.77	0.880	0.094	0.026	78	74
JUN 1987											
10	3.8	7.5	27	<5	0.110	0.88	0.880	0.065	0.025	55	100
NOV											
20	5.7	14	23	<5	0.240	0.67	0.640	0.070	0.012	110	95
MAY 1988											
11	3.6	8.5	12	<5	0.100	0.61	0.580	0.060	0.005	67	67
JUN											
08	3.9	7.3	20	<5	0.020	0.83	0.620	0.110	0.005	79	56
21	3.8	15	26	--	0.140	1.2	0.640	0.080	0.003	75	100
28	--	9.8	29	6	0.130	0.74	0.500	0.070	0.010	76	83
JUL											
07	--	16	48	6	0.020	0.55	0.230	0.135	0.005	75	250
14	3.8	2.4	54	6	0.070	0.70	0.180	0.075	0.007	58	62
22	--	26	51	7	0.210	1.1	0.430	0.085	0.032	61	81
28	--	29	49	--	0.120	1.0	0.770	0.060	0.022	91	74
AUG											
04	--	15	29	4	0.030	1.1	0.400	0.090	0.012	86	95
12	--	25	48	7	0.100	0.91	0.110	0.060	0.005	52	82
25	--	15	29	4	0.060	0.60	0.280	0.050	0.018	62	70
SEP											
01	5.6	19	37	4	0.160	0.83	0.370	0.075	0.019	170	110
08	--	15	26	3	0.100	1.0	0.480	0.030	0.005	93	90
15	--	13	25	4	0.120	0.82	0.300	0.050	0.007	83	66
22	--	14	23	3	0.130	0.74	0.380	0.040	0.020	110	79
29	--	14	24	4	0.060	0.78	0.280	0.035	0.005	91	71
					430557077344404 - Allen Creek Tributary at Rochester						
MAY 1986											
08	0.09	--	20	<5	0.020	0.98	0.370	0.050	<0.005	96	93
28	0.10	--	17	<5	0.040	1.1	0.610	0.060	0.012	190	99
JUN 1988											
08	--	2.6	4	<5	0.040	0.11	0.280	0.070	0.011	120	94

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