In cooperation with the Fox Waterway Agency

Hydrology, Water Quality, and Nutrient Loads to Lake Catherine and Channel Lake, near Antioch, Lake County, Illinois

Water-Resources Investigations Report 00–4088

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

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By Robert T. Kay, Gary P. Johnson, and David L. Schrader

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De Kalb, Illinois
2000

U.S. DEPARTMENT OF THE INTERIOR
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U.S. GEOLOGICAL SURVEY
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CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATED WATER-QUALITY UNITS

Multiply	By	To obtain
Length		
inch (in.)	2.54	centimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
foot per foot (ft/ft)	0.3048	meter per meter
Area		
acre	0.4047	hectare
square foot (ft^2)	0.09290	square meter
Volume		
cubic foot (ft^3)	0.02832	cubic meter
acre-foot (acre-ft)	1,233	cubic meter
Flow rate		
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
cubic foot per day (ft^3/d)	0.02832	cubic meter per day
Mass		
pound, avoirdupois (lb)	0.4536	kilogram
ton	0.0011	kilogram
Hydraulic conductivity		
foot per day (ft/d)	0.3048	meter per day
Velocity		
foot per second (ft/s)	0.3048	meter per second
miles per hour (mph)	1.609	kilometer per hour
Application rate		
ton per acre (tons/acre)	0.00056	kilogram per hectare
ton per acre per year [(ton/acre)/yr]	0.00056	kilogram per hectare per year
pound per acre per year [(lb/acre)/yr]	1.1208	kilogram per hectare per year
pound per acre per day [(lb/acre)/d]	1.1208	kilogram per hectare per day
pound per day (lb/d)	0.4536	kilogram per day
ton per day (ton/d)	0.00022	kilogram per day

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F = (1.8 \times °C) + 32$$

Sea level: In this report, “sea level” refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Altitude, as used in this report, refers to distance above or below sea level.

Abbreviated water-quality units used in this report: Chemical concentration is given in metric units. Chemical concentration is given in micrograms per liter (µg/L). Micrograms per liter is a unit expressing the concentration of chemical constituents in solution as weight (micrograms) of solute per unit volume (liter) of water. One thousand micrograms per liter is equivalent to one milligram per liter (mg/L).

The following abbreviations are used in this report:

mg/m^3	milligrams per cubic meter
µS/cm	microSiemens per centimeter at 25° Celsius
ml	milliliter
L	liter
$(g/m^2)/d$	grams per square meter per day
mole/L	moles per liter
g/L	grams per liter

Hydrology, Water Quality, and Nutrient Loads to Lake Catherine and Channel Lake, near Antioch, Lake County, Illinois

By Robert T. Kay, Gary P. Johnson, *and* David L. Schrader

Abstract

From April 21, 1998, through April 30, 1999, the U.S. Geological Survey, in cooperation with the Fox Waterway Agency, conducted an investigation designed to characterize the hydrology, water quality, hydrologic budget, sediment budget, and nutrient budget of Lake Catherine and Channel Lake, Lake County, Illinois. These lakes are the northernmost lakes of the Fox Chain of Lakes. Lake Catherine and Channel Lake are divided into two basins by a submerged ridge but are continuous at the surface. The lakes are marginally to moderately eutrophic. Lake Catherine and Channel Lake have a combined volume of 7,098 acre-feet at a stage of about 736.5 feet above sea level. Lake Catherine and Channel Lake are subject to thermal stratification. Although most of the water in the lakes is well oxidized, nearly anoxic conditions were present at the bottom of Lake Catherine and Channel Lake during part of the summer in 1998. Water enters Lake Catherine and Channel Lake as inflow from surface water in the watershed (61.9 percent), inflow through the State Highway 173 bridge openings (20.7 percent), direct precipitation (8.2 percent), inflow from storm drains (7.2 percent), and inflow of ground water (2.0 percent). Water exits Lake Catherine and Channel Lake as outflow through the State Highway 173 bridge openings (87.8 percent), evaporation (7.2 percent), and as outflow to ground water (5.0 percent).

About 5,200 pounds of phosphorus and 107,200 pounds of nitrogen compounds were added to the lakes during the period of investigation. Phosphorus compounds were derived from primarily internal regeneration (40.2 percent), inflow from surface water in the watershed (30.9 percent), inflow from storm drains (12.5 percent), and inflow through the State Highway 173 bridge openings (9.8 percent). Inflowing ground water, waterfowl excrement, precipitation, and atmospheric deposition of particulate matter account for 6.6 percent of the phosphorus load. Nitrogen was derived from inflow of surface water from within the watershed (52.9 percent), internal regeneration (19.5 percent), inflow through the State Highway 173 bridge openings (10.7 percent), precipitation (7 percent), and inflow from storm drains (6.5 percent). Inflowing ground water, waterfowl excrement, and atmospheric deposition of particulate matter account for about 3.4 percent of the nitrogen load. About 2,220 pounds of phosphorus and 52,300 pounds of nitrogen compounds are removed from the lakes, primarily through the openings at State Highway 173.

Nitrate, nitrite, ammonia, and dissolved phosphorus are utilized by algae and aquatic macrophytes. Uptake of these nutrients by aquatic macrophytes and algae temporarily removes them from the water column but not from the lake basin. Because the amount of nutrients entering the lake greatly exceeds the amount leaving, the nutrients are concentrated in the sediments at the lake bottom, where the nutrients can be used by the rooted aquatic macrophytes (rooted aquatic plants large enough to be visible to the unaided eye) and released to the water column during reducing conditions. The buildup of nitrogen and phosphorus

compounds in the lakes has the potential over time to stimulate algal and plant growth to nuisance levels that have the potential to affect the fishery and detract from the aesthetic quality of these lakes.

INTRODUCTION

Lake Catherine and Channel Lake are the northernmost lakes in the Fox Chain of Lakes system in northern Illinois (fig. 1). These lakes are about 1.5 mi west of the village of Antioch, Illinois. Although continuous at the surface, the lake basins are partially separated by a submerged ridge. Every year, Lake Catherine and Channel Lake are used by over 200,000 people for recreational activities, including swimming, boating, fishing, and water skiing (Sefton, 1978). The lakes are not used for drinking-water supply and do not receive discharge from publicly owned wastewater-treatment works.

The U.S. Geological Survey (USGS), in cooperation with the Fox Waterway Agency, conducted an investigation of the hydrology and water quality in and around Lake Catherine and Channel Lake in the northern part of Lake County, Illinois, from May 1, 1998, through April 30, 1999. This investigation was designed to quantify the hydrologic, sediment, and nutrient budget of the lakes. This investigation was done as part of the Illinois Environmental Protection Agency's (IEPA) Conservation 2000 Illinois Clean Lakes Program, which is designed to provide funding for investigation and remediation of lakes in Illinois. The investigation was designed to provide the data that will form the basis for future lake-management strategies to improve the quality of the environment of Lake Catherine and Channel Lake. Many of the previous investigations focused on the entire Chain of Lakes (fig. 1), extrapolating some of the conclusions about hydrology and water quality for Lake Catherine and Channel Lake. Other investigations focused on specific aspects of the water quality of these lakes. The data collected for this investigation, and the resulting interpretations, provide a comprehensive understanding of the hydrology, water quality, and (to a lesser extent) biology of Lake Catherine and Channel Lake on the basis of data specific to these lakes (figs. 2, 3).

Results of Previous Investigations

Previous investigations of Lake Catherine and Channel Lake were done as part of an investigation of the Fox Chain of Lakes in the mid-1970's and ongoing statewide lake monitoring efforts. Investigations of the Fox Chain of Lakes in 1974–75 indicated that, as a whole, these lakes were in an advanced state of eutrophication, experiencing problems of luxuriant algal blooms, periodic fish kills, excessive sedimentation, and offensive odors since the 1940's (Kothandaraman and others, 1977). The nutrients that contributed to the eutrophication of the Chain of Lakes were derived from primarily surface-water inflow, including streams that receive point sources of wastewater discharge (Kothandaraman and Evans, 1978 a, b). Internal regeneration of nutrients also was considered to be a source of substantial amounts of nutrients in the deeper lakes. Ground-water inflow from septic fields and precipitation were not determined to be substantial components of the nutrient budget of the Chain of Lakes (Kothandaraman and Evans, 1978b).

During a 1-year period from December 1974 through November 1975, the Fox Chain of Lakes retained approximately 4,070 lbs/d of nitrogen and 630 lbs/d of phosphorus (Kothandaraman and Evans, 1978b). This amount was determined to be greatly in excess of amounts that can be assimilated without giving rise to nuisance algal blooms (Kothandaraman and Evans, 1978b). Nutrients released from lake-bottom sediments under reducing conditions also are considered to be sufficient to sustain algal growth of bloom proportions in the deeper lakes, including Lake Catherine and Channel Lake. Phosphorus was suggested to be the limiting algal nutrient in the Chain of Lakes during previous investigations (Kothandaraman and Evans, 1978a).

The stage of the Chain of Lakes, including Lake Catherine and Channel Lake, is affected by the Stratton Lock and Dam across the Fox River at McHenry (fig. 1). An elevated stage is maintained by the dam during the summer. Stage is lowered in the winter by lowering the dam. Flow in the Chain of Lakes, including Lake Catherine and Channel Lake, typically is from north to south. However, hydraulic gradients are about 0.20 ft/ft between Channel Lake and the Stratton Lock and Dam, and occasional reversals in the direction of flow were observed on the Chain of Lakes, including Lake Catherine and Channel Lake. Some of the reversals in the direction of flow on the Fox Chain of Lakes have been attributed to southeasterly

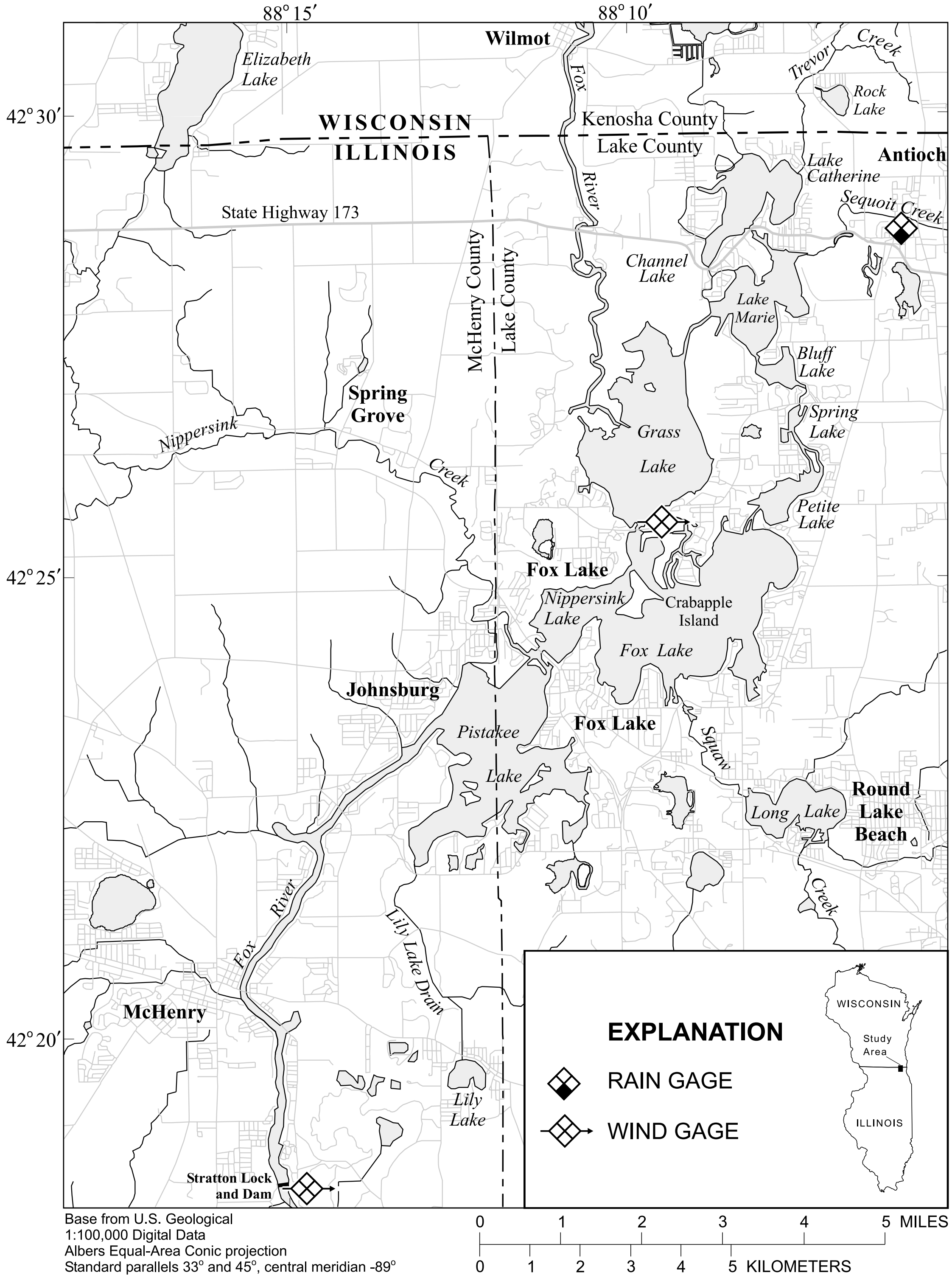

Figure 1. Location of Fox Chain of Lakes system in northern Illinois and southern Wisconsin.

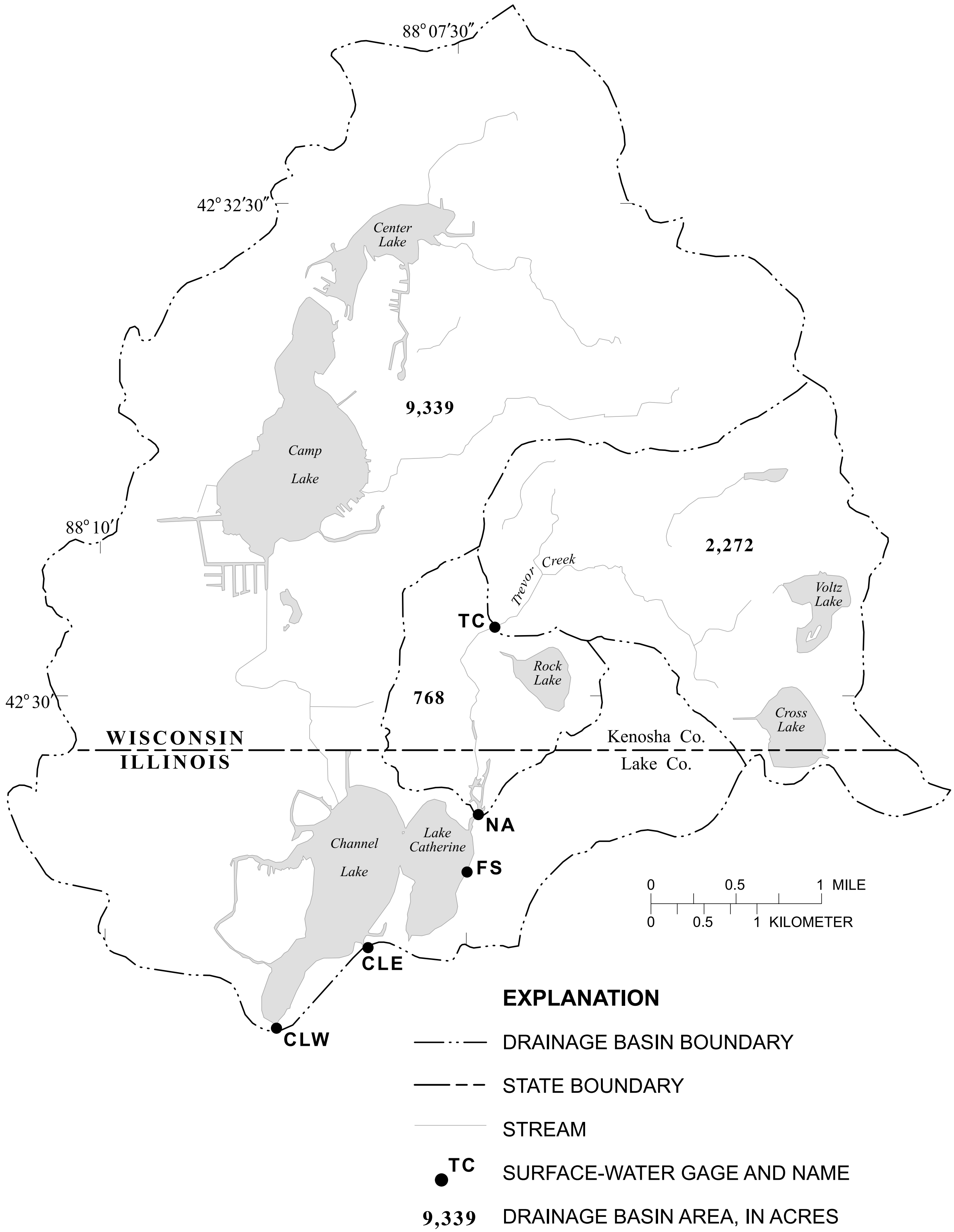

Figure 2. Location of Lake Catherine and Channel Lake, near Antioch, Illinois.

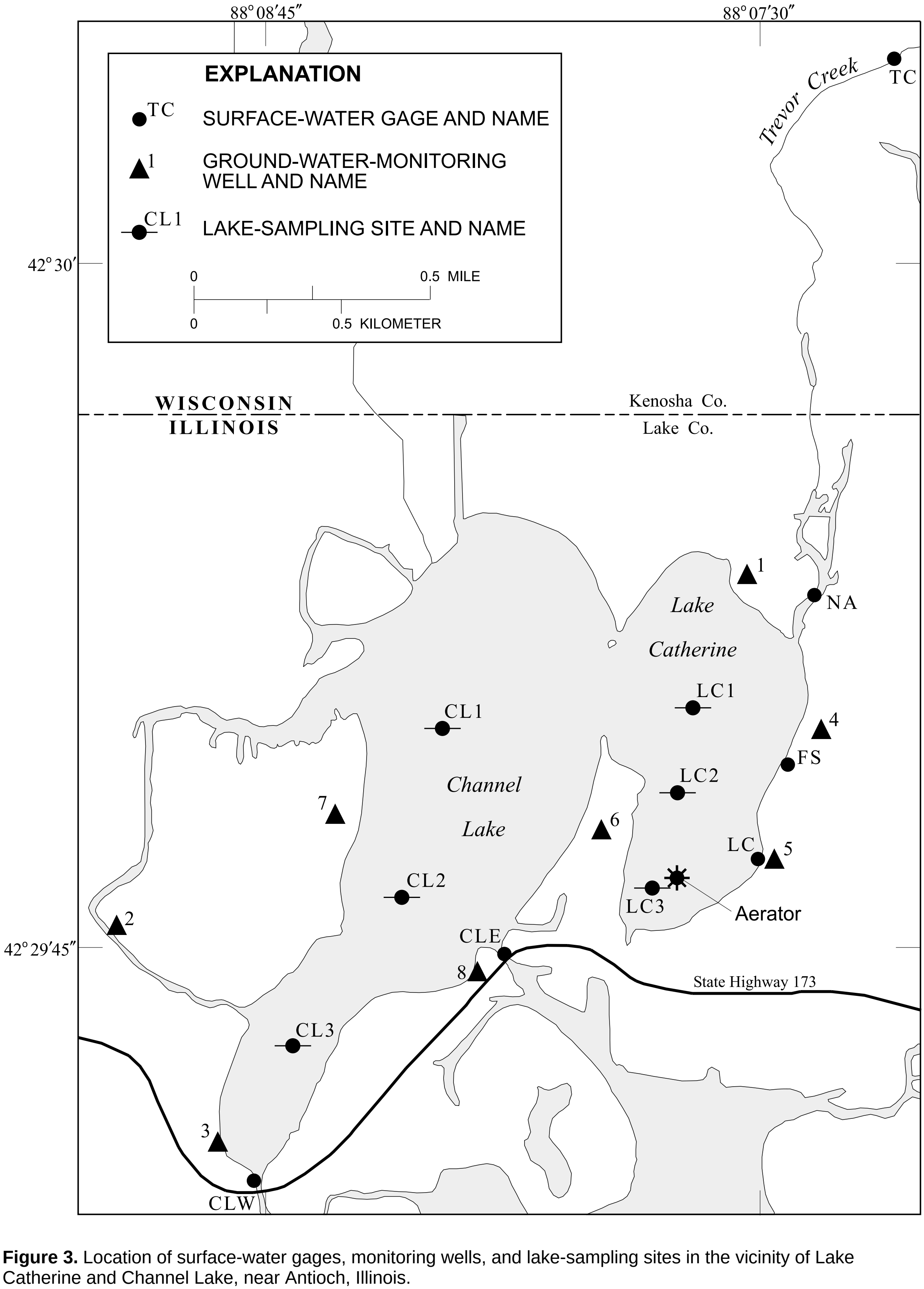

Figure 3. Location of surface-water gages, monitoring wells, and lake-sampling sites in the vicinity of Lake Catherine and Channel Lake, near Antioch, Illinois.

winds pushing water to the north (Kothandaraman and others, 1977).

The altitude of the bottom of Lake Catherine and Channel Lake was measured at four lines of cross section in 1975 and compared with the altitude obtained in 1964 near the cross sections (Kothandaraman and others, 1977, p. 51). Differences in the altitude of the lake bottom at the lines of section indicated that a maximum of 2–3 ft of sediment was deposited along most of the southern part of Channel Lake, with slight erosion near the southeastern shore of the lake. Approximately 2–3 ft of erosion was measured along the entire transect near the center part of the lake. Sedimentation of 7–8 ft was measured near the northern part of Channel Lake. A cross section of the center part of Lake Catherine showed some deposition near the shores and up to 3 ft of erosion in the center of the lake. The bottom sediments at Lake Catherine and Channel Lake contain more than 93 percent silt and clay sized particles with large amounts of organic material derived from dead plants and algae (Kothandaraman and others, 1977, p. 9).

Previous measurements of water quality in Lake Catherine and Channel Lake demonstrated that the maximum volume of the anoxic zone during the period of thermal stratification in 1975 was 39.9 percent of the total volume of Lake Catherine and 31.3 percent of the total volume of Channel Lake (Kothandaraman and Evans, 1978a). Concentrations of dissolved phosphorus and ammonia increased substantially with depth during previous investigations, indicating phosphorus and ammonia are produced by decomposition of organic matter on the lake bottom during anoxic conditions. Sediment oxygen demand for Lake Catherine was determined to be 12.98 $(g/m^2)/d$ at 25°C (Kothandaraman and others, 1977, p. 136). Blue-green algae were the dominant algae in both lakes, varying from an average of 55.2 to 70.9 percent of the algal density in these lakes. Flagellate (15.5 to 21.0 percent), diatom (8.4 to 16.3 percent), and green algae (3.8 to 8.6 percent) also were detected (Kothandaraman and others, 1977, p. 158).

In 1977, Lake Catherine and Channel Lake were rated in good condition with a high potential for exhibiting problems with eutrophication or sediment pollution (Sefton, 1978, p. 86). In 1978, statewide monitoring of these lakes by the IEPA indicated the lakes were considered to be of good quality with a high potential for degradation. Moderate problems (occasional occurrences that adversely affect lake use) with sediment deposition, algal blooms, and unstable water levels were identified for Lake Catherine (Sefton, 1978). Severe (frequent occurrences that adversely affect lake use) problems with sedimentation and moderate problems with algae blooms and unstable water levels were identified for Channel Lake. The sources of the sedimentation and unstable water levels were not identified. The algal blooms were attributed to septic systems and agricultural runoff.

In May 1978, an aeration destratification system was installed at a depth of 26 ft in Lake Catherine to increase the amount of dissolved oxygen in the lake and reduce the potential for internal regeneration of nutrients from the bottom sediments (fig. 3). Water-quality monitoring was done in Lake Catherine during initial operation of the aeration destratification system. Concurrent water-quality monitoring was done in Channel Lake during 1978 and subsequent years to provide a reference for determining water-quality changes in Lake Catherine. Water-quality monitoring demonstrated that the system was able to maintain a dissolved oxygen concentration greater than 2.0 mg/L above a depth of 26 ft in Lake Catherine, whereas dissolved oxygen was practically depleted below 18 ft in Channel Lake (Kothandaraman and others, 1979). Aeration had no effect on the concentration of nutrients and other chemical parameters in Lake Catherine, presumably because the aeration system did not extend over the entire depth of the lake.

In August 1978, the algicide copper sulfate was applied to Lake Catherine to determine the effects of reducing algal growth in the lake on water quality. The application of copper sulfate improved the clarity of Lake Catherine but caused a temporary decline in the dissolved oxygen concentration in the lake as a whole. This decline in dissolved oxygen concentration was assumed to be caused by increased oxygen demand created by decomposition of the dead algae (Kothandaraman and others, 1979).

During the summer of 1979, the aerator in Lake Catherine was moved to a depth of 34 ft in an attempt to expand the oxygenated area of the lake. Four times during the summer of 1979, copper sulfate was applied to reduce the amount of algae in the lake and to shift the algal communities away from dominance by blue-green algae. Twice during the summer, potassium permanganate was applied to the lake to help raise dissolved oxygen concentrations, which may have been lowered by the oxygen demand from decaying algae (Kothandaraman and others, 1980). The aerator increased the depth at which dissolved oxygen was detected in Lake Catherine but was not sufficient to aerate the entire lake. Secchi transparency was improved by the application of copper sulfate, but transparency decreased within 10 days of application, at least partially due to the effect of untreated water flowing in from Channel Lake. Aeration and algicide application reduced the algal density in Lake Catherine and decreased the dominance of blue-green algae. Treatment also reduced the concentrations of those components of water quality affected by anaerobic decomposition of lake-bottom sediments, including silica, alkalinity, dissolved and total phosphorus, and ammonia, in the deep parts of Lake Catherine.

Additional water-quality monitoring of Lake Catherine and Channel Lake by the Lake County Health Department during the summer of 1981, a period of aerator use and herbicide and algicide application, indicated the aerator improved the amount of dissolved oxygen in Lake Catherine and algicide application improved the Secchi transparency. These treatments had little or no affect on nutrient concentrations, temperature, pH, or the plankton community in Lake Catherine (Moylan and others, 1983). The aerator still operates during the summer months.

Aquatic macrophytes (plants visible to the unaided eye), including coontail, elodea, and milfoil, were observed throughout the lakes during the summer of 1998 (Mark Pfister, Lake County Health Department, oral commun., 1999). In addition, dense blooms of filamentous algae (algal mats) were reported during recent summers, including the summer of 1998. The proliferation of aquatic macrophytes and algae detracts from the aesthetic quality of the lakes, impedes recreational uses, and causes changes in water chemistry that have the potential to affect the fishery (Engel, 1990).

Purpose and Scope

This report presents the results of an investigation designed to determine the sources of the nutrients and sediment contributing to the eutrophication of Lake Catherine and Channel Lake. In addition to a description of the surface- and ground-water hydrology of the area, the results of surface-water-flow measurements, precipitation measurements, aquifer testing, surface- and ground-water-level measurements, water-quality sampling, and waterfowl counts in the vicinity of these lakes are presented. Water-quality samples were collected from precipitation, ground water, streams, storm drains, and near the surface and the bottom of the lakes. Water-quality samples were analyzed for nitrogen and phosphorus compounds, and volatile and total suspended solids. Lake water also was analyzed for temperature and dissolved-oxygen content with depth. The report presents the hydrologic budget, sediment budget, and nutrient budget for the lakes. The nutrient limiting algal growth and the trophic state of the lakes also are determined. Investigation results are based on data collected between April 21, 1998, and April 30, 1999, and will be used to develop remediation strategies for these lakes.

Physical Setting

Lake Catherine and Channel Lake are in the Wheaton Morainal Country of the Great Lakes Section of the Central Lowland Physiographic Province (Leighton and others, 1948). The Wheaton Morainal Country is characterized by knob and kettle topography with numerous kames. The landscape of the investigation area and its surroundings were shaped principally by the action of water and glacial ice. The major landforms were shaped by the last glaciers to cover northern Illinois, which formed in the Valparaiso Morainic System. The Valparaiso Morainic System is composed of a broad series of moraine ridges with interspersed undrained depressions containing small lakes and swamps filled with peat and muck. Lake Catherine and Channel Lake occupy a kettle depression between the ridges of the Valparaiso Morainic System.

Watershed Characteristics

The boundaries of the surface-drainage basin, or watershed, of Lake Catherine and Channel Lake were determined from the USGS 1:24,000 topographic quadrangle maps of the area (figs. 2, 4). The watershed boundary is approximately defined by Illinois State Highway 173 to the south (fig. 1), the surface drainage to Trevor Creek to the northeast, the surface drainage to the unnamed creek that enters Channel Lake to the northwest, direct drainage to Lake Catherine to the east, and direct drainage to Channel Lake and the wetlands to the west. Trevor Creek and the unnamed creek received flow from, or flow into, other lakes in the watershed prior to entering Lake Catherine and Channel Lake. Most of the drainage area for the lakes is in Wisconsin. The altitude of the land surface

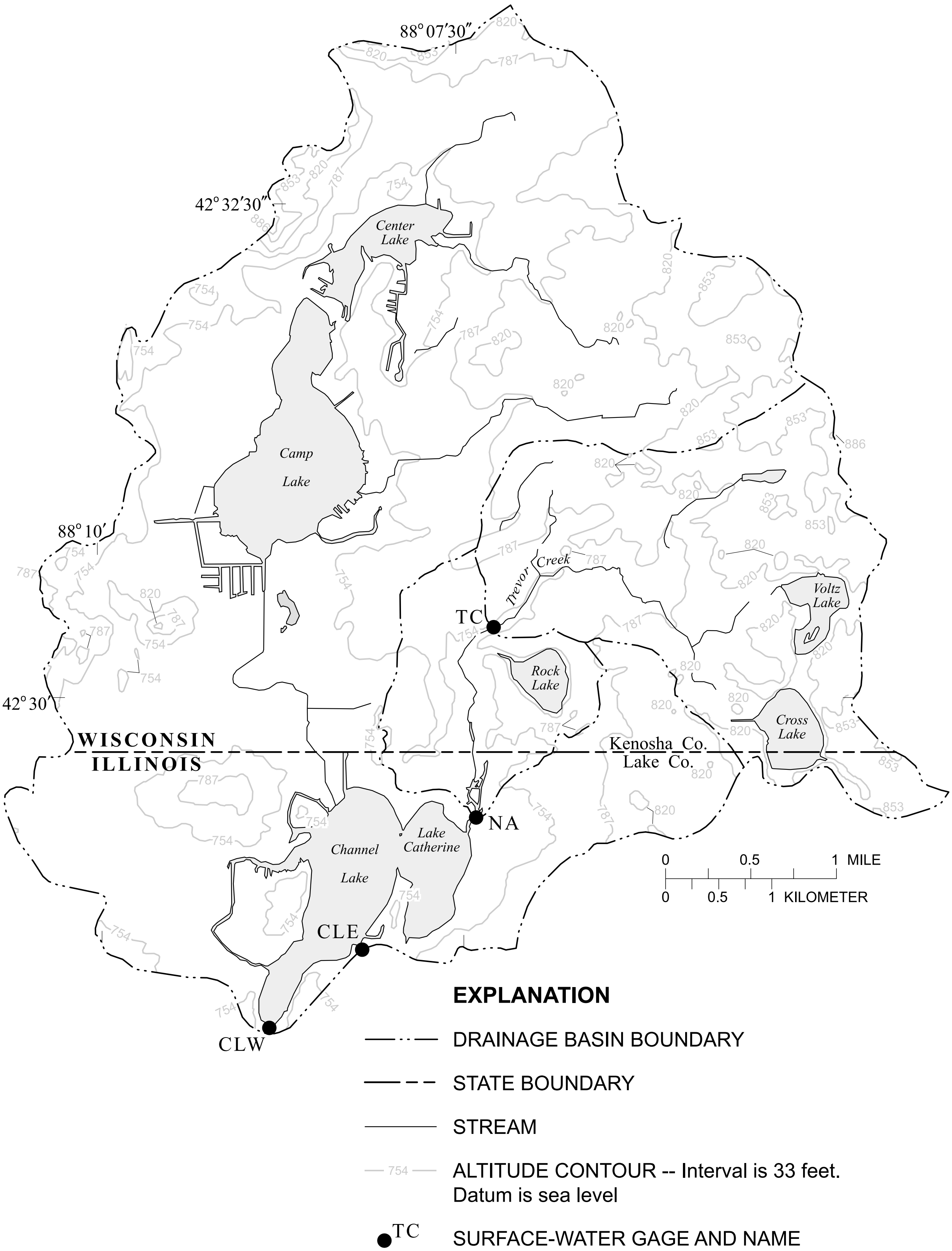

Figure 4. Lake Catherine and Channel Lake watershed, Illinois and Wisconsin.

at the watershed boundary exceeds 810 ft above sea level in much of the northern and eastern parts of the watershed, is typically less than 790 ft above sea level in the southeastern part of the watershed, and is between 790 and about 750 ft above sea level at the western and southern boundaries. The surface area of the watershed, including Lake Catherine, Channel Lake, and the other lakes, was calculated to be 12,379 acres (fig. 2).

The watershed shown in figures 2 and 4 represents the area of surface drainage to Lake Catherine and Channel Lake during typical flow conditions when flow is out of the lakes to the south. During periods of flow reversal, when water enters Channel Lake (and Lake Catherine) from the south, the watershed theoretically includes the Fox River watershed in southern Wisconsin, including the lower part of the Chain of Lakes (fig. 1).

Land use in the watershed was calculated from land-use coverages obtained from the WISCLAND Land Cover (1998) and the Illinois Department of Natural Resources (1996). The coverage was updated by field surveys done by USGS personnel in 1999. The land use was placed in a polygon coverage and analyzed using ARC/INFO software (fig. 5). The land-use coverages indicate that in 1995 about 4,161 acres (33.6 percent) of the land use in the watershed was classified as cropland. About 2,992 acres (24.2 percent) of the land use was classified as urban and urban grassland. About 2,341 acres (18.9 percent) of the land use was classified as forest. About 1,372 acres (11.1 percent) of the land use was classified as wetland. About 1,184 acres (9.5 percent) of the land use was classified as open water. About 329 acres (2.7 percent) of the land use was unclassified or classified as barren.

The surface-drainage area of the watershed upstream from Trevor Creek at the TC gage and the area served by the storm drainage at the FS gage also were determined from the USGS 1:24,000 topographic quadrangle maps of the area and entered into polygon coverages (fig. 2). Using ARC/INFO software, the surface-drainage area of Trevor Creek upstream from the TC gage was determined to be 2,272 acres, which is 18.34 percent of the total watershed.

Land use in the part of the watershed that drains to Trevor Creek at the TC gage was determined to be 42.6 percent cropland, 24.3 percent urban and urban grassland, 17.7 percent forest, 6.8 percent open water, 6.2 percent wetland, and 2.4 percent barren or unclassified land. These percentages are fairly representative of the entire watershed.

Lake Basin and Shoreline Characteristics

A bathymetric survey of Lake Catherine and Channel Lake was done by USGS personnel on April 22–23, 1999. On these dates, the altitude of the lake surface was about 737.30 ft above sea level, which is about 0.80 ft above the normal lake stage for the period of record (1939–present), 736.50 ft (Sefton, 1978; Kothandaraman and others, 1979). The bathymetric survey involved making approximately 40 transects of the lakes at a spacing of about 100 ft between transects. Readings of horizontal location and depth to the bottom of the lake were collected at intervals of approximately 1 ft along each transect. Horizontal location was measured using a differentially corrected global positioning system, typically accurate to within 3 ft. Depth to the bottom of the lake was measured using a digital fathometer accurate to within 6 in. under choppy lake-surface conditions that were present at the time of the survey. Horizontal location and depth measurements were contoured using a contouring package in ARC/INFO (lattice contour) to produce a bathymetric map (fig. 6).

Based on the bathymetric survey, the maximum depths of Lake Catherine and Channel Lake were about 40 and 36 ft, respectively, at a stage of 737.30 ft above sea level. These values indicate that the maximum depth of Lake Catherine and Channel Lake at their normal stage of 736.5 ft above sea level would be about 39 and 35 ft, respectively.

In 1975, bathymetric surveys were done along a line of section in Lake Catherine and along 3 lines of section along Channel Lake (Kothandaraman and others, 1977). The stage of the lakes during these measurements was 736.89 ft. The maximum depths of Lake Catherine and Channel Lake measured during this survey were approximately 39 and 37 ft, respectively. A bathymetric survey of Lake Catherine and Channel Lake also was done in May 1989 (Austen, 1993). The lake stage during the survey was about 737.1 ft, and the maximum measured depths of Lake Catherine and Channel Lake were greater than 39 and 35 ft, respectively. Adjusting for differences in stage, the amount of lake bottom surveyed, and the number of measurements made, a substantial decrease in the maximum depth of Lake Catherine and Channel Lake is not indicated.

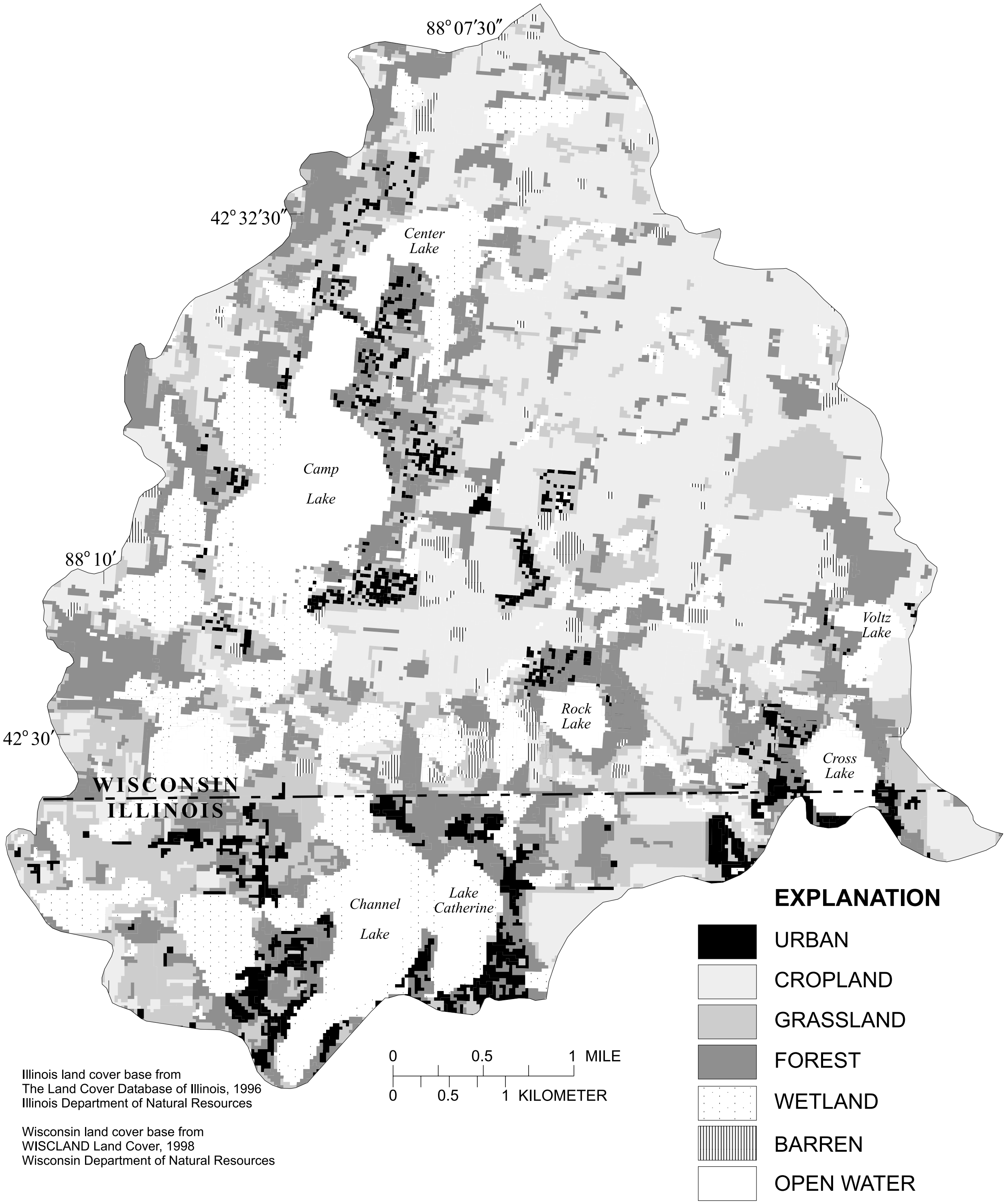

Figure 5. Land use in the Lake Catherine and Channel Lake watershed, Illinois and Wisconsin.

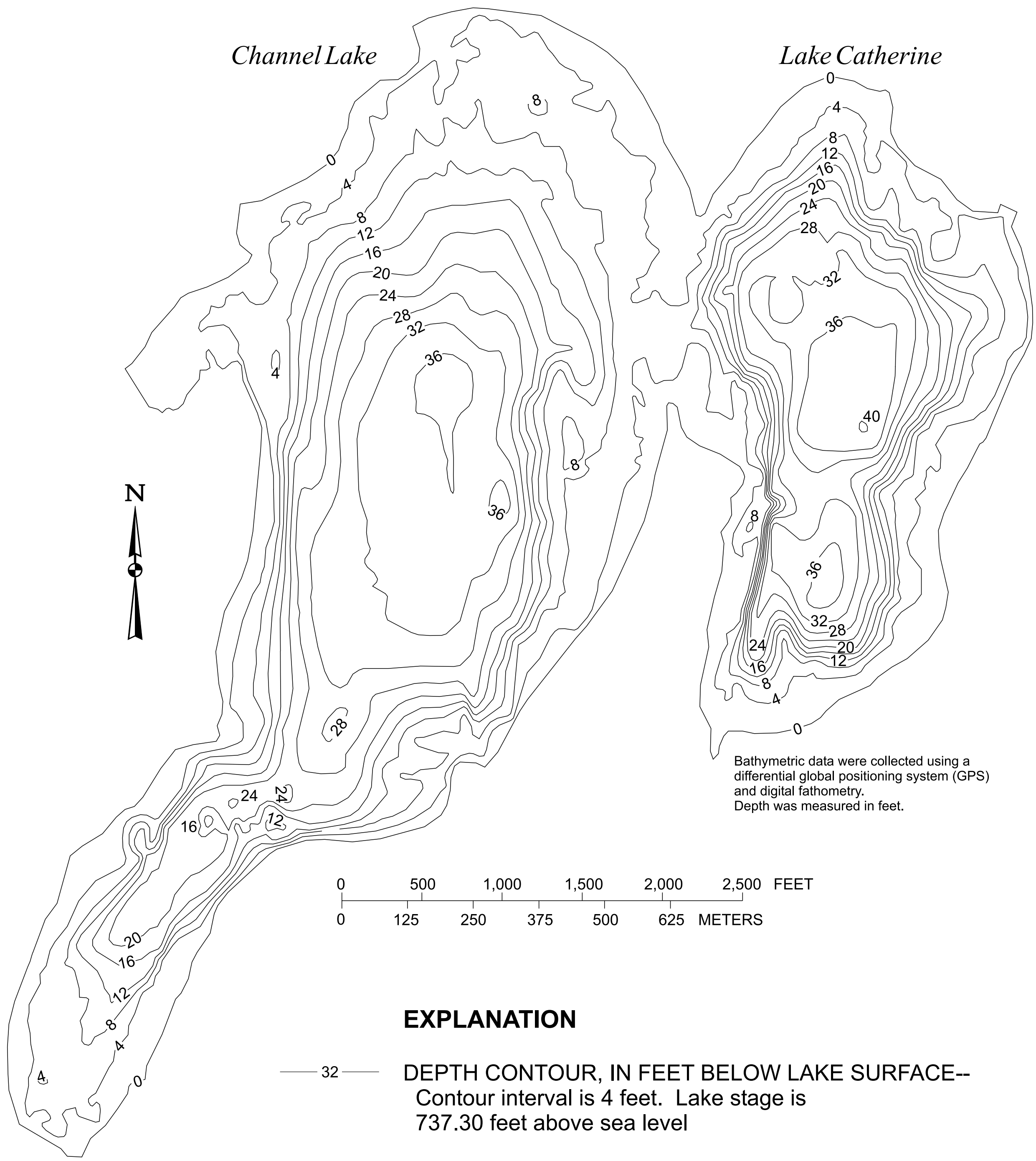

Figure 6. Bathymetry of Lake Catherine and Channel Lake, near Antioch, Illinois, April 22–23, 1999.

A ridge at a depth of less than 8 ft is present between the lakes, separating the deepest parts of the lake basins (fig. 6). A smaller basin is in the southern part of each lake. The smaller basin is defined by the 36-ft contour in the southern part of Lake Catherine and the 24-ft contour near the narrow part of southern Channel Lake.

The steepest parts of the lake basins are in the southwestern part of Lake Catherine and southern part of Channel Lake. The slope (change in depth divided by change in horizontal distance over which depth is measured) of the lake bottom from the water surface to the deepest part of Lake Catherine ranges from 1.7×10^{-2} to 5.0×10^{-2} ft/ft. The slope of the lake bottom from the surface to the deepest part of Channel Lake ranges from 6.5×10^{-3} to 2.9×10^{-2} ft/ft. The slopes of both lake bottoms are higher in the east-west direction than in the north-south direction.

Using ARC/INFO software and USGS quadrangle maps, the total surface area of Lake Catherine and Channel Lake was calculated to be 487 acres at a stage of 737.3 ft above sea level. The surface area of Channel Lake was calculated to be 337 acres, which is more than twice the surface area of Lake Catherine (150 acres). If the area of the watershed that drains to the lakes is approximately 12,379 acres, the ratio of the area of the surface-drainage basin to surface area of Lake Catherine and Channel Lake is approximately 25:1.

The volume of the lakes during the bathymetric survey was calculated from the bathymetric data using the ARC/INFO software. At a stage of 737.30 ft above sea level, the volume of Lake Catherine was calculated to be 2,500 acre-ft, the volume of Channel Lake was calculated to be 4,895 acre-ft, resulting in a total volume of 7,395 acre-ft. If this volume of water were spread evenly over the 12,379 acres of the watershed, the water depth would be about 0.60 ft.

The mean depth of Lake Catherine and Channel Lake was calculated by dividing the volume of each lake by its surface area. A mean depth of 16.7 and 14.5 ft was calculated for Lake Catherine and Channel Lake, respectively, at a stage of 737.3 ft above sea level. The mean depth of Lake Catherine and Channel Lake would be about 15.9 and 13.7 ft, respectively, at their normal stage of 736.5 ft.

Lake Catherine has about 9,715 ft of shoreline, an estimated 98 percent of which has been developed for residential use (Sefton, 1978). An estimated 2 percent of the Lake Catherine shoreline consists of park or woodland. Retaining walls are along most of the Lake Catherine shoreline where it has been developed for residential use. Channel Lake has about 17,793 ft of shoreline, an estimated 90 percent of which has been developed for residential use. An estimated 5 percent of the Channel Lake shoreline is woodland and 5 percent is wetland (Sefton, 1978). Retaining walls are along most of the Channel Lake shoreline where it has been developed for residential use.

Acknowledgments

The authors extend their thanks to the individuals and associations listed below who provided assistance with data collection or allowed the USGS to install monitoring sites on their property: Mr. Bachan, Mr. Droegkamp, Mr. and Ms. Gance, Mr. and Ms. Gifford, Mr. and Ms. Martini, Mr. Mentone, Mr. and Ms. Schroeder, Mr. Stanek, Mr. Otter, Felters Subdivision Homeowners Association, and Channel Lake Bluffs Subdivision Homeowners Association. The authors also thank Ms. Ingrid Enriquez, Director of the Fox Waterway Agency; Mr. Gregg Goode and Ms. Amy Walkenbach of the Illinois Environmental Protection Agency; and the Lake County Health Department for their assistance during the investigation.

HYDROLOGY

The components to the hydrology of Lake Catherine and Channel Lake include precipitation, evaporation, stormwater runoff, inflow and outflow of surface water, and the interaction between ground water and the lakes. Each component affects the water level in the lakes and the amount of nutrients that enter and leave the lakes.

The USGS installed surface-water gages on Trevor Creek, Lake Catherine, a storm drain into Lake Catherine, and the Channel Lake openings (fig. 3, table 1). The gage at Trevor Creek was installed to determine the amount of flow in the creek at that point. The gage on Lake Catherine was installed to determine the altitude of the lake surface. The gage in the storm drain was installed to determine the volume of water flowing to the lake through that drain. The gage on the western opening of Channel Lake is part of the USGS routine monitoring network and was used to determine the stage of the lake. The gage on the eastern opening of Channel Lake was installed to determine the direction and volume of flow through the opening. Stage and flow data collected at the gages were combined with geographic information and water-quality data to quantify the amount of water, sediment, and nutrients added to and removed from the lakes from surface-water sources.

The USGS installed eight ground-water-monitoring wells to characterize the interaction between surface water and ground water in the area (fig. 3, table 1). Surface- and ground-water-level data were combined with the results of hydraulic testing and water-quality sampling to quantify the amount of water and nutrients added to the lake by inflow from ground

Table 1. Well and surface-water gage data, Lake Catherine and Channel Lake, near Antioch, Ill.

Ground-water-monitoring well name	Latitude/longitude (degrees, minutes, seconds)	Depth of open interval (feet below land surface)[1]	Land-surface altitude (feet above sea level)	Measuring-point altitude (feet above sea level)
1	42°29′26″/88°07′35″	5–15	742.4	741.85
2	42°28′48″/88°09′10″	5–15	758.2	760.87
3	42°28′24″/88°08′55″	4–14	741.2	743.78
4	42°29′09″/88°07′24″	10–20	746.0	745.74
5	42°28′55″/88°07′32″	7–17	740.6	743.23
6	42°28′58″/88°07′57″	9–19	746.3	748.91
7	42°29′00″/88°08′37″	29–39	739.2	741.54
8	42°28′43″/88°08′16″	8–18	737.8	739.76

Surface-water gage name	Latitude/longitude (degrees, minutes, seconds)	Surface-water body monitored
TC	42°30′23″/88°07′12″	Trevor Creek
NA	42°29′24″/88°07′25″	Trevor Creek at North Avenue
CLE	42°28′44″/88°08′16″	Channel Lake east outlet
CLW	42°28′20″/88°08′50″	Channel Lake west outlet
LC	42°28′55″/88°07′33″	Lake Catherine
FS	42°29′06″/88°07′30″	Storm drainage

[1]Depth of bottom of open interval equals depth of well.

water and the amount of water and nutrients removed from the lake by outflow to ground water.

Data from USGS and National Oceanic and Atmospheric Administration (NOAA) rain gages in Antioch were used to determine the amount of water added to the lake from precipitation. The amount of precipitation was combined with the results of water-quality sampling of the precipitation to quantify the nutrient load to the lakes from precipitation. Climate data were obtained from published sources to determine the amount of evaporation from the lake.

Precipitation and Evaporation

The amount of precipitation at the USGS and NOAA rain gages (located within 100 ft of each other) in the village of Antioch (fig. 1) was measured daily from May 1, 1998, through April 30, 1999 (fig. 7). Although at least one of the gages was functional throughout the period of investigation, neither gage functioned for the entire period of investigation. Therefore, the highest monthly total measured at either gage was assumed for the study (table 2).

During the investigation, the total amount of precipitation measured at the Antioch gages was 34.70 in. (table 2), which was 1.07 in. less than the normal annual precipitation measured at this station from 1961 through 1990 (National Oceanic and Atmospheric Administration, 1998). Precipitation varied from a low of slightly more than 1.0 in. in February and March 1999 to a high of 6.80 in. in April 1999.

During the investigation, the amount of monthly evaporation from the lakes was calculated from temperature data obtained at the NOAA gage in Antioch, on the basis of the technique of Hamon (1961) (table 2). The total amount of evaporation during the period of investigation was calculated to be 29.69 in., which was 5.01 in. less than the amount of precipitation. Evaporation varied from less than 0.50 in. in January 1999 to 5.18 in. in July 1998.

Surface Water

The surface-water bodies of concern to this investigation are Trevor Creek, Lake Catherine, Channel Lake, and the storm drainage to Lake Catherine from the Felter’s subdivision. Data have been obtained from representative areas at each of the surface-water bodies.

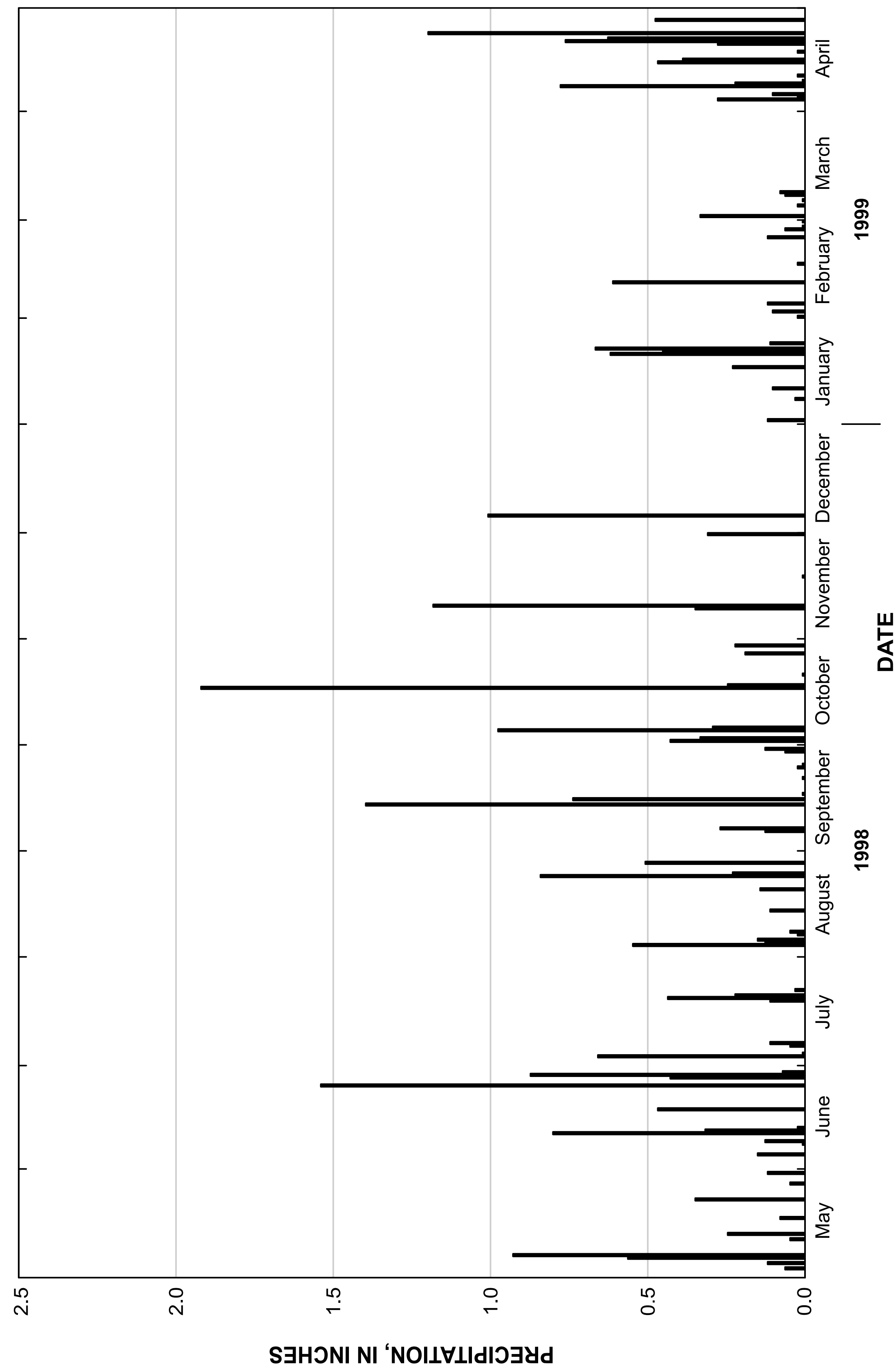

Figure 7. Precipitation at Antioch, Ill., May 1, 1998–April 30, 1999.

Table 2. Monthly summary of precipitation and evaporation at Lake Catherine and Channel Lake, near Antioch, Ill., May 1998–April 1999

[+, precipitation exceeds evaporation; –, evaporation exceeds precipitation]

Month and year	Precipitation measured at Antioch gage (inches)	Calculated amount of evaporation at Lake Catherine and Channel Lake (inches)	Difference, amount of precipitation and evaporation (inches)
May 1998	3.00	3.68	–0.68
June 1998	4.84	4.67	+.17
July 1998	1.63	5.18	–3.55
August 1998	2.73	4.67	–1.94
September 1998	2.78	3.07	–.29
October 1998	4.62	1.59	+3.03
November 1998	1.96	.86	+1.10
December 1998	1.90	.52	+1.38
January 1999	2.33	.43	+1.90
February 1999	1.07	.98	+.09
March 1999	1.04	1.17	–.13
April 1999	6.80	2.87	+3.93
Total	34.70	29.69	+5.01

Trevor Creek

Trevor Creek was monitored using standard USGS methods (Rantz and others 1982a, b). A stilling well was mounted to the downstream side of the bridge over the creek at Rock Lake Road, and a datalogger recorded the surface-water altitude (stage) every 15 minutes. The stage of Trevor Creek at the TC gage during the investigation ranged from 742.80 ft above sea level in mid-August 1998 to 745.75 ft above sea level on April 23, 1999 (fig. 8). The high stages measured periodically during most of the investigation reflect primarily overland runoff and stormwater discharge to the creek associated with precipitation events (compare figs. 7 and 8). The high stage measured in late January through mid-February 1999 reflects primarily overland runoff of water from widespread snowmelt in the basin. The stage of the creek typically rose quickly after precipitation events, cresting within 2 days then declined asymptotically toward the altitude of the streambed at about 742.5 ft above sea level.

On the basis of 15 streamflow measurements collected over a range of stages, a simple stage-discharge relation was computed for Trevor Creek. The stage-discharge relation was used to calculate the mean daily discharge at the TC gage from the measured stage values (fig. 9). Mean daily discharge ranged from approximately 1.0×10^{-1} ft^3/s in late July and parts of August 1998 to 7.3×10^{1} ft^3/s on April 23, 1999, following a time of large amounts of precipitation.

The mean daily discharge of Trevor Creek at the TC gage was multiplied by the number of seconds per day (86,400) to obtain the volume of flow (in cubic feet) past the gage on a daily basis. Daily values were totaled to determine the volume of flow past the gage each month and converted from cubic feet to acre-feet (table 3). The total volume of water flowing past the TC gage was 250 acre-ft in May 1998 and declined to 9 acre-ft during the dry part of the growing season in August 1998. The volume of water measured at the TC gage after August 1998 increased overall to nearly 350 acre-ft during the period of snowmelt and precipitation in January and February 1999, decreased substantially in March 1999, and reached a maximum of more than 550 acre-ft in response to the large amount of precipitation during April 1999. The volume of water flowing through Trevor Creek at the TC gage totaled more than 1,940 acre-ft during the period of investigation.

The stage of Trevor Creek at the NA gage (fig. 3) was determined by measuring the depth to water from a point of known altitude at the gage on May 11, June 11, July 13, August 8, September 14, and September 24, 1998, and on March 16, 1999. The stage of Trevor Creek at the NA gage on these dates was from 3.52 to 6.67 ft lower than the stage measured at the TC gage. The distance along Trevor Creek between the TC and NA gages is approximately 6,700 ft (fig. 3), indicating Trevor Creek has a gradient from 5.25×10^{-4} to 9.96×10^{-4} ft/ft along this reach. On June 11 and July 13, 1998, attempts to measure the flow of Trevor Creek at the NA gage were unsuccessful because water velocity was too low to be detected.

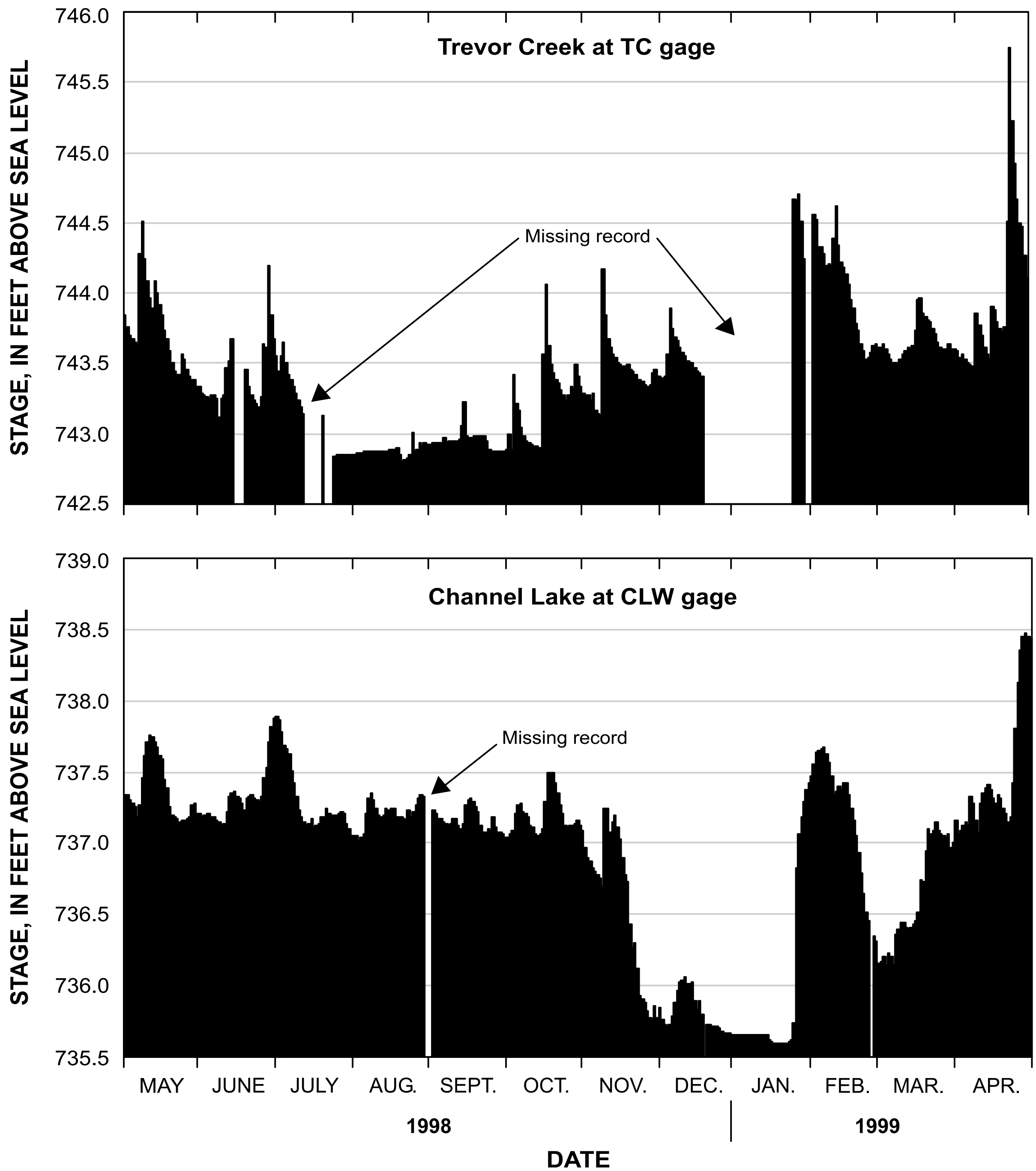

Figure 8. Stage of Trevor Creek and Channel Lake, near Antioch, Ill., May 1, 1998–April 30, 1999.

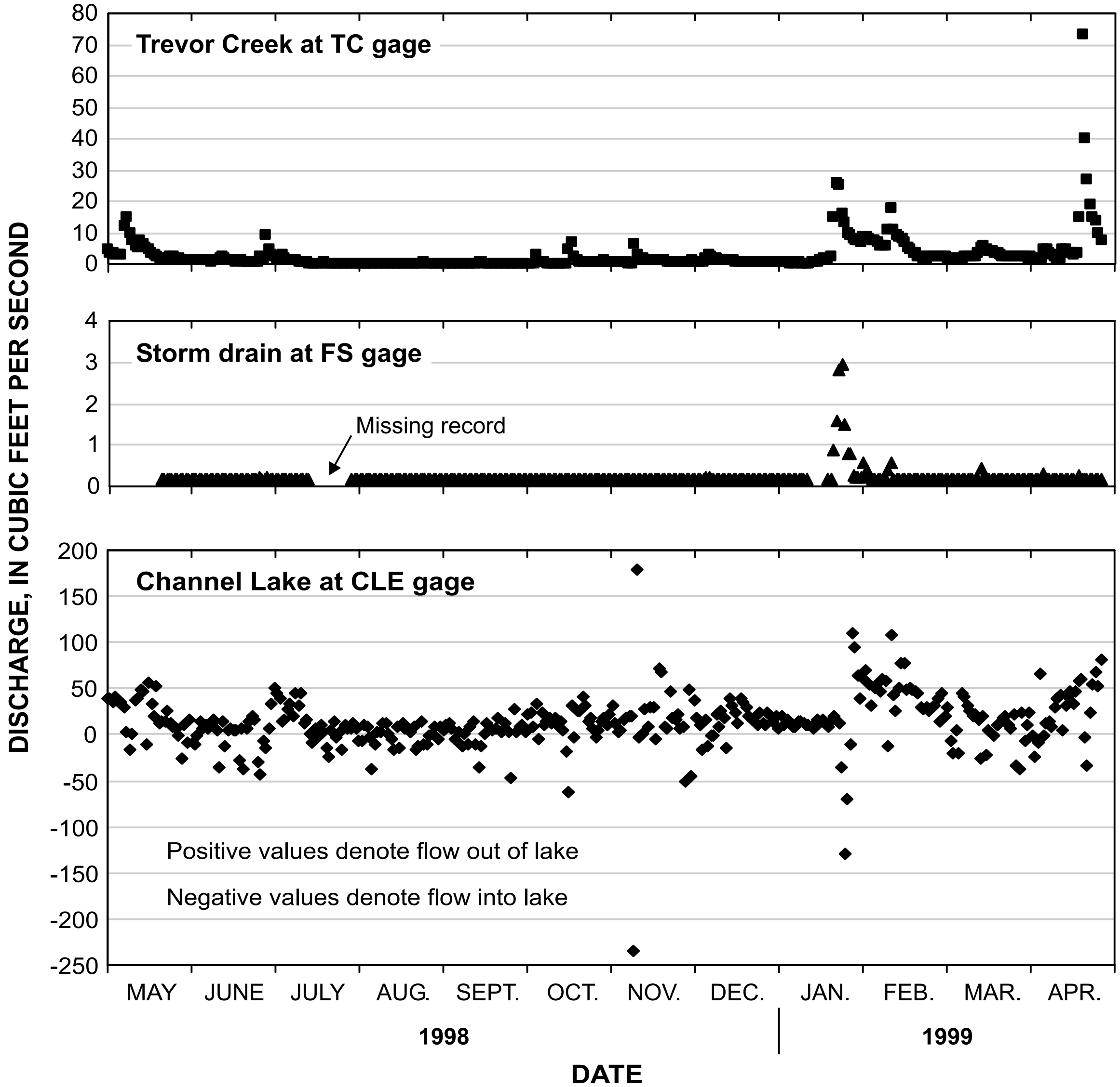

Figure 9. Mean daily discharge of Trevor Creek at the TC gage, the storm drain at the FS gage, and the east opening of Channel Lake at the CLE gage, near Antioch, Ill., May 1, 1998–April 30, 1999.

Storm Drain

The flowmeter at the FS gage measured stage and water velocity through the drainage pipe from May 1, 1998, through April 31, 1999. Stage and velocity data were measured at 5- or 10-minute intervals and combined with the area of the pipe through which water was flowing at the measured stage to determine the instantaneous discharge at the storm drain. Data are missing from parts of May, July, and August 1998 and part of January 1999. The volume of flow through the storm drain during the periods of missing record was estimated by comparing the measured amounts of flow and precipitation during the period of record in a given month then using the measured precipitation for that month to extrapolate the total volume of flow.

Prior to mid-August 1998, the storm drain monitored by the FS gage received all drainage from a subdivision along the east-central part of Lake Catherine (fig. 10). After mid-August, the storm drain was connected to a retention pond that drains a new subdivision that was being developed. The area of drainage to the FS gage was 31.65 acres prior to mid-August, or about 13.6 percent of the area near Lake Catherine and Channel Lake served by storm drains at that time. The combined area drained by the storm drain at the FS gage increased to 134.57 acres after mid-August, or about 40.1 percent of the area near Lake

Table 3. Volume of flow at the TC (Trevor Creek), FS (storm drain), and CLE (east opening of Channel Lake) gages, near Antioch Ill., May 1998–April 1999
[–, denotes flow into Channel Lake through opening]

Month and year	Measured volume of flow on Trevor Creek at the TC gage (acre-feet)	Measured volume of flow through storm drain at FS gage (acre-feet)	Estimated volume of flow through storm drain at FS gage including low-flow estimates (acre-feet)	Measured volume of flow from Lake Catherine and Channel Lake through Route 173 bridge opening at the CLE gage (acre-feet)	Measured volume of flow into Lake Catherine and Channel Lake through Route 173 bridge opening at the CLE gage (acre-feet)
May 1998	250	0.068	11.1	1,418	–126
June 1998	92	1.14	11.8	426	–442
July 1998	41	.066	11.1	943	–138
August 1998	9	.003	11.1	254	–309
September 1998	14	.26	10.9	359	–277
October 1998	55	1.46	12.5	911	–178
November 1998	60	.42	11.1	1,472	–580
December 1998	54	1.04	12.1	1,069	–181
January 1999	299	47.64	58.3	1,150	–486
February 1999	349	14.76	22.2	2,621	–24
March 1999	166	5.76	16.4	959	–328
April 1999	555	37.97	46.9	1,732	–151
Total	1,944	110.587	235.5	13,314	–3,220

Catherine and Channel Lake served by the storm drains. However, the water level in the retention basin did not rise to the level where water flowed into the storm drain until January 1999. The storm drain at the FS gage drained the smaller part of the basin for that part of the investigation from May 1 to December 31, 1998.

The measured instantaneous discharge through the storm drain at the FS gage ranged from 0.0 to 26.43 ft^3/s and was highest following precipitation events and snowmelt. Discharge also was higher during January–April 1999, when the storm drain received water from a larger area, than during May–December 1998. Flow through the storm drain was observed almost every time the FS gage was serviced or water-quality samples were taken. However, water velocities during most of these periods were below the detection limit of the flowmeter. The inability of the flowmeter to measure low-flow velocities indicates some flow through the storm drain during the entire period of investigation, but most of the flow could not be measured. Therefore, five field measurements of the discharge rate were made at the FS gage during low-flow periods. Flow rates ranged from 6.4×10^{-2} to 4.4×10^{-1} ft^3/s, with a mean of 1.8×10^{-1} ft^3/s. Nonsewage wastewater from private residences and inflow from shallow ground water appear to be the source of water moving through the storm drain during periods of no precipitation.

Instantaneous discharge measurements recorded by the flowmeter at the FS gage were multiplied by the number of seconds between measurements (either 300 or 600 seconds) and totaled on a daily (fig. 9) and monthly basis (table 3) to determine the measured volume of flow past the gage. Approximately 110 acre-ft of water was measured to have flowed through the storm drain during the investigation (table 3), excluding that flow too low to be detected by the flowmeter. Less than 0.1 acre-ft of flow was detected by the flowmeter at the FS gage during May, July, and August 1998. More than 10 acre-ft of water was detected flowing past the gage during snowmelt periods in January and February 1999 and during the period of large amounts of precipitation in April 1999. The substantial increase in the volume of flow through the storm drain in January–April 1999 can be partially attributed to the increase in the acreage feeding into the storm drain. If the mean discharge of 0.18 ft^3/s measured at the storm drain during periods of low flow is multiplied by the number of seconds per day when flow was not detected by the flowmeter, the estimated volume of water flowing through the storm drain during the period of investigation more than doubles to about 235 acre-ft (table 3).

Lake Catherine and Channel Lake

An acoustic velocity meter (Laenen, 1985) was used at the CLE gage to measure lake stage and the rate and direction of flow through the channel at the east opening of Channel Lake (figs. 2, 3). Stage was

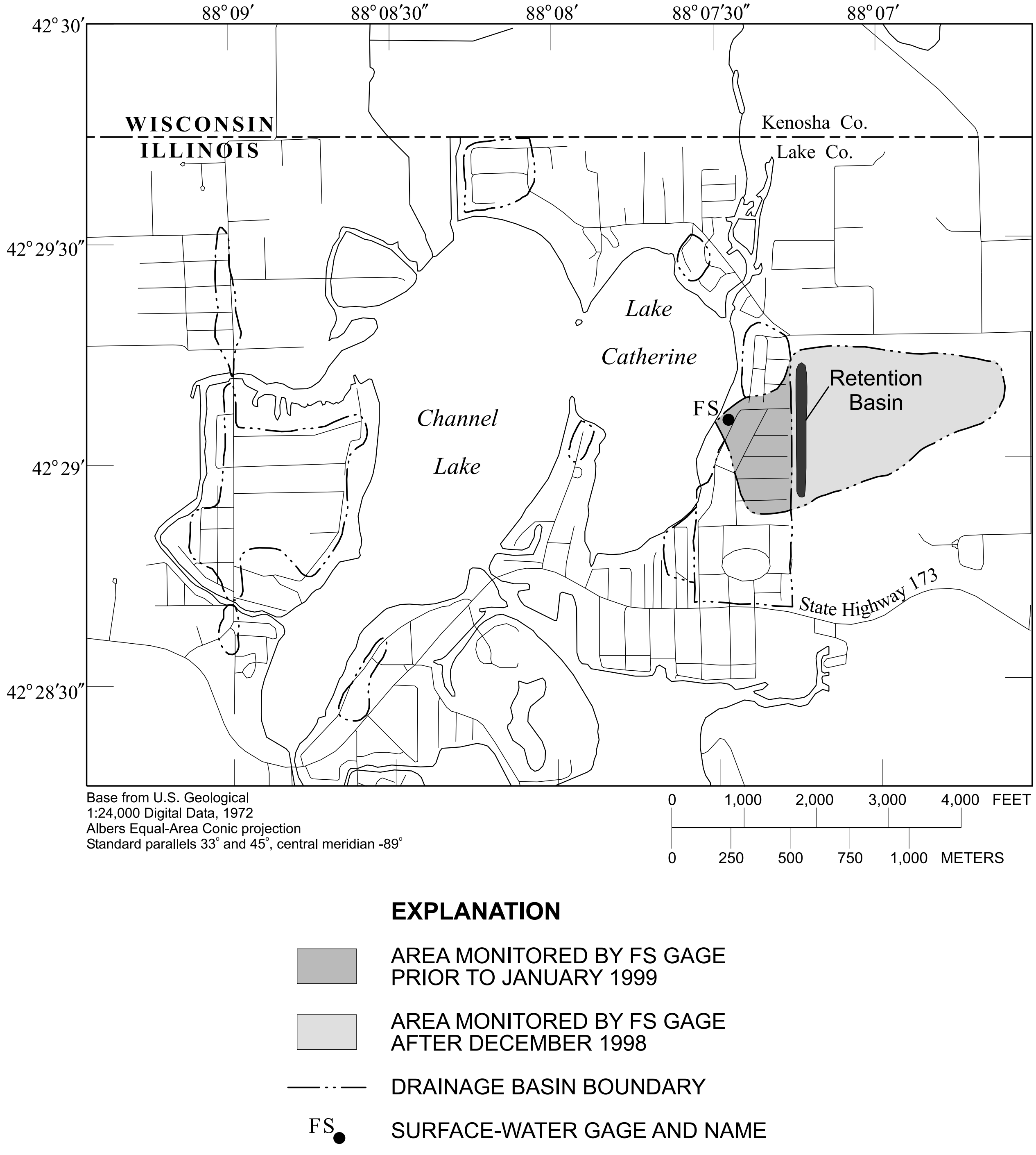

Figure 10. Area of surface flow to storm drains in the vicinity of Lake Catherine and Channel Lake, near Antioch, Ill.

measured every 15 minutes using a sonic transducer connected to the acoustic velocity meter. Water discharges for the gage were computed on the basis of an index-velocity rating (Rantz and others, 1982a, b) because of the backwater conditions periodically present at the gage. The water velocities at the CLE gage usually were less than 0.2 ft/s, making accurate measurements using a Price AA meter impossible; therefore, discharges were measured using an acoustic Doppler current profiler (Simpson and Oltmann, 1993) for calibration purposes. Doppler flowmeter surveys of the channel near the CLE gage were done on July 29, 1998, September 15, 1998, and April 28, 1999. Streamflow was measured at the CLE gage on April 23, 1999.

Stage was measured every 15 minutes at the CLW gage. This gage is inside a stilling well and has been monitored by the USGS since October 1939 (Wicker and others, 1998). Specifics of the operation and maintenance of the stilling well are described by Rantz and others (1982a, b). Backwater conditions and reversals in flow directions did not allow for development of a stage-discharge relation at this gage.

Measurements from the NA, LC, CLE, and CLW gages indicate the stage of Lake Catherine and Channel Lake essentially was identical at any given time during the period of investigation. Stage readings fluctuated more at the CLE gage than at the CLW gage. Differences in the amount of fluctuation in stage readings were caused by the rapid measurement speed of the acoustic stage sensor at the CLE gage, which was measuring the peaks and troughs of waves in the channel. Waves also have some affect on the stage readings at the LC and NA gages. The stage sensor at the CLW gage was contained in a stilling well, which is designed to restrict the interference caused by waves. Because of the long period of record and the relative stability of the measurements, the discussion of the stage of Lake Catherine and Channel Lake will be based on the data collected at the CLW gage.

The stage of Lake Catherine and Channel Lake measured at the CLW gage (figs. 2, 3), from May 1, 1998, through April 30, 1999, ranged from 735.60 ft during a period of ice cover in January 1999 to 738.47 ft above sea level following a storm in late April (fig. 8). The mean water level of the lakes during the investigation was 736.91 ft above sea level, slightly higher than the mean stage of 736.5 ft reported by previous investigators (Sefton, 1978; Kothandaraman and others, 1979). The highest stage ever recorded at the CLW gage was 741.29 ft above sea level in April 1960 (Wicker and others, 1998). The lowest stage ever recorded at this gage was 734.65 ft above sea level in January 1977. The lake stage measured during the current investigation was within the stage of record.

The stage of Lake Catherine and Channel Lake is affected primarily by operations at the Stratton Lock and Dam across the Fox River at McHenry (fig. 1). During the period from May 1 through late October 1998, the Stratton Lock and Dam was closed, and the stage of Lake Catherine and Channel Lake was greater than 737 ft above sea level during much of this period (fig. 8). In November 1998, the Stratton Lock and Dam was opened to increase the outflow of water, and the stage of Lake Catherine and Channel Lake dropped to about 735.8 ft above sea level. The dam was closed again in late February 1999, resulting in a gradual increase in the stage of the lakes to above 737 ft.

In addition to dam operations, the stage of the lakes also is affected by natural processes. The stage of Lake Catherine and Channel Lake showed several peaks associated with precipitation events throughout the period of investigation, as well as a large peak associated with snowmelt in January and February 1999 (compare figs. 7 and 8). The elevated lake stage associated with precipitation events other than the snowmelt typically lasted for 5–10 days. Peaks in the hydrograph at Lake Catherine and Channel Lake typically lagged behind those peaks at Trevor Creek (fig. 8), reflecting the effects of flow from a larger watershed. In addition, a number of peaks and troughs in the lake stage were associated with wind action on the lake surface. Wind direction and velocity were measured at Grass Lake during the investigation (fig. 1).

During the investigation, flow through the east outlet of Channel Lake was both into and out of Channel Lake. Data from the acoustic velocity meter at the CLE gage indicate flow into Channel Lake at the east opening during about 21 percent of the period of investigation and flow out of Channel Lake at the east opening during about 79 percent of the period of investigation. The maximum instantaneous discharge measured out of Channel Lake at the CLE gage was 463 ft^3/s on November 11, 1998. The maximum instantaneous discharge measured into Channel Lake at the CLE gage was –698 ft^3/s on November 10, 1998 (negative values denote discharge into the lake, positive values denote discharge out of the lake). The mean daily discharge measured out of Channel Lake at the CLE gage ranged from 0.1 ft^3/s on August 28, 1998, to

179 ft^3/s on November 11, 1998 (fig. 9). The mean daily discharge measured into Channel Lake at the CLE gage ranged from –0.23 ft^3/s on April 9, 1999, to –235 ft^3/s on November 10, 1998.

An unusual pattern in the discharges at the CLE gage was noted on days when more than 0.5 in. of rain was recorded and the stage in Channel Lake rose by 0.5 ft. The pattern would start with the typical discharge out of Channel Lake (about 10 to 20 ft^3/s), water would eventually flow into Channel Lake at a rate of –100 to –300 ft^3/s, and after the lake stage peaked, water would flow out of Channel Lake at a rate of 100 to 200 ft^3/s.

Strong winds from the southwest occasionally pushed water from the southern parts of the Fox Chain of Lakes upstream into Lake Catherine and Channel Lake. The most dramatic occurrence of wind-induced inflow to Channel Lake occurred on November 10, 1998, a period when the wind speeds were measured at over 30 mph at the Stratton Lock and Dam in McHenry (Illinois Department of Natural Resources, 1999). Discharge at the CLE gage decreased from 69 ft^3/s flowing out of the lake to –698 ft^3/s flowing into the lake, the highest instantaneous discharge measured into the lake during the investigation. As the wind lessened, discharge out of Channel Lake at the CLE gage rose to 463 ft^3/s, the highest instantaneous discharge measured out of the lake during the investigation. The water level at the CLE gage increased by more than 1 ft during a 20-hour span on November 9–10, 1998.

On April 8–9, 1998, winds from the north caused the water level at the CLE gage to decrease by as much as 0.42 ft. During this period, discharge out of the lake increased from about 40 ft^3/s to a maximum of 299 ft^3/s as the wind pushed water out of the lake. During the evening of April 9, 1999, after the wind velocity decreased, as much as –263 ft^3/s of water flowed back into Channel Lake.

Multiplying the instantaneous discharge measurements by the appropriate time period and summing the resulting volumes on a daily and monthly basis indicates –3,220 acre-ft of water flowed into Lake Catherine and Channel Lake through the east opening during the investigation and about 13,314 acre-ft of water flowed out of the lakes through the east opening during the investigation (table 3). The largest monthly amount of inflow to the lakes through the east opening (–580 acre-ft) occurred in November 1998, during high winds on the Chain of Lakes. The largest monthly amount of outflow from the lake through the east opening (2,621 acre-ft) occurred in February 1999, during a snowmelt period.

Streamflow measurements were made at the west opening of Channel Lake on July 29, 1998, September 15, 1998, and April 23, 1999. The volume of flow through the west opening showed no clear correlation with the volume of flow through the east opening. Doppler flowmeter surveys were attempted at the west opening on July 29 and September 15, 1998, but were unsuccessful because of the shallow water at the opening. Typically, flow through the west opening was in the same direction as flow in the east opening during the measurements.

Ground Water

Ground water flows through the Wadsworth Till Member of the Wedron Formation, the Grayslake Peat, the Carmi Member of the Equality Formation, and the Wasco and Batavia Members of the Henry Formation into Lake Catherine and Channel Lake (fig. 11). The geologic nomenclature used in this report is that of the Illinois State Geological Survey (Larsen, 1973) and does not necessarily conform to the usage of the USGS.

The Wadsworth Till is composed of a silt matrix with imbedded dolomite and shale pebbles. These deposits are as much as 100 ft thick in the investigation area (Larsen, 1973). The Wadsworth Till Member of the Wedron Formation underlies the entire investigation area but intercepts the sides of Lake Catherine and the northern part of Channel Lake. Lithologic logs obtained during well drilling confirm that well 7 is open to the Wadsworth Till below the Carmi Member of the Equality Formation (fig. 11).

The sand-and-gravel deposits of the Wasco and Batavia Members of the Henry Formation overlie the Wedron Formation. These deposits can be as much as 100 ft thick in this area (Larsen, 1973) and are present at the southern part of Channel Lake. Wells 3 and 8 are open to the Henry Formation (fig. 11).

The silt and clay deposits that compose the Carmi Member of the Equality Formation tend to be less than 15 ft thick and overlay till or sand-and-gravel deposits. Lithologic logs obtained during well drilling confirm that wells 1, 2, 4, 5, and 6 are open to the Carmi Member of the Equality Formation (fig. 11).

The Grayslake Peat deposits are concentrated in topographically low areas in the northern part of Lake Catherine and Channel Lake and west of the large island in Channel Lake (fig. 11). These deposits are

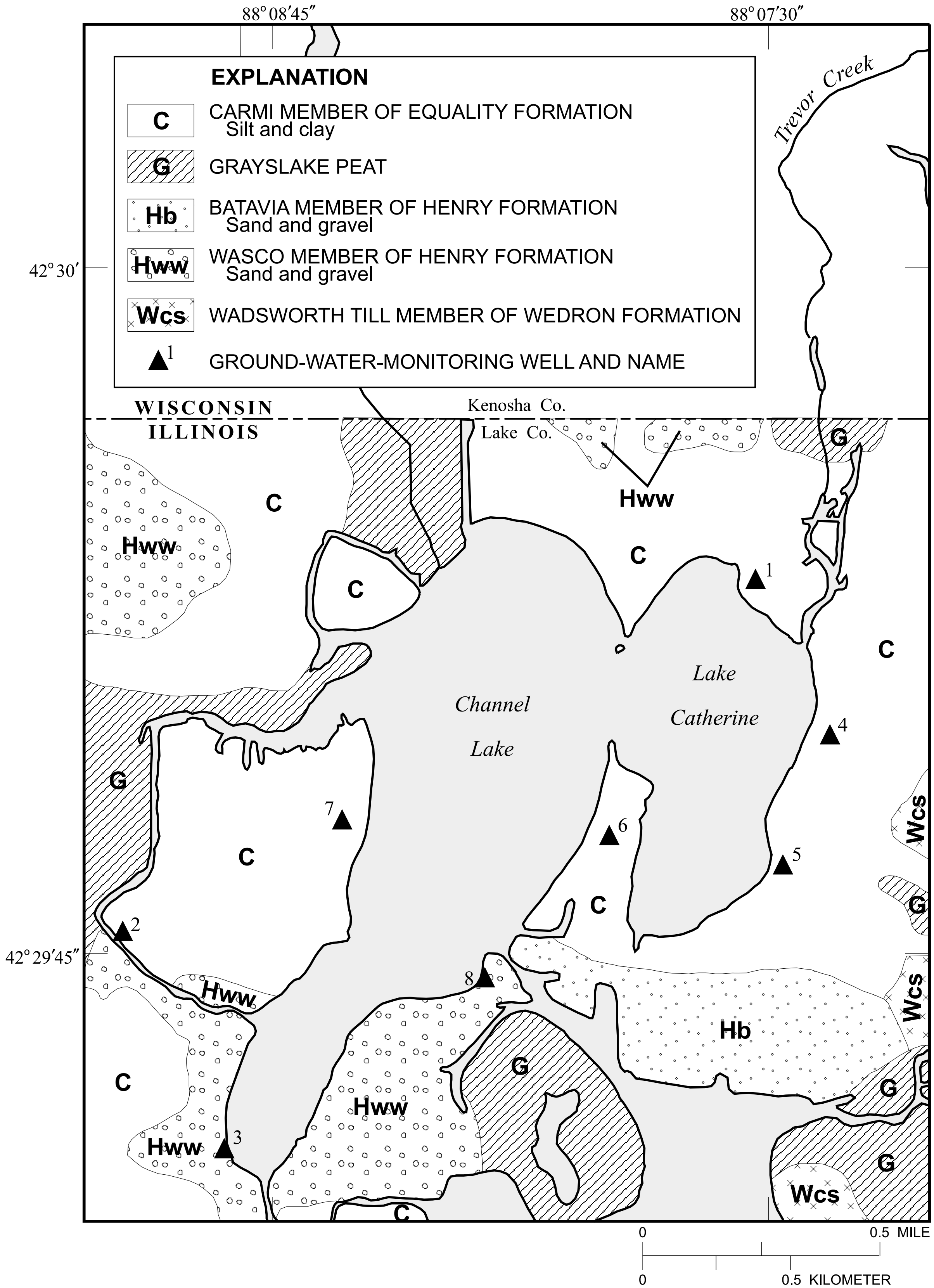

Figure 11. Surficial geology in the vicinity of Lake Catherine and Channel Lake, near Antioch, Ill. (modified from Larson, 1973).

typically less than 10 ft thick and appear to overlay primarily till or silty-sand deposits. None of the wells drilled for this investigation are open to this deposit.

Slug tests were done by USGS personnel in each of the wells drilled for this investigation to determine the horizontal hydraulic conductivity of the geologic deposits surrounding the lakes (table 4). Procedures used for collection and analysis of slug-test data and assumptions used for the analysis are presented in Kay (1998). Slug-test data for well 8 displayed an oscillatory water-level response and were analyzed on the basis of the technique developed by van der Kamp (1976). Slug-test data for the remaining wells displayed a continual decline in water levels with time and were analyzed on the basis of the technique of Bouwer and Rice (1976).

Table 4. Horizontal hydraulic conductivities calculated from slug-test data in wells 1–8 in the vicinity of Lake Catherine and Channel Lake, near Antioch, Ill.

Ground-water-monitoring well name	Geologic material tested	Horizontal hydraulic conductivity (feet per day)
1	Clay	1.29×10^{-2}
2	Clay	2.55×10^{-1}
3	Sand and gravel	7.44×10^{0}
4	Clay	7.85×10^{-3}
5	Clay	1.37×10^{-2}
6	Clay	1.92×10^{-2}
7	Clay	8.53×10^{-3}
8	Sand and gravel	1.74×10^{2}
Geometric mean of values in clay deposit		1.97×10^{-2}
Geometric mean of values in sand-and-gravel deposit		3.60×10^{1}

Calculated horizontal hydraulic conductivities of the low permeability deposits of the Wadsworth Till and the Carmi Member of the Equality Formation ranged from 7.85×10^{-3} to 2.55×10^{-1} ft/d, with a mean value of 1.97×10^{-2} ft/d (table 4 and fig. 11). Calculated horizontal hydraulic conductivities from the two wells open to the sand-and-gravel deposits of the Henry Formation were 7.44×10^{0} and 1.74×10^{2} ft/d, with a mean value of 3.60×10^{1} ft/d.

Water levels were measured in each well approximately every week from April 29, 1998, to April 24, 1999, typically by volunteers using a steel tape graduated in increments of 0.01 ft. The altitude of the water level in each well on a given date was compared to the lake stage to determine the direction of flow between ground water and the lakes at discrete segments of the lakeshore (appendix 1).

From April 29 to June 6, 1998, ground-water levels in the wells were higher than lake levels, except in well 8 where lake stage was 1.25–2.0 ft higher than the ground-water level (appendix 1). Overall, ground-water levels decreased from north to south during this period. Ground water had the potential to flow into the lake along most of Lake Catherine and Channel Lake, except in the sand-and-gravel deposits near the southern edge of Lake Catherine where lake water had the potential to flow out to ground water. Ground-water levels were comparatively high during this time because of substantial recharge from precipitation. Ground-water levels in wells 1, 4, and 6 remained higher than the stage of the lakes during the entire investigation.

Ground-water-level measurements from June 13 to November 14, 1998, decreased so that by June 13 water levels in well 5 were lower than the lake stage (appendix 1). Water levels in well 3 decreased below the stage of the lakes by June 27. Water levels in well 7 were lower than the lake stage after August 22. Water levels in well 8 were 2.1–3.2 ft lower than the lake stage during June 13–November 14, 1998. At this time, ground water had the potential to flow from the Carmi Member into the northern part of the lake. Lake water had the potential to flow out to ground water in the Carmi Member and Henry Formation along the southern part of the lake during most or all of this time period. These conditions reflect stable surface-water levels affected by the lock and dam and declining ground-water levels because of evapotranspiration and a lack of recharge from precipitation.

For most of the period from November 21, 1998, to April 24, 1999, ground-water levels exceeded lake stage in all wells except well 8, indicating the potential for ground water to flow into surface water along most of Lake Catherine and Channel Lake (appendix 1). Water levels in well 8 were 1.5–2.8 ft lower than the lake stage during this time. Water levels in well 3 were lower than the lake stage during periods of high lake stage associated with snowmelt periods in late-January and early-February, and late-February 1999. These water-level trends reflect the decrease in the lake stage associated with the opening of the lock and dam in November 1998.

Surface- and ground-water level measurements were combined with horizontal-hydraulic-conductivity data, information on the configuration of the geologic deposits at Lake Catherine and Channel Lake, and the depths of the lakes using procedures outlined in Kay (1998). This information was used to determine the volume of flow from ground water into the lakes, and into ground water from the lakes by solution of the Darcy Equation (appendix 1).

The Darcy Equation is

$$Q = KAI, \tag{1}$$

where

Q is the specific discharge, into or out of the lakes, in cubic feet per day;

K is the horizontal hydraulic conductivity of the geologic deposits transmitting water and is equal to the mean value determined from the slug tests (36 ft/d for the sand and gravel and 0.0197 ft/d for the silt and clay);

A is the cross-sectional area of flow between the aquifer and the lakes, in square feet, and is equal to the length of the lakeshore along which water is flowing multiplied by the maximum depth of the lake at that time; and

I is the horizontal hydraulic gradient, the difference in the water levels between the lake and the wells divided by the distance between the well and the lakeshore.

The volume of water flowing from ground water into the lakes or from the lakes out to ground water is calculated by multiplying the specific discharge by the time between measurement periods. Volume, calculated in cubic feet, then is converted to volume in acre-feet for inclusion into table 5.

The total volume of flow from ground water into Lake Catherine and Channel Lake from May 1, 1998, through April 30, 1999, was calculated to be 358 acre-ft. The total volume of flow out of Lake Catherine and Channel Lake into ground water was calculated to be 830 acre-ft. Almost all flow between ground water and Lake Catherine and Channel Lake is through the sand-and-gravel deposits of the Henry Formation at the southern part of Channel Lake.

Lake Stage and Storage

The data from the bathymetric survey were used to determine the relation between the stage of Lake Catherine and Channel Lake and the volume of water in the lakes (fig. 12). The volume of water in Lake Catherine and Channel Lake at the lowest stage ever recorded (734.6 ft above sea level) was calculated to be 6,198 acre-ft. The volume of water in Lake Catherine and Channel Lake at the mean lake stage for the period of record (736.5 ft) was calculated to be 7,098 acre-ft. Comparison of the calculated volume of the lakes at 0.5 ft increments between 734.5 and 737.5 ft above sea level indicates about 226 acre-ft of water is added to the volume of the lakes for each 0.5 ft increase in stage. The rate of increase in the volume of water is about 5.6 acre-ft for every 0.5 ft of increase in stage from 734.5 to 737.5 ft.

Hydrologic Budget

The hydrologic budget is the basis for understanding many of the processes in a lake and its watershed. Because determining the nutrient and sediment budgets depends on the hydrologic budget, the nutrient and sediment budgets cannot be reliably evaluated without an accurate hydrologic budget. If the hydrologic budget is inaccurate, propagation and magnification of error results when computing the subsequent nutrient and sediment budgets.

A general equation describing the hydrologic budget of Lake Catherine and Channel Lake consists of several components that are summarized as

$$DS = P - E + SI - SO + GI - GO + SD, \tag{2}$$

where

DS is the change in volume of lake storage,

P is precipitation on the lake surface,

E is evaporation off the lake surface,

SI is streamflow into the lake,

SO is surface outflow through the lake opening,

GI is ground-water inflow to the lake,

GO is ground-water outflow from the lake, and

SD is storm drain discharge to the lake.

The volume of water added to or removed from Lake Catherine and Channel Lake by each component of the lake budget was compiled monthly for the period of investigation (table 5).

Table 5. Hydrologic budget of Lake Catherine and Channel Lake, near Antioch, Ill., May 1998–April 1999
[--, not determined; na, not applicable]

Month and year	Volume of precipitation added to lake (acre-feet)	Volume of inflow to lake from storm drains (acre-feet)	Volume of inflow to lake through Route 173 bridge openings (acre-feet)	Volume of inflow to lake from surface water in watershed (acre-feet)	Volume of inflow to lake from ground water (acre-feet)	Total volume of water added to lake (acre-feet)	Volume of evaporation removed from lake (acre-feet)	Volume of outflow from lakes through Route 173 bridge openings (acre-feet)	Volume of outflow to ground water from lake (acre-feet)	Total volume of water removed from lake (acre-feet)	Calculated change in lake stage (feet)	Measured change in lake stage (feet)
May 1998	122	82	138	1,365	92	1,798	149	1,560	23	1,732	--	--
June 1998	196	87	487	504	129	1,404	189	469	46	704	--	--
July 1998	66	82	152	222	4	526	210	1,037	58	1,306	--	--
August 1998	111	81	340	50	.11	582	190	279	118	587	--	--
September 1998	113	80	305	74	.11	572	125	395	180	700	--	--
October 1998	187	92	196	299	.19	775	64	1,002	166	1,233	--	--
November 1998	80	81	638	328	14	1,141	35	1,619	64	1,719	--	--
December 1998	77	89	200	297	26	688	21	1,176	34	1,231	--	--
January 1999	95	209	534	1,634	19	2,491	18	1,265	52	1,335	--	--
February 1999	43	92	26	1,909	12	2,083	40	2,884	47	2,970	--	--
March 1999	42	93	361	907	38	1,441	48	1,055	20	1,122	--	--
April 1999	276	160	167	3,031	24	3,657	117	1,905	22	2,043	--	--
Total	1,408	1,228	3,544	10,620	358.41	17,158	1,206	14,646	830	16,682	1.01	1.1
Percent	8.2	7.2	20.7	61.9	2.0	na	7.2	87.8	5.0	na	na	na

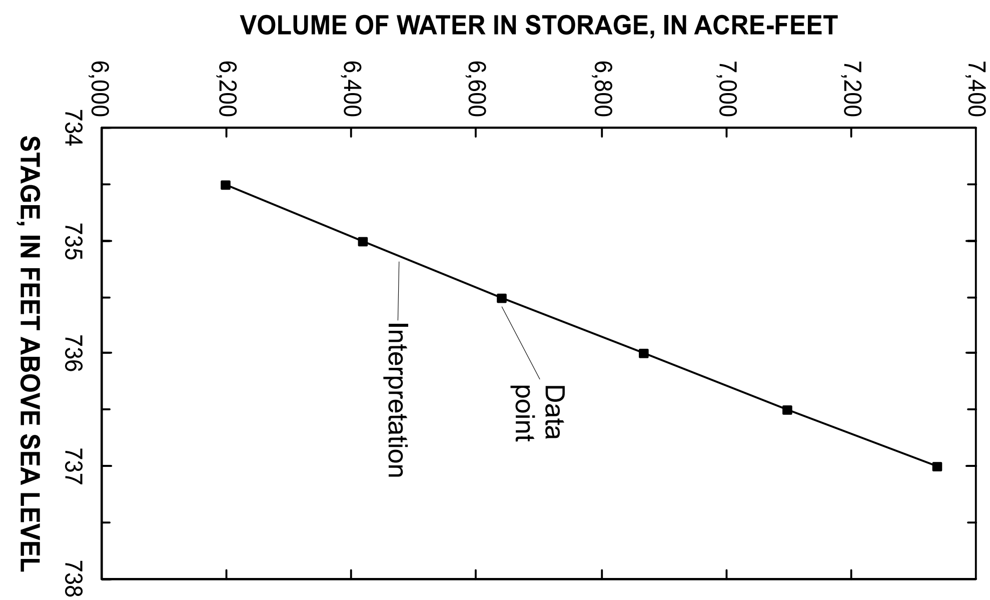

Figure 12. Stage-storage relation at Lake Catherine and Channel Lake, near Antioch, Ill.

The volume of water added to, or removed from, the lakes by precipitation and evaporation was determined by multiplying the monthly amount of precipitation and evaporation by the surface area of the lakes. During the investigation, approximately 1,400 acre-ft of water was added to the lakes from precipitation and approximately 1,200 acre-ft of water evaporated off the lakes.

The volume of water added to the lakes by inflow from ground water or removed from the lakes by outflow to ground water was determined by totaling the volumes from each of the periodic measurements (appendix 1) and prorating the volumes for the measurement periods that cover two separate months. Less than 400 acre-ft of water was added to the lakes from recharging ground water, whereas more than 800 acre-ft was removed from the lakes by surface-water discharge to ground water.

Calculation of the volume of inflow to the lakes from the storm drains was determined by extrapolating the data from the FS gage during each month of the investigation over the total area served by storm drains that discharge directly to Lake Catherine and Channel Lake. Prior to January 1999, the FS gage measured drainage from about 13.6 percent of the total area served by storm drains. The monthly discharge data from the FS gage (table 3) was extrapolated over the total area served by storm drains to estimate the volume of water entering the lakes through storm drains from May 1 through December 31, 1998. The area served by the FS gage was effectively increased in January 1999. The area served by the FS gage prior to January 1, 1999, was about 23.5 percent of the area served by the gage from January 1, 1999, through the end of the investigation. From January 1 through April 31, 1999, 23.5 percent of the flow measured at the FS gage was assumed to be derived from the area served by the gage prior to January 1, 1999. This value was extrapolated over the pre-January 1999 area of the lakes served by storm drains and the resulting value added to the 76.5 percent of the water measured at the FS gage, assumed to be derived from the newly added drainage area, to determine the total volume of inflow to the lakes from storm drains. The data indicate that about 1,228 acre-ft of water entered Lake Catherine and Channel Lake from storm drains between May 1, 1998, and April 30, 1999 (table 5).

Calculation of the volume of inflow to the lakes from surface water in the watershed was determined by extrapolating the data from Trevor Creek at the TC gage. Trevor Creek at the point of the TC gage receives drainage from an area of 2,272 acres, or 18.34 percent of the watershed. Extrapolating the monthly discharge data measured at the TC gage (table 3) over the entire area of the watershed indicates that 10,620 acre-ft of water entered Lake Catherine and Channel Lake from inflow of surface water in the watershed from May 1, 1998, through April 30, 1999 (table 5).

The cross-sectional area of the west opening of the outlet to Channel Lake is about 10 percent of the cross-sectional area of the east opening. The volume of water flowing through the west opening during the investigation was assumed to be 10 percent of the amount of water measured to be flowing through the east opening. Flow through both openings was assumed to be in the same direction at all times. A total of 3,544 acre-ft of water was calculated to have entered Lake Catherine and Channel Lake through the State Highway 173 bridge openings during the period of investigation, and 14,646 acre-ft of water was calculated to have flowed out of the lakes through these openings (table 5).

A total of 17,158 acre-ft of water was calculated to have entered Lake Catherine and Channel Lake during the investigation. More than 80 percent of the water entered the lakes as inflow from the watershed and through the bridge openings at State Highway 173. A total of 16,682 acre-ft of water was calculated to have been removed from the lakes by outflow through the bridge openings (87.8 percent), evaporation (7.2 percent), and outflow to ground water (5 percent) during the 1-year period of investigation. If a total of 16,682 acre-ft of water is removed from Lake Catherine and Channel Lake every year and the lakes have a volume of about 7,395 acre-ft, the residence time of water in the lakes is about 0.44 years.

Verification of the hydrologic budget is accomplished by comparing the measured change in the water level of the lakes during the period of investigation to the calculated change in water level for the net amount of water added to, or removed from, the lake. The calculated change in the water level of the lakes is derived from the stage-storage relation. The change in the volume of Lake Catherine and Channel Lake was assumed to be a constant of 473.6 acre-ft of water for every 1 ft of change in stage. Over the 3-ft range in lake stage during the investigation, this simplification of the stage-storage relation will have no substantial effect on the hydrologic budget. If the hydrologic budget indicates a net addition of 476 acre-ft of water to the lake, the calculated change in the stage of the lakes over the course of the year should be 1.0 ft (table 5). This value is in good agreement with the measured difference of 1.1 ft (fig. 8), indicating the hydrologic budget is accurate.

WATER QUALITY

Water-quality samples were collected from precipitation in the area, Trevor Creek at the TC gage, the storm drain to Lake Catherine monitored by the FS gage, the Channel Lake opening at the CLE gage, the ground-water-monitoring wells, and at three sites on both lakes as part of this investigation (fig. 3). Profiles of temperature and dissolved oxygen also were collected from three sites on each lake. USGS personnel collected the samples from Trevor Creek, the storm drain, the Channel Lake opening, and the ground-water-monitoring wells. Personnel from the Fox Waterway Agency and the IEPA collected water-quality samples, and temperature and dissolved oxygen profiles of the lakes. All samples were collected, preserved, and analyzed using standard procedures outlined by the Illinois Environmental Protection Agency (1987a, b).

Shallow samples were collected about 1.0 ft below the surface of Lake Catherine and Channel Lake at sites LC1S, LC2S, LC3S, CL1S, CL2S, CL3S (fig. 3). Deep samples were collected about 2 ft above the bottom of Lake Catherine and Channel Lake at sites LC1D and CL1D. All lake samples, as well as the samples from Trevor Creek, the storm drain, and the east opening of Channel Lake, were analyzed for total and dissolved phosphorus, nitrate and nitrite as nitrogen, total Kjeldahl nitrogen (TKN), ammonia nitrogen, total suspended solids (TSS), volatile suspended solids, and turbidity—the standard list of analytes for the IEPA Clean Lakes 2000 investigations. The IEPA laboratory in Champaign, Illinois, performed all analyses. A concentration of one-half the reported detection limit was assumed for all analytes present at concentrations below the detection limit when the mean concentration of the analyte was calculated. Field measurements of Secchi depth, conductivity, and pH also were collected at sites LC1, LC2, LC3, CL1, CL2, and CL3.

Chlorophyll *a*, *b*, *c*; pheophytin; and algae samples were collected at sites LC1, LC2, LC3, CL1, CL2, and CL3. Chlorophyll and algae samples are integrated samples collected from the interval from the lake surface to twice the Secchi depth. The photic zone of the lake is sampled in this interval.

Precipitation

Precipitation samples from individual rain events on May 23, 1998, September 14, 1998, and April 22, 1999, were analyzed for concentrations of nitrate and nitrite as nitrogen, ammonia nitrogen, TKN, and total phosphorus (table 6). Samples were collected in open plastic bottles placed on docks or open fields away from tree cover. The mean concentrations of nitrate and nitrite as nitrogen and ammonia nitrogen were about 0.60 mg/L, which were approximately an order of magnitude higher than the mean total phosphorus concentration (0.021 mg/L). Most of the TKN present is in the form of ammonia.

Trevor Creek

Water samples were collected from Trevor Creek at the TC gage on May 11, June 11, July 13, August 7, September 14 and 15, October 3 and 6, November 10 and 18, December 7 and 13, 1998, and January 18 and 22, February 11, March 15 and 17, and April 9,

Table 6. Nutrient concentrations in precipitation in the vicinity of Lake Catherine and Channel Lake, near Antioch, Ill., May 23, 1998–April 22, 1999

Constituent	Date of sample collection			Geometric mean
	May 23, 1998	September 14, 1998	April 22, 1999	
Nitrate and nitrite, total as nitrogen (milligram per liter)	0.74	0.41	0.77	0.616
Nitrogen, ammonia (milligrams per liter)	1.6	.24	.73	.654
Nitrogen, total Kjeldahl (milligrams per liter)	2.9	.40	.74	.95
Phosphorus, total (milligram per liter)	.041	.01	.023	.021

22, and 23, 1999. The second sample collected on June 11, 1998, the samples collected on September 15, October 6, November 10, and December 7, 1998, and the sample collected on January 22, February 13, March 17, and April 9, 22, and April 23, 1999, were collected following precipitation events or snowmelt and reflect runoff conditions of higher than normal flow during that time period. The samples from Trevor Creek not requiring filtration or a preservative were collected by submerging a plastic sample bottle in approximately the middle of the creek so that the bottle opening was about 0.10 ft above the streambed. Samples requiring filtration or a preservative were transferred from a separate bottle that was submerged to about 0.10 ft above the stream bottom near the middle of the creek to the sample bottle.

Nitrogen usually is present in the form of organic nitrogen and inorganic forms, such as ammonia, nitrate, and nitrite. Ammonia, a by-product of the breakdown of plant and animal matter, is converted to nitrate in aerobic water. In anoxic water, nitrate is converted to ammonia. Therefore, nitrate tends to be the dominant form of nitrogen in aerobic water, whereas ammonia tends to be the predominate form of nitrogen in anaerobic water.

Concentrations of nitrate and nitrite as nitrogen at the TC gage were above 2.0 mg/L during periods of normal flow (no recent precipitation event) in July, August, and September and were below 2.0 mg/L during periods of normal flow for the rest of the period of sampling (table 7). July through September 1998 was a period of low flow in the creek, indicating much of the nitrate and nitrite in the creek during this period was derived from ground-water base flow or wastewater discharge. During runoff conditions, mean concentrations of nitrate and nitrite as nitrogen at Trevor Creek were only slightly higher than concentrations during more normal flow (table 7).

In samples from Trevor Creek, concentrations of ammonia nitrogen were highly variable and showed no clear trends with time during the period of sampling (table 7). The mean concentration of ammonia nitrogen for all samples was 0.12 mg/L during the sampling period, more than an order of magnitude less than the mean concentration of nitrate and nitrite as nitrogen (1.44 mg/L). Ammonia nitrogen concentrations in the samples collected during runoff conditions were slightly lower (0.04 mg/L) than concentrations in samples collected during more normal flow.

TKN measures chemically reduced nitrogen present as ammonia and organic nitrogen. Typically, organic nitrogen is present as algae, humic acids, and plant matter. The mean concentration of TKN in the samples from Trevor Creek at the TC gage exceed the mean concentration of ammonia by more than a factor of six, indicating that more than 80 percent of the TKN in Trevor Creek is present as organic nitrogen. TKN concentrations showed no trends with time but were about 0.10 mg/L higher during runoff periods than during more normal flow (table 7). This pattern is counter to the ammonia nitrogen trends observed during runoff conditions, indicating that small amounts of organic nitrogen (as opposed to ammonia nitrogen) were being added to the creek in runoff following precipitation events.

Total phosphorus includes particulate and dissolved forms of phosphorus in the water column. During periods of normal flow, total phosphorus concentrations at Trevor Creek increased consistently from 0.052 mg/L in May 1998 to 0.141 mg/L in October 1998, then showed an overall decrease to 0.011 mg/L in March 1999 (table 7). Total phosphorus concentrations were less than a factor of two higher during runoff conditions than during more normal flow, indicating runoff of phosphorus bound to particulate matter.

Dissolved phosphorus is that part of the total phosphorus dissolved in water, which is considered to be all forms of phosphorus less than 0.45 microns in size. In the samples from Trevor Creek, dissolved phosphorus concentrations are approximately one-half the concentration of total phosphorus, indicating the phosphorus in the creek is roughly equally divided between the dissolved and particulate phases. During nonstorm sampling periods, temporal trends in the concentrations of dissolved phosphorus at Trevor Creek were similar to the trends in concentrations of total phosphorus, increasing from May through October 1998 and decreasing substantially from November 1998 through March 1999 (table 7). Concentrations of dissolved phosphorus measured during runoff conditions were slightly higher (0.009 mg/L) than concentrations detected during more normal flow.

TSS concentrations constitute all organic and inorganic particles, including sediment, algae, and decaying plant matter, suspended in the water column and often is related to the transparency of the water. During periods of normal flow, TSS concentrations at

Table 7. Water-quality data for Trevor Creek at the TC gage in the vicinity of Lake Catherine and Channel Lake, near Antioch, Ill., May 11, 1998–April 23, 1999

[Shaded cell denotes sample collected during runoff conditions; na, not analyzed; k, constituent present below detection limit; q, holding time for sample exceeded limit]

Constituent	Date of sample collection												
	May 11, 1998	June 11, 1998	June 11, 1998	July 13, 1998	August 7, 1998	September 14, 1998	September 15, 1998	October 3, 1998	October 6, 1998	November 10, 1998	November 18, 1998	December 7, 1998	December 13, 1998
Nitrate and nitrite, total as nitrogen (milligrams per liter)	0.85	1.3	na	2.46	2.14	4.66	0.45	0.68	2.36	1.61	0.91	1.06	0.83
Nitrogen, ammonia (milligram per liter)	.21	.14	na	.16	.047	.45	.18	.01k	.15	.01k	.15	.01	.30
Nitrogen, total Kjeldahl (milligrams per liter)	.60	.50	na	.62	.87	4	1.7	.83	1	1.1	.33	.61	.46
Phosphorus, total (milligram per liter)	.052	.061	na	.63	.093	.10	.222	.141	.099	.121	.072	.035	.021
Phosphorus, dissolved (milligram per liter)	.022	.033	na	.032	.04	.06	.071	.099	.051	.082	.072	.03	.018
Solids, total suspended (milligrams per liter)	6	13	22	14	35	46q	282	29q	22q	252q	13	5	3
Solids, volatile suspended (milligrams per liter)	1k	3	4	4	13	10q	52	7q	5q	52q	3	4	1k
Turbidity (nephelometric turbidity units)	26	4.2	84	3.9	7.5	5	19	6	5	38	8.2	11	2.8

Constituent	Date of sample collection									Geometric mean of all samples	Geometric mean of samples collected during normal flow conditions	Geometric mean of samples collected during runoff conditions
	January 18, 1999	January 22, 1999	February 11, 1999	March 15, 1999	March 16, 1999	March 17, 1999	April 9, 1999	April 22, 1999	April 23, 1999			
Nitrate and nitrite, total as nitrogen (milligrams per liter)	1.71	2.77	1.76	0.96	1.28	1.68	1.91	1.61	1.52	1.44	1.40	1.48
Nitrogen, ammonia (milligram per liter)	.53	.5	.31	.19	.37	.45	.18	.06	.15	.12	.15	.11
Nitrogen, total Kjeldahl (milligrams per liter)	1.4	.82	.52	.24	.70	.47	.56	1.2	.52	.734	.679	.80
Phosphorus, total (milligram per liter)	.059	.132	.023	.011	.022	.025	.029	.057	.253	.066	.063	.07
Phosphorus, dissolved (milligram per liter)	.014	.096	.015	.011	.021	.013	.023	.024	.06	.034	.03	.039
Solids, total suspended (milligrams per liter)	6	12	4	40	6	7	8	23	136	18	13.1	25.1
Solids, volatile suspended (milligrams per liter)	3	5	4	8	2	3	2	6	18	4.8	3.4	7.2
Turbidity (nephelometric turbidity units)	7.9	8.9	2.4	2.7	20	17	17	1.5	6.1	8.3	5.4	10.6

Trevor Creek increased from May through September 1998, decreased overall from October 1998 through February 1999, and increased in March 1999 (table 7). The mean TSS concentration following a precipitation event was nearly twice the concentration measured during normal flow.

Volatile suspended solids (VSS) typically are organic material (algae, detritus) that decompose upon exposure to temperatures of 550°C. The difference between TSS before heating and the residue remaining after heating is the VSS. In Trevor Creek, TSS concentrations typically are more than three times VSS concentrations, indicating that inorganic particulate material constitutes most of the suspended solids in the creek (table 7). Mean VSS concentrations were twice as high following precipitation events as during periods of normal flow.

For the period of investigation the loads of total nitrate and nitrite as nitrogen, ammonia nitrogen, TKN, dissolved phosphorus, total phosphorus, TSS, and VSS in Trevor Creek at the TC gage were calculated using constituent-transport rating curves (Colby, 1956). The first step for development of a rating curve is to determine the load of the constituent by multiplying the constituent concentration by the instantaneous discharge at the time of sample collection. The load then is converted to some appropriate units, typically tons per day. The calculated load of a constituent in tons per day then is plotted on a log-log scale against the mean daily discharge on the date of the sample collection, in cubic feet per second. A best-fit curve to the data points in the plot was drawn (fig. 13), and the equation describing the relation between discharge and constituent load was obtained using the trend-line analysis available from the EXCEL spreadsheet program. The mean daily discharge measured at the TC gage is applied to the equation of the best-fit curve for each constituent to calculate the daily load at the gage (appendix 2). These daily loads then were summed to obtain the monthly totals (table 8). Constituent-transport rating curves have been widely used to compute loads at sites by the USGS, U.S. Army Corps of Engineers, and U.S. Bureau of Reclamation.

Approximately 3.5 tons of total nitrogen as nitrate, 1.66 tons of TKN (approximately 0.28 tons of which is ammonia nitrogen), 0.147 tons of total phosphorus, 49.3 tons of TSS, and 12.6 tons of VSS were calculated to have been transported past the TC gage from May 1, 1998, through April 30, 1999 (table 8). Loads of all constituents decreased from May through August 1998, increased gradually from September through December 1998, increased by approximately a factor of four from December 1998 to January 1999, and increased overall from January through April 1999.

The total nitrogen load per area, calculated by summing the loads of TKN and nitrate and nitrite as nitrogen, for Trevor Creek at the TC gage was calculated to be 2.27×10^{-3} tons/acre for the 1-year period of this investigation (May 1998–April 1999). Beaulac and Reckhow (1982) summarize load per area for a variety of land uses and cropping practices. They reported

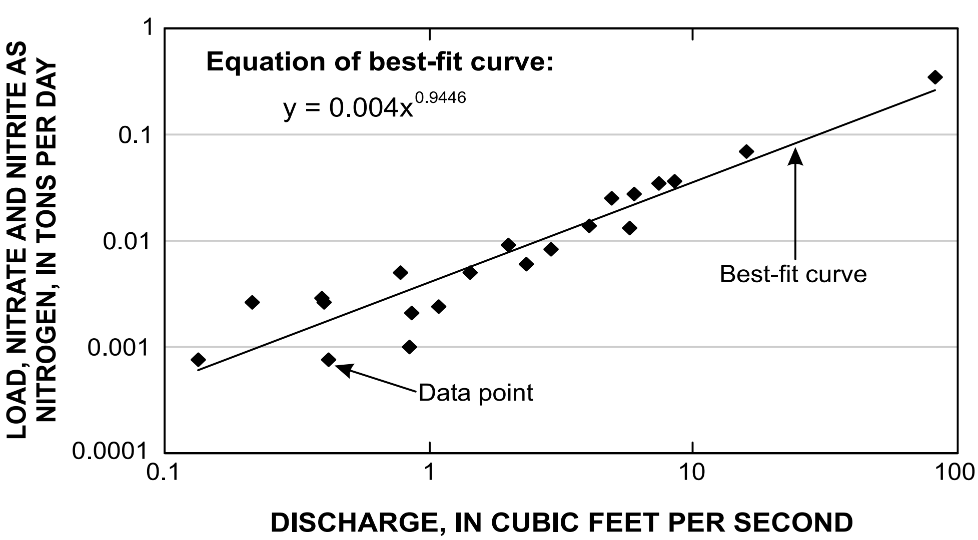

Figure 13. Total nitrate and nitrite as nitrogen transport curve for Trevor Creek at the TC gage, near Antioch, Ill., May 11, 1998–April 23, 1999.

Table 8. Constituent loads for Trevor Creek at the TC gage in the vicinity of Lake Catherine and Channel Lake, near Antioch, Ill., May 1998–April 1999

Month and year	Load of total nitrogen as nitrate and nitrite at TC gage (tons)	Load of ammonia nitrogen at TC gage (tons)	Load of Kjeldahl nitrogen at TC gage (tons)	Load of total phosphorus at TC gage (tons)	Load of dissolved phosphorus at TC gage (tons)	Load of total suspended solids at TC gage (tons)	Load of volatile suspended solids at TC gage (tons)
May 1998	0.46	0.036	0.22	0.019	0.010	6.3	1.62
June 1998	.179	.014	.09	.008	.004	2.3	.61
July 1998	.082	.006	.043	.004	.002	1.0	.27
August 1998	.02	.001	.012	.001	.001	.2	.06
September 1998	.029	.002	.017	.002	.001	.32	.09
October 1998	.107	.008	.054	.005	.003	1.3	.36
November 1998	.119	.009	.061	.006	.003	1.5	.40
December 1998	.109	.008	.057	.005	.003	1.3	.36
January 1999	.527	.043	.239	.021	.011	7.7	1.92
February 1999	.631	.050	.294	.026	.013	8.9	2.26
March 1999	.316	.024	.156	.014	.007	4.1	1.09
April 1999	.952	.078	.42	.036	.018	14.4	3.54
Total	3.531	.279	1.663	.147	.076	49.32	12.58

loads for nitrogen ranging from about 1.34×10^{-3} to 1.79×10^{-2} (tons/acre)/yr for corn and soybean row crops—the single largest land use in the drainage basin monitored by the TC gage. Forest and urban land-use loads are lower than loads for corn and soybean row crops from 5.3×10^{-3} to 8.4×10^{-3} (tons/acre)/yr and from 1.0×10^{-2} to 3.0×10^{-2} (tons/acre)/yr, respectively. The comparatively low nitrogen yield for this watershed appears to reflect the effect of the forest and urban land uses.

The total phosphorus load per area for Trevor Creek at the TC gage was calculated to be 6.47×10^{-5} tons/acre for the 1-year period of this investigation. This value is below the range of phosphorus loads from 2.34×10^{-4} to 2.23×10^{-3} (tons/acre)/yr for corn and soybean row crops, from 2.64×10^{-4} to 7.92×10^{-4} (tons/acre)/yr for forest, and from 1.63×10^{-3} to 7.13×10^{-3} (tons/acre)/yr for urban land use (Beaulac and Recknow, 1982). The low phosphorus yield for this part of the watershed indicates low application of phosphorus in the basin or consumption of phosphorus in some of the source water for Trevor Creek. Phosphorus consumption by algae in Voltz and Cross Lakes, at the headwaters of Trevor Creek, may explain part of the low phosphorus yield. The TSS load per area for Trevor Creek at the TC gage was calculated to be 2.16×10^{-2} tons/acre for the period of investigation.

Storm Drain

Water samples were collected from the storm drain to Lake Catherine monitored by the FS gage on May 11, June 11, July 13, August 7, September 14 and 15, October 3 and 6, November 10 and 18, and December 7 and 13, 1998, and on January 18 and 22, February 11, March 15, 16, and 17, and April 9, 22, and 23, 1999 (table 9). The second sample collected on June 11, the samples collected on September 15, October 6, November 10, and December 7, 1998, and on January 22, March 16 and 17, and on April 9, 22, and 23, 1999, were collected following precipitation events and reflect runoff conditions of higher than normal flow during that time period. Samples from the storm drain were collected by submerging a plastic sample bottle near the center of the stream so that the bottle opening was about 0.10 ft above the bottom of the streambed at the outlet.

Concentrations of nitrate and nitrite as nitrogen in samples from the storm drain showed no clear variation through time (table 9). The mean concentration of nitrate and nitrite as nitrogen during conditions of higher flow was about 0.30 mg/L greater than the mean concentration during more normal flow conditions.

Concentrations of ammonia nitrogen at the storm drain showed no consistent trends through time but were 0.18 mg/L lower during runoff conditions than during more normal flow (table 9). These variations are similar to the variations in the TKN concentrations at the storm drain. Ammonia concentrations at the storm

Table 9. Water-quality data for the storm drain at the FS gage in the vicinity of Lake Catherine and Channel Lake, near Antioch, Ill., May 11, 1998–April 23, 1999

[Shaded cells denote sample collected during runoff conditions; na, not analyzed; q, holding time for sample exceeded]

Constituent	Date of sample collection												
	May 11, 1998	June 11, 1998	June 11, 1998	July 13, 1998	August 7, 1998	September 14, 1998	September 15, 1998	October 3, 1998	October 6, 1998	November 10, 1998	November 18, 1998	December 7, 1998	December 13, 1998
Nitrate and nitrite, total as nitrogen (milligrams per liter)	1.1	1.67	na	1.25	1.95	1.23	5.81	1.84	2.34	4.35	1.84	1.89	1.99
Nitrogen, ammonia (milligrams per liter)	.38	2.6	na	.87	.6	2.0	.46	.34	.2	.99	.44	.10	.62
Nitrogen, total Kjeldahl (milligrams per liter)	.80	na	na	2.3	1.6	5.5	2.4	2.8	.87	1.5	.56	.36	.71
Phosphorus, total (milligrams per liter)	.201	2.6	na	.276	.281	.87	.252	.337	.196	.278	.097	.072	.11
Phosphorus, dissolved (milligram per liter)	.156	.356	na	.185	.192	.68	.196	.275	.139	.246	.019	.052	.082
Solids, total suspended (milligrams per liter)	32	9	37	9	249	10q	24	16q	49q	19q	6	18	16
Solids, volatile suspended (milligrams per liter)	7	3	6	4	205	5q	8	7q	10q	5q	2	4	3
Turbidity (nephelometric turbidity units)	31	3.3	2.7	4.1	13	4.6	15	5.7	4.7	21	4.7	13	3.1

Constituent	Date of sample collection									Geometric mean of all samples	Geometric mean of samples collected during normal flow conditions	Geometric mean of samples collected during runoff conditions
	January 18, 1999	January 22, 1999	February 11, 1999	March 15, 1999	March 16, 1999	March 17, 1999	April 9, 1999	April 22, 1999	April 23, 1999			
Nitrate and nitrite, total as nitrogen (milligrams per liter)	2	1.45	1.84	2.1	1.29	1.61	1.54	1.06	1.54	1.80	1.67	1.96
Nitrogen, ammonia (milligrams per liter)	1.2	.4	.01	.51	.38	.66	.4	.17	.25	.41	.51	.33
Nitrogen, total Kjeldahl (milligrams per liter)	2.6	.98	.40	.51	.65	.74	.70	.58	.61	1.01	1.25	.82
Phosphorus, total (milligram per liter)	.309	.124	.081	.108	.054	.144	.138	.124	.327	.199	.258	.149
Phosphorus, dissolved (milligram per liter)	.252	.096	.065	.09	.036	.129	.103	.051	.059	.119	.149	.093
Solids, total suspended (milligrams per liter)	11	19	6	57	20	12	43	65	340	25.1	17.1	33.7
Solids, volatile suspended (milligrams per liter)	5	5	3	8	3	5	9	8	34	6.5	6.1	6.9
Turbidity (nephelometric turbidity units)	8.2	10	2.2	2.3	24	15	37	1	5.9	7.0	5.3	9.2

drain were less than one-half of the TKN concentrations, indicating that most of the TKN in the storm drain was organic nitrogen.

Concentrations of total phosphorus during periods of normal flow were greater than 0.250 mg/L in most of the period from June through October and less than 0.250 mg/L during most of the rest of the investigation (table 9). Concentrations of dissolved phosphorus during periods of normal flow typically were greater than 0.18 mg/L in June through October and, typically, less than 0.18 mg/L during the rest of the investigation. The mean concentration of total and dissolved phosphorus in samples collected following precipitation events was less than the mean concentration detected in the samples collected during more normal periods of flow. The mean concentration of dissolved phosphorus was more than one-half the mean concentration of total phosphorus.

Measured concentrations of TSS at the storm drain showed no clear trends through time. However, if the suspect data from August 7, 1998, is excluded, TSS values during periods of normal flow were higher on May 11, 1998, and March 15, 1999, than during the rest of the investigation (table 9). During runoff conditions, mean TSS concentrations at the storm drain were almost twice the concentrations detected during more normal flow. During runoff conditions, VSS concentrations at the storm drain were similar to concentrations detected during conditions of normal flow. Mean TSS concentrations during normal flow were about a factor of three higher than the mean VSS concentrations during normal flow, but TSS concentrations during runoff conditions were about a factor of five higher than VSS concentrations during runoff conditions. This pattern indicates that most of the increase in TSS associated with the runoff conditions can be attributed to inorganic material.

The mean concentration of all constituents, particularly the phosphorus compounds, is higher at the storm drain than at Trevor Creek. The mean concentration of ammonia, TKN, total phosphorus, and dissolved phosphorus in samples collected at the storm drain following precipitation events was less than the mean concentration detected during periods of more normal flow. These concentrations indicate the nutrients are more abundant in the household water that appears to be the primary source of water to the storm drain during periods of no precipitation, and precipitation dilutes this water.

Transport curves were used to determine the load of total nitrate and nitrite as nitrogen, ammonia nitrogen, TKN, dissolved phosphorus, total phosphorus, TSS, and VSS in the storm drain at the FS gage (table 10, appendix 2). For the May–December 1998 and January–April 1999 periods, separate transport curves were developed for the FS gage. Data from periods when no flow was measured at the FS gage were not used for development of the transport curves.

Approximately 0.38 ton of nitrate and nitrite as nitrogen, 0.23 ton of TKN (0.08 ton of which is ammonia nitrogen), 0.032 ton of total phosphorus (approximately 0.052 ton dissolved), 5.9 tons of TSS,

Table 10. Constituent loads for storm drainage at the FS gage in the vicinity of Lake Catherine and Channel Lake, near Antioch, Ill., May 1998–April 1999

Month and year	Load of total nitrogen as nitrate and nitrite at FS gage (tons)	Load of ammonia nitrogen at FS gage (tons)	Load of Kjeldahl nitrogen at FS gage (tons)	Load of dissolved phosphorus at FS gage (tons)	Load of total phosphorus at FS gage (tons)	Load of total suspended solids at FS gage (tons)	Load of volatile suspended solids at FS gage (tons)
May 1998	0.029	0.0074	0.022	0.0032	0.0050	0.28	0.085
June 1998	.029	.0073	.022	.0031	.005	.27	.084
July 1998	.029	.0074	.022	.0032	.005	.28	.085
August 1998	.029	.0074	.022	.0032	.005	.28	.085
September 1998	.028	.0072	.021	.0031	.0049	.27	.083
October 1998	.030	.0076	.022	.0033	.0051	.28	.087
November 1998	.028	.0072	.021	.0031	.0049	.27	.083
December 1998	.029	.0075	.022	.0032	.0051	.28	.086
January 1999	.063	.011	.028	.0032	.0048	1.27	.261
February 1999	.028	.0039	.011	.0012	.0023	.808	.148
March 1999	.026	.0035	.0095	.0011	.0022	.814	.145
April 1999	.028	.0039	.011	.0012	.0024	.831	.151
Total	0.376	0.0813	0.2295	0.0321	0.0517	5.933	1.383

and 1.4 tons of VSS were calculated to have been transported through the storm drain from May 1, 1998, through April 30, 1999 (table 10). Loads of TSS and VSS typically were lower during May–December 1998 than during January–April 1999, whereas loads of ammonia nitrogen, TKN, total phosphorus, and dissolved phosphorus were higher during May–December 1998.

During May through December 1998, prior to the arrival of flow from the newly connected drainage area, the load per unit area of nitrate and nitrite as nitrogen, ammonia nitrogen, TKN, total phosphorus, dissolved phosphorus, TSS, and VSS at the storm drain were calculated to be 7.30×10^{-3}, 1.86×10^{-3}, 5.51×10^{-3}, 1.26×10^{-3}, 8.02×10^{-4}, 6.96×10^{-2}, and 2.14×10^{-2} tons/acre, respectively. Extrapolating these data for a period of 1 year results in a load per unit area of 1.96×10^{-2} tons/acre for total nitrogen and 1.92×10^{-3} tons/acre for total phosphorus. The load per unit area of nitrate and nitrite as nitrogen, ammonia nitrogen, TKN, total phosphorus, and dissolved phosphorus at the storm drain decreased to 1.08×10^{-3}, 1.67×10^{-4}, 4.39×10^{-4}, 8.72×10^{-5}, and 4.90×10^{-5} tons/acre, respectively, from January through April 1999. The load per unit area of TSS and VSS, 2.76×10^{-2} and 5.24×10^{-3} tons/acre, respectively, from January through April 1999, also decreased from the load per unit area from May through December 1998. Extrapolating these data for a period of 1 year results in a calculated load per unit area of 4.59×10^{-3} tons/acre for total nitrogen and 2.64×10^{-4} tons/acre for total phosphorus. A range from 1.02×10^{-2} to 3.05×10^{-2} (tons/acre)/yr for total nitrogen and from 1.69×10^{-3} to 7.35×10^{-3} (tons/acre)/yr for total phosphorus were reported for an urban land use (Beaulac and Reckhow, 1982).

Channel Lake Opening

Water samples were collected from the Channel Lake opening at the CLE gage on May 11, June 11, July 13, August 7, September 14 and 15, October 3, October 6, November 10, November 18, December 7, and December 13, 1998, and on January 18, February 11, March 15 and 17, April 9, April 22 and 23, 1999 (table 11). A second sample collected on June 11, the samples collected on September 15, October 6, November 10, and December 7, 1998, as well as the samples collected on March 17, April 9, 22, and 23, 1999, typically were collected following precipitation events (samples collected on March 17 also are associated with increasing water levels affected by the raising of the Stratton Lock and Dam) and all reflect conditions of higher than normal flow during that time period. Except for the sample collected from a hole in the ice about 50 ft north of the east opening on January 18, 1999, the samples from the outlet were collected by lowering a sample bottle at a constant rate from the water surface to just above the streambed at three locations across the channel to produce a composite sample. Ice prevented collection of a sample at the CLE gage on January 22, 1999.

Concentrations of nitrate and nitrite as nitrogen in samples from the east opening of Channel Lake were below the detection limit (0.01 mg/L) during most of the period from June through early November 1998 and greater than 0.10 mg/L during most of the remaining sampling periods (table 11). At this location, nitrate concentrations below the detection limit during the summer and fall indicates uptake of nitrate and nitrite nitrogen by algae and aquatic macrophytes in Lake Catherine and Channel Lake during the growing season. At the CLE gage, the mean concentration of nitrate and nitrite as nitrogen during runoff conditions was more than a factor of three higher than the mean concentration detected during more normal flow. The mean concentration of nitrate and nitrite as nitrogen during runoff conditions may have been elevated because most of the runoff samples were collected during the late fall through early spring, when biological uptake of these nutrients would be lower.

During conditions of normal flow, concentrations of ammonia nitrogen at the east opening of Channel Lake were below 0.25 mg/L for most of the period from May through September 1998, increased to more than 0.40 mg/L for much of the period from October 1998 through February 1999, and decreased to less than 0.25 mg/L in March 1999 (table 11). The lower ammonia nitrogen concentration detected during the May through September growing season indicates uptake of ammonia nitrogen by algae and aquatic macrophytes in Lake Catherine and Channel Lake. Concentrations of TKN showed no clear trends through time. The mean concentration of ammonia nitrogen and TKN was essentially identical during runoff conditions and more normal flow. At this site, the mean TKN concentration exceeded the mean ammonia concentration by more than a factor of four, indicating that most of the TKN at the outlet is present as organic nitrogen.

Table 11. Water-quality data for the east opening of Channel Lake at the CLE gage, near Antioch, Ill., May 11, 1998–April 23, 1999

[Shading denotes sample collected during runoff conditions; na, not analyzed; k, constituent present below detection limit; q, holding time exceeded]

Constituent	Date of sample collection												
	May 11, 1998	June 11, 1998	June 11, 1998	July 13, 1998	August 7, 1998	September 14, 1998	September 15, 1998	October 3, 1998	October 6, 1998	November 10, 1998	November 18, 1998	December 7, 1998	December 13, 1998
Nitrate and nitrite, total as nitrogen (milligram per liter)	0.11	0.01k	na	0.01k	0.01k	0.01k	0.01k	0.01k	0.12	0.01k	0.06	0.83	0.15
Nitrogen, ammonia (milligram per liter)	.27	.05	na	.54	.21	.21	.17	.49	.09	.55	.53	.20	.43
Nitrogen, total Kjeldahl (milligrams per liter)	1.00	1.10	na	.54	1.70	2.20	1.80	1.10	2.20	2.60	1.10	.87	.61
Phosphorus, total (milligram per liter)	.026	.087	na	.046	.162	.067	.061	.055	.198	.166	.12	.029	.024
Phosphorus, dissolved (milligram per liter)	.011	.009	na	.009	.018	.015	.01	.009	.023	.044	.02	.012	.011
Solids, total suspended (milligrams per liter)	6	15	7	7	43	na	5	20q	188q	166q	200	81	5
Solids, volatile suspended (milligrams per liter)	1	5	3	5	39	na	2	7q	51q	50q	54	24	2
Turbidity (nephelometric turbidity units)	27	150	10	3.6	14	na	7.2	5.2	6.1	19	13	10	2.4

Constituent	Date of sample collection							Geometric mean of all samples	Geometric mean of samples collected during normal flow conditions	Geometric mean of samples collected during runoff conditions
	January 18, 1999	February 11, 1999	March 15, 1999	March 17, 1999	April 9, 1999	April 22, 1999	April 23, 1999			
Nitrate and nitrite, total as nitrogen (milligram per liter)	0.5	0.8	0.36	0.98	0.63	0.28	0.28	0.07	0.04	0.14
Nitrogen, ammonia (milligrams per liter)	.52	.91	.20	.24	1.50	.16	.29	.297	.318	.27
Nitrogen, total Kjeldahl (milligrams per liter)	16.0	1.20	.69	1.20	1.50	.78	.85	1.33	1.32	1.34
Phosphorus, total (milligram per liter)	.073	.036	.025	.039	.023	.045	.053	.056	.054	.058
Phosphorus, dissolved (milligram per liter)	.014	.018	.009	.013	.007	.014	.019	.014	.012	.015
Solids, total suspended (milligrams per liter)	19	7	67	19	17	11	7	20.8	18.6	23.5
Solids, volatile suspended (milligrams per liter)	12	3	11	8	6	5	2	7.6	7.0	8.2
Turbidity (nephelometric turbidity units)	9.4	2.7	2.5	22	15	1.4	4.5	8.4	8.6	8.2

During the investigation, the concentration of dissolved phosphorus in samples from the east opening of Channel Lake showed no clearly defined trends through time and did not vary between runoff conditions and more normal flow conditions. The concentration of total phosphorus in samples from the east opening of Channel Lake also showed no clear trend through time and did not vary substantially between runoff conditions and more normal flow conditions. Comparison of the mean concentrations indicates dissolved phosphorus (0.014 mg/L) is one-quarter of the total phosphorus (0.056 mg/L) in the water at the east opening of Channel Lake.

Measured concentrations of TSS and VSS at the east opening of Channel Lake were substantially higher from October 6 through December 7, 1998, than during most of the other sampling periods. Mean TSS and VSS concentrations were higher during runoff conditions than during periods of more normal flow (table 11). At this location, the mean VSS concentration was about one-third of the mean TSS concentration.

The mean concentration of nitrate and nitrite as nitrogen, dissolved phosphorus, and total phosphorus at the east opening of Channel Lake was lower than the mean concentration of these constituents at Trevor Creek and the storm drain (tables 7, 9, 11), indicating these constituents are being utilized by algae and aquatic macrophytes in the lakes from which the flow at the east opening is derived. The mean concentration of ammonia nitrogen in the samples collected at the east opening to Channel Lake is higher than the mean concentration at Trevor Creek and lower than the mean concentration from the storm drain, whereas the mean concentration of TKN at the outlet is higher than the mean concentration at Trevor Creek and the storm drain. Given the relative volumes of flow from surface water in the watershed, storm drains, and flow through the Route 173 bridge openings (table 5), the presence of elevated concentrations of TKN and ammonia nitrogen at the east opening to Channel Lake indicates these constituents are being generated by in-lake processes.

Transport curves were used to determine the load of nitrate and nitrite as nitrogen, ammonia nitrogen, TKN, dissolved phosphorus, total phosphorus, TSS, and VSS at the east opening of Channel Lake (table 12). The transport curves indicate the loads of all constituents exiting the lakes through the east opening of Channel Lake exceeded the loads entering the lakes through this opening by a factor of about four. During the investigation, no clearly defined trends in load through time were indicated for any constituent except for the increase in TSS load flowing into the lakes from November 1998 through January 1999.

Ground Water

Ground-water samples were collected from all monitoring wells on May 27, 1998, August 8, 1998, November 2, 1998, and March 15, 1999 (appendix 3). Wells 1, 2, 3, 4, 5, 6, and 7 are open to low-permeability deposits. These wells were purged dry using a clean teflon bailer and allowed to recover for at least 1 hour before the sample was collected. Wells 3 and 8 are open to permeable deposits and were purged of a minimum of three times the volume of water in the well prior to sample collection to ensure a representative sample (Schuller and others, 1981).

With the exception of TKN, which was detected at the highest concentrations in May and November 1998 and the lowest concentrations in March 1999, mean nutrient concentrations in ground water near Lake Catherine and Channel Lake varied by less than a factor of three between sampling periods (table 13). Nutrient concentrations did vary substantially among wells.

The mean concentration of nitrate and nitrite as nitrogen was from a factor of three to ten higher in wells 4 and 7 than in the other wells (table 13). Concentrations of nitrate and nitrite as nitrogen in ground water from every well in the vicinity of Lake Catherine and Channel Lake were less than 2.0 mg/L and, therefore, probably can be attributed to natural sources (Mueller and Helsel, 1996). The increased concentration of nitrate and nitrite as nitrogen in water from wells 4 and 7 appears to be caused by natural variability in the ground-water quality.

Mean concentrations of ammonia nitrogen, TKN, and total phosphorus were higher in wells 3 and 8 than in the other wells (table 13), indicating sources of nitrogen and phosphorus to water from these wells that are not present at the other wells. Wells 3 and 8 are the only wells open to sand-and-gravel deposits. Water quality in well 3 appears to be affected by the observed seepage from septic systems near the well. Water quality in well 8 may be affected by recharge of water from Channel Lake.

Table 12. Constituent loads for the east opening of Channel Lake at the CLE gage, near Antioch, Ill., May 1998–April 1999

Month and year	Load of total nitrogen as nitrate and nitrite flowing into lakes at CLE gage (ton)	Load of total nitrogen as nitrate and nitrite flowing out of lakes at CLE gage (tons)	Load of ammonia nitrogen flowing into lakes at CLE gage (tons)	Load of ammonia nitrogen flowing out of lakes at CLE gage (tons)	Load of total Kjeldahl nitrogen flowing into lakes at CLE gage (tons)	Load of total Kjeldahl nitrogen flowing out of lakes at CLE gage (tons)	Load of total phosphorus flowing into lakes at CLE gage (ton)	Load of total phosphorus flowing out of lakes at CLE gage (ton)
May 1998	0.03	0.18	0.048	0.55	0.168	2.17	0.007	0.098
June 1998	.05	.11	.086	.17	.306	.59	.013	.023
July 1998	.03	.15	.053	.36	.183	1.38	.007	.061
August 1998	.07	.08	.118	.10	.408	.31	.016	.011
September 1998	.05	.10	.107	.14	.399	.45	.017	.017
October 1998	.03	.16	.069	.35	.278	1.28	.013	.053
November 1998	.03	.17	.236	.58	1.188	2.42	.071	.120
December 1998	.03	.16	.070	.41	.262	1.53	.011	.065
January 1999	.03	.17	.194	.45	.875	1.78	.046	.083
February 1999	.01	.23	.009	1.03	.030	4.34	.001	.212
March 1999	.05	.15	.127	.37	.477	1.39	.021	.060
April 1999	.03	.18	.058	.68	.213	2.79	.009	.133
Total	0.44	1.84	1.75	5.19	4.787	20.43	0.232	0.936

Month and year	Load of dissolved phosphorus flowing into lakes at CLE gage (ton)	Load of dissolved phosphorus flowing out of lakes at CLE gage (ton)	Load of total suspended solids flowing into lakes at CLE gage (tons)	Load of total suspended solids flowing out of lakes at CLE gage (tons)	Load of total volatile suspended solids flowing into lakes at CLE gage (tons)	Load of total volatile suspended solids flowing out of lakes at CLE gage (tons)
May 1998	0.002	0.027	3.3	47.1	1.09	15.8
June 1998	.004	.007	6.1	11.2	2.03	3.7
July 1998	.002	.017	3.5	29.2	1.17	9.8
August 1998	.005	.004	7.9	5.5	2.62	1.8
September 1998	.005	.006	8.3	8.4	2.78	2.8
October 1998	.004	.016	6.2	25.9	2.10	8.6
November 1998	.015	.031	33.0	56.8	11.41	19.3
December 1998	.003	.019	5.5	34.8	1.83	10.6
January 1999	.011	.022	21.8	39.6	7.44	13.4
February 1999	.000	.055	.6	100.6	.18	34.0
March 1999	.006	.018	9.9	29.1	3.32	9.7
April 1999	.003	.035	4.3	63.8	1.45	21.4
Total	0.060	0.257	110.4	452	37.42	150.9

Table 13. Geometric mean concentrations of nutrients in ground water in the vicinity of Lake Catherine and Channel Lake, near Antioch, Ill., May 27, 1998–March 15, 1999

Constituent	Mean concentration in all samples[1]	Mean concentration of samples by date[2]				Mean concentration of samples from wells[3]							
		May 27, 1998	August 8, 1998	November 2, 1998	March 15, 1999	Well 1	Well 2	Well 3	Well 4	Well 5	Well 6	Well 7	Well 8
Nitrate and nitrite, total as nitrogen (milligram per liter)	0.047	0.060	0.053	0.030	0.053	0.024	0.083	0.047	0.170	0.036	0.016	0.174	0.017
Nitrogen, ammonia (milligrams per liter)	.275	.32	.37	.25	.20	.143	.262	1.01	.15	.161	.15	.36	.62
Nitrogen, total Kjeldahl (milligrams per liter)	.692	1.24	.68	1.08	.25	.42	.612	4.05	.33	.58	.52	.56	.92
Phosphorus, dissolved (milligram per liter)	.0189	.025	.022	.018	.013	.023	.011	.021	.017	.018	.015	.027	.025
Phosphorus, total (milligram per liter)	.0698	.115	.073	.067	.042	.038	.054	.91	.031	.04	.021	.061	.18

[1]Thirty-two samples were used for the mean calculation.

[2]Eight samples were used for the mean calculation.

[3]Four samples were used for the mean calculation.

Lake Water

Water-quality samples were collected from Lake Catherine and Channel Lake on April 21, May 15, June 15, June 17, July 13, August 11, October 26, and November 25–27, 1998 (appendix 4). On these dates, temperature and dissolved oxygen profiles also were measured at sites LC1, LC2, LC3, CL1, CL2, and CL3. Additional samples were collected from Lake Catherine on August 31 and from Channel Lake on September 15 and October 14, 1998. The laboratory did not analyze lake-water samples collected after November 1998. Algae samples were collected from Lake Catherine and Channel Lake on April 21, July 13, August 11, and October 26, 1998. Algae samples also were collected from Lake Catherine on June 17, 1998.

Secchi depth is the depth at which the black and white Secchi disk (8-in. diameter) is no longer visible and is a measure of the clarity of the lake water. Mean Secchi values for the period of measurement were higher in Lake Catherine than in Channel Lake (table 14). Mean Secchi values for Lake Catherine and Channel Lake were within 6 in. during May, June, July, and October 1998 (appendix 4). In August and September 1998, Secchi values on Lake Catherine were more than 10 in. higher than on Channel Lake. In April 1998, Secchi values on Channel Lake were more than 20 in. higher than on Lake Catherine. Mean Secchi readings were greater than 60 in. in April, May, and June 1998, below 50 in. from July through mid-October 1998, and increased to more than 50 in. by late October 1998 (table 14). The photic zone, or the zone of the lake with sufficient sunlight penetration to allow photosynthesis by algae and aquatic macrophytes, is considered to be 2–3 times the Secchi reading (Illinois Environmental Protection Agency, 1988). If the maximum depth of Lake Catherine is about 40 ft (480 in.) and the maximum depth of Channel Lake is about 36 ft (432 in.), at least one-quarter of the total depth of the lakes should have been within the photic zone during most of the period of measurement.

The geometric means of the TSS, VSS, and turbidity concentrations in the samples collected from the shallow parts of the lakes were less than a factor of two higher in Channel Lake than in Lake Catherine and less than a factor of two higher in the shallow samples than in the deep samples (table 14). TSS, VSS, and turbidity concentrations in Lake Catherine and Channel Lake are below their respective Illinois Lake Assessment Criteria (Illinois Pollution Control Board, 1989) for moderate use impairment. Typically, TSS,

Table 14. Concentration of constituents in Lake Catherine and Channel Lake, near Antioch, Ill., April 21–November 27, 1998

[na, not analyzed; alkalinity expressed as milligrams per liter of calcium carbonate]

Constituent	Mean concentrations of shallow samples by date										
	April 21, 1998	May 15, 1998	June 15–17, 1998	July 13, 1998	August 11, 1998	August 31, 1998	September 15, 1998	September 30, 1998	October 14, 1998	October 26, 1998	November 27, 1998
Nitrate and nitrite, total as nitrogen (milligram per liter)	0.316	0.116	0.005	0.005	0.007	0.005	0.006	0.005	0.005	0.0194	0.0597
Nitrogen, ammonia (milligram per liter)	.3091	.1174	.0108	.0703	.0496	.1004	.204	.1237	.2918	.3425	.4087
Nitrogen, total Kjeldahl (milligrams per liter)	.681	.531	.799	.627	.921	1.063	1.379	1.049	1.608	1.470	na
Phosphorus, total (milligram per liter)	.0375	.0223	.0346	.052	.0325	.0333	.0401	.0387	.0523	.0591	.0422
Phosphorus, dissolved (milligram per liter)	na	na	.012	.0086	.006	na	na	na	na	.0169	na
Solids, total suspended (milligrams per liter)	6.3	4.4	10.2	6	9.7	2.6	4	6.5	4.6	3.2	5.6
Solids, volatile suspended (milligrams per liter)	4.0	1.4	3	4	4	.8	1.5	2.4	1.6	1.2	3.0
Turbidity (nephelometric turbidity units)	5.9	1.6	13	3.3	53.6	4.6	3.7	3.0	3.7	3.4	na
Conductivity, field (microSiemens per centimeter)	607	na	586	586	594	na	na	na	na	590	na
pH, field	8.37	na	8.65	8.63	8.49	na	na	na	na	8.58	na
Alkalinity, phenolphthalein (milligrams per liter)	na	na	12.8	7	6.7	na	na	na	na	8.5	na
Alkalinity, total (milligrams per liter)	na	na	204	207	204	na	na	na	na	182	na
Secchi reading (inches)	75.8	156.0	74	45.9	34.8	44.9	45.3	na	47.7	56.2	na

Table 14. Concentration of constituents in Lake Catherine and Channel Lake, near Antioch, Ill., April 21–November 27, 1998—Continued

Constituent	Mean concentration of deep samples by date										
	April 21, 1998	May 15, 1998	June 15–17, 1998	July 13, 1998	August 11, 1998	August 31, 1998	September 15, 1998	September 30, 1998	October 14, 1998	October 26, 1998	November 27, 1998
Nitrate and nitrite, total as nitrogen (milligram per liter)	0.2449	0.0663	na	0.005	0.005	na	na	0.005	na	0.0245	na
Nitrogen, ammonia (milligrams per liter)	.3447	.1342	na	.839	2.60	na	na	.1449	na	.3846	na
Nitrogen, total Kjeldahl (milligrams per liter)	.8199	.5916	na	1.1849	na	na	na	1.249	na	.7029	na
Phosphorus, total (milligram per liter)	.0354	.0225	.3286	.1568	.385	na	na	.0657	na	.0349	na
Phosphorus, dissolved (milligram per liter)	na	na	.3175	.0729	.362	na	na	na	na	.0193	na
Solids, total suspended (milligrams per liter)	5.0	1.4	na	5.0	8.0	na	na	na	na	na	9.8
Solids, volatile suspended (milligrams per liter)	2.4	na	na	2.2	4.0	na	na	na	na	na	4.2
Turbidity (nephelometric turbidity units)	5.1	1.7	na	2.9	57	na	na	4.5	na	3.8	na
Conductivity, field (microSiemens per centimeter)	621	na	653	614	658	na	na	na	na	596	na
pH, field	8.08	na	7.17	7.89	7.1	na	na	na	na	8.30	na
Alkalinity, phenolphthalein (milligrams per liter)	na	na	na	na	na	na	na	na	na	na	na
Alkalinity, total (milligrams per liter)	na	na	241	212	247	na	na	na	na	na	na

Table 14. Concentration of constituents in Lake Catherine and Channel Lake, near Antioch, Ill., April 21–November 27, 1998—Continued

Constituent	Mean concentrations by location											
	Site name								Geometric mean of shallow samples from Lake Catherine	Geometric mean of shallow samples from Channel Lake	Geometric mean of all shallow samples	Geometric mean of all deep samples
	LC1S	LC1D	LC2S	LC3S	CL1S	CL1D	CL2S	CL3S				
Nitrate and nitrite, total as nitrogen (milligram per liter)	0.017	0.020	0.021	0.018	0.016	0.024	0.015	0.011	0.019	0.014	0.016	0.022
Nitrogen, ammonia (milligram per liter)	.2101	.3743	.1856	.1583	.0947	.3382	.1243	.073	.1835	.0951	.1321	.3558
Nitrogen, total Kjeldahl (milligrams per liter)	1.0163	.8795	.8715	.8509	.9772	1.0743	.9741	1.1147	.91	1.0199	.9634	.972
Phosphorus, total (milligram per liter)	.0386	.0765	.0352	.0341	.0404	.0779	.0493	.0402	.0359	.0431	.0393	.0772
Phosphorus, dissolved (milligram per liter)	.0086	.0749	.0084	.0093	.0117	.132	.0106	.0099	.0088	.0107	.0097	.0995
Solids, total suspended (milligrams per liter)	5.9	3.2	4.2	4.6	4.7	5.4	7.3	5.8	4.9	5.8	5.3	4.2
Solids, volatile suspended (milligrams per liter)	2.1	1.2	1.7	1.4	2.3	2.5	3.3	2.8	1.7	2.8	2.2	1.8
Turbidity (nephelometric turbidity units)	6.5	5.3	4.1	5.3	6.8	3.5	5.2	6.1	5.2	6.0	5.6	4.3
Conductivity, field (microSiemens per centimeter)	597	626	599	599	589	614	588	589	598	588	593	620
pH, field	8.39	7.74	8.52	8.48	8.59	7.91	8.62	8.61	8.46	8.61	8.53	7.83
Alkalinity, phenolphthalein (milligrams per liter)	9.05	8.00	6.93	7.11	10.38	1.21	9.16	7.96	7.64	9.11	8.35	3.10
Alkalinity, total (milligrams per liter)	213	228	201	206	199	238	201	204	207	201	204	233
Secchi reading (inches)	57.3	na	65.0	58.9	52.8	na	58.2	49.9	60.3	53.5	56.8	na

VSS, and turbidity are directly related to each other and inversely related to Secchi values (Sefton and others, 1980). Based on visual observation of the plots of data from Lake Catherine and Channel Lake, mean VSS values generally increased with increased TSS, but TSS and VSS had no clear relation to Secchi readings or turbidity values. The lack of a correlation at the lakes may be because of the comparatively small data set, inaccurate measurements, or may indicate that other factors (for example, water color and plant growth) are affecting the clarity of the lake water.

Conductivity, as defined in this report, is the capacity of a unit area of water to convey electrical current. Mean conductivity values showed little variation through time or with location, varying from 586 to 658 μS/cm (table 14). These variations are attributed to small changes in the amounts of the common inorganic ions dissolved in the lake water. The geometric mean for the values of field conductivity varied by 10 μS/cm in the shallow samples at Lake Catherine and Channel Lake and was about 30 μS/cm higher near the bottom of the lakes than near the surface.

Alkalinity is an indication of the acid neutralizing capability of water and typically is related to the concentration of carbonate compounds dissolved in water. The available data indicate alkalinity concentrations do not vary between the lakes, but the alkalinity near the bottom of the lakes is about 30 mg/L higher than the alkalinity near the surface (table 14). Alkalinity values are directly related to conductivity values, indicating carbonate compounds are an important dissolved constituent in the lake water.

The pH of the lake water (the negative log of the concentration of hydrogen ion) ranged from 6.88 to 8.72 pH units. The geometric mean of the pH values was higher at the lake surface (mean value of 8.53) than near the bottom of the lakes (mean value of 7.83) and typically was more than 0.1 pH units higher in Channel Lake than in Lake Catherine (table 14). In temperate lakes, pH values greater than 8.0 can be an indication that the photosynthetic activity of algae and aquatic macrophytes is consuming dissolved carbonate compounds faster than it is being replaced by plant and animal respiration, breakdown of organic matter, and atmospheric diffusion (Lampert and Sommer, 1997). Bicarbonate ion, formed from the dissolution of carbon dioxide in water, may be used for photosynthesis under these conditions, which has the effect of decreasing alkalinity of the water and increasing pH. pH was inversely related to alkalinity concentration in the lake water, as would be expected if photosynthetic uptake of carbonate species was the reason for the increase in pH. pH concentrations also were inversely related to conductivity.

Nitrogen in the form of nitrate and nitrite is readily utilized by algae as a growth nutrient. The mean concentration of nitrate and nitrite as nitrogen did not vary substantially between Lake Catherine and Channel Lake and was similar in the deep samples and in the shallow samples (table 14). The mean concentration of nitrate and nitrite as nitrogen in the lakes was greater than 0.25 mg/L on April 21, decreased to near or below the detection limit from about June 15 through mid-October 1998, and increased to about 0.06 mg/L by November 27, 1998 (table 14). The lack of detectable concentrations of nitrate and nitrite during the summer and early fall months indicates these constituents were being consumed by physical, chemical, and biological processes during this period, particularly in the shallow part of the lakes.

Ammonia nitrogen also is readily utilized by phytoplankton and algae as a growth nutrient. The geometric mean of the ammonia nitrogen concentration in the shallow samples was nearly a factor of two higher at Lake Catherine than at Channel Lake (table 14). The geometric mean of the ammonia concentration in the deep parts of Lake Catherine and Channel Lake were similar (appendix 4). Mean ammonia concentrations in the deep samples exceeded concentrations in the shallow samples by nearly a factor of three. The mean concentration of ammonia nitrogen in the shallow samples, collected near the surface of the lakes, decreased from April 21 through June 15–17, 1998, was less than 0.11 mg/L from mid-June through August 11, 1998, and increased overall to about 0.40 mg/L by November 27, 1998. Ammonia concentrations in the deep samples, taken near the bottom of Lake Catherine and Channel Lake, were similar to concentrations in the shallow part of the lakes on April 21, 1998. Ammonia concentrations in the deep part of the lakes increased to more than 2.5 mg/L by August 1998, then decreased to a concentration similar to the concentration in the shallow part of the lakes by September 30, 1998. The temporal trends in the concentration of ammonia nitrogen may be caused by uptake of ammonia in the shallow part of the lake by plants and algae during the summer months, release of ammonia from bottom sediments to the bottom of the lakes during decomposition of organic matter in the summer months, and mixing of water from the lower and upper parts of the lakes during the fall.

TKN concentrations in the shallow part of Lake Catherine and Channel Lake were less than 1.0 mg/L in April through mid-August 1998 and exceeded 1.0 mg/L from late August through at least late October, 1998 (table 14). TKN concentrations were about 0.10 mg/L higher in the shallow part of Channel Lake than in the shallow part of Lake Catherine. Concentrations of TKN typically were greater than twice the ammonia concentrations in all shallow samples and in the deep samples collected during the spring and fall. Most of the TKN in the shallow parts of Lake Catherine and Channel Lake is organic nitrogen, which has not been shown to be used by algae (Vollenweider, 1968). In July and August 1998, ammonia nitrogen concentrations in the deep samples were approximately equal to the TKN concentrations. During the summer months, most of the TKN near the bottom of Lake Catherine and Channel Lake is ammonia nitrogen and can be readily utilized as a growth nutrient if brought into contact with algae.

Total phosphorus concentrations were slightly higher in Channel Lake than concentrations in Lake Catherine and were about a factor of two higher in the deep samples than in the shallow samples (table 14). The mean concentration of total phosphorus in the shallow samples of Lake Catherine and Channel Lake decreased from April to May 1998, then showed an overall increase from May through October 1998. Total phosphorus concentrations in the deep samples collected in April and May 1998 and late September through the end of the period of sampling on November 27, 1998, were similar to the concentrations in the surface samples. Samples collected near the bottom of the lakes in June, July, and August 1998 had total phosphorus concentrations that were an order of magnitude higher than concentrations in the surface samples at that time, indicating production of phosphorus compounds from the bottom sediments.

Dissolved phosphorus is the form most readily utilized for algae and macrophyte growth. Although dissolved-phosphorus data are limited, concentrations are essentially identical in the shallow parts of the lakes (table 14). The mean concentration of dissolved phosphorus near the surface of Lake Catherine and Channel Lake decreased from mid-June through mid-August 1998, then increased by October 26, 1998. The concentration of dissolved phosphorus near the bottom of the lakes was an order of magnitude higher than concentrations near the surface of the lakes from June through at least mid-August 1998. Concentrations of dissolved phosphorus near the bottom and the surface of Lake Catherine and Channel Lake were essentially identical in October 1998. Concentrations of dissolved phosphorus typically are less than one-half the concentration of total phosphorus for the near-surface samples, indicating most phosphorus near the surface of the lakes is bound to particulate matter and, therefore, not readily utilized for plant and algae growth. Dissolved phosphorus is most or all of the total phosphorus in the deep samples at Lake Catherine and Channel Lake during June, July, and August 1998, with the exception of the sample from LC1D collected on July 13, 1998. Dissolved phosphorus was measured to be about one-quarter of the total phosphorus in the deep part of Lake Catherine on July 13, 1998. During the summer months, most of the phosphorus in the deep part of the lakes is in the dissolved form, which can be readily utilized for plant and algae growth. The elevated concentration of dissolved phosphorus near the bottom of the lakes appears to be produced by release from bottom sediments during the decomposition of organic matter.

Chlorophyll *a* is a photosynthetic pigment that is necessary for photosynthesis in most plants and in blue-green, green, yellow-green, and yellow-brown algae; diatoms; euglenoids; and dinoflagellates. Blue-green algae contain only chlorophyll *a*. Chlorophyll *b* is an accessory photosynthetic pigment present in green algae and euglenoids. Chlorophyll *c* is an accessory photosynthetic pigment present in diatoms, yellow-green and yellow-brown algae, and dinoflagellates. Pheophytin *a* is a breakdown product of chlorophyll *a*. High concentrations of pheophytin are indicative of a stressed algal population or a recent algae die off. Chlorophyll *a* values must be corrected for pheophytin to determine the amount of living biomass in the sample. Concentrations of chlorophyll *a* (corrected), measured at Lake Catherine and Channel Lake showed an overall increase between April 21 and October 26, 1998, then decreased by a factor of about four between October 26 and November 9, 1998 (table 15). Chlorophyll *b* and chlorophyll *c* had similar patterns of increasing concentrations through the spring and summer of 1998. Chlorophyll *b* typically was at maximum concentration during the last sampling period on November 25, 1998, whereas chlorophyll *c* was at maximum concentration on October 26 or November 25, 1998 (table 15, appendix 4). The

Table 15. Results of lake-water-quality sampling from site CL1 at a depth of 4.4-22 feet and site LC1 at a depth of 5.1-40 feet, Lake Catherine and Channel Lake, near Antioch, Ill., April 21–November 25, 1998

[k, constituent present below detection limit; na, not analyzed]

Constituent	Date of sample collection										
	April 21, 1998	May 15, 1998	July 13, 1998	August 11, 1998	August 31, 1998	September 15, 1998	September 30, 1998	October 14, 1998	October 26, 1998	November 9, 1998	November 25, 1998
Site CL1											
Chlorophyll-*a* (micrograms per liter)	6.41	4.27	24.0	46.1	42.7	53.4	77.4	na	118	22	30
Chlorophyll-*a*-uncorrected (micrograms per liter)	5.88	3.81	24.3	44.7	42.1	51.4	76.2	na	113	24.1	35.2
Chlorophyll-*b* (micrograms per liter)	.75	.86	.06	2.69	1.18	1k	4.31	na	2.36	1.33	11.3
Chlorophyll-*c* (micrograms per liter)	.00	.58	.87	3.17	2.63	4.62	12.9	na	20.2	3.58	15.6
Pheophytin-*a* (micrograms per liter)	.00	.00	.00	.00	.00	1k	1k	na	1k	2.27	8.28
Chlorophyll filtered	500	1,000	300	434	200	300	400	na	450	400	400
Total algal density (per milliliter)	2,541	na	8,589	21,489	na	na	na	na	3,274	na	na
Depth of sample (feet)	16	22	8	5	4.4	6	6	na	9	10	10
Site LC1											
Chlorophyll-*a* (micrograms per liter)	15.49	3.47	33.40	45.50	30.70	34.7	72.8	98.8	96.6	15.4	10.7
Chlorophyll-*a*-uncorrected (micrograms per liter)	15.22	2.79	32.40	44.80	30.70	32	71.4	96.2	94.6	16.2	13.5
Chlorophyll-*b* (micrograms per liter)	.97	.77	.87	2.30	1.29	1k	4.25	3.03	2.9	1k	8.57
Chlorophyll-*c* (micrograms per liter)	.00	.46	2.88	3.63	2.09	3.11	12.1	18.4	17.3	2.17	10
Pheophytin-*a* (micrograms per liter)	.00	.00	.00	.00	.00	1k	1k	1k	1k	1k	5.21
Chlorophyll filtered	500	1,000	400	464	400	400	400	300	412	400	400
Total algal density (per milliliter)	7,465	na	6,592	17,244	na	na	na	na	2,276	na	na
Depth of sample (feet)	10	40	8	8	8	12	8	5.1	5.6	10	10

presence of elevated concentrations of pheophytin *a* in the samples collected on November 25, 1998, indicates the algal population was under some stress at that time.

Results of the algae sampling in Lake Catherine and Channel Lake indicate that counts of the identified algae exceeded 2,000 per ml, and that blue-green algae were the most abundant algae identified in the lakes during most of the sampling periods (Larry O'Flaherty, Western Illinois University, written commun., 1999). Algae densities were higher in Lake Catherine than in Channel Lake in April 1998 but were higher in Channel Lake during the other sampling periods. A "bloom" of blue-green algae, identified by a density of 1 million or more algae per liter, occurred between June 17 and July 13, 1998. Densities of all measured algae reached a maximum of more than 16,000 per ml at both lakes on August 11, 1998, with blue-green algae being more than 92 percent of the algae determined to be present on that date. Green algae and dinoflagellates were present at concentrations of greater than 100 per ml during most of the sampling period, whereas diatoms and euglenoids were present at concentrations of less than 100 per ml. Diatoms, blue-green algae, green algae, and euglenoids were at their maximum density during the August sampling. Cyrptomonads attained their highest density during the April 1998 sampling and were the dominant phytoplankton at that time. Dinoflagellates were present at their highest densities during the October 1998 sampling.

Total densities of the identified algae were higher in 1998 than densities for comparable dates during previous sampling periods in 1979, 1987, and 1993 for Channel Lake and 1987 for Lake Catherine. As was the case during the current investigation, blue-green algae were the dominant algae detected in both lakes during previous sampling periods, varying from an average of 55.2 to 70.9 percent of the measured algal density in these lakes (Kothandaraman and others, 1977, p. 158; Larry O'Flaherty, Western Illinois University, written commun., 1999). Flagellates (15.5 to 21.0 percent), diatoms (8.4 to 16.3 percent), and green algae (3.8 to 8.6 percent) also were detected during previous investigations.

Algae require a variety of elements to grow, including nitrogen, phosphorus, carbon, and hydrogen. In freshwater lakes, all elements, except phosphorus or nitrogen, typically are available in sufficient quantity for algal growth. Because certain forms of algae can obtain nitrogen from the atmosphere, phosphorus is the nutrient that limits algal growth in most lakes (the limiting algal nutrient) (Schindler, 1977). If the concentration of dissolved phosphorus in lake water is less than 0.005 mg/L, a lack of biologically available phosphorus may limit algal growth (United Nations Educational, Scientific, and Cultural Organization, 1989). If the total concentration of biologically available nitrogen (ammonia, nitrate, nitrite) in lake water is less than 0.020 mg/L, a lack of nitrogen may limit algal growth. Dissolved phosphorus concentrations in the samples of the shallow water in Lake Catherine and Channel Lake typically were greater than 0.005 mg/L during the summer months (table 14). Nitrate and nitrite as nitrogen concentrations in the shallow lake water typically were present at concentrations near or below the detection limit of 0.01 mg/L. Ammonia nitrogen concentrations in the shallow lake water typically were present at concentrations greater than 0.020 mg/L. Whether algal growth is limited by the concentration of nitrogen or phosphorus in Lake Catherine or Channel Lake is not clearly indicated.

The limiting nutrient for a lake usually can be identified by comparing the weight ratio of total nitrogen (TKN and nitrate and nitrite nitrogen) to total phosphorus. The N:P atomic ratio in algal cell tissue is about 16:1 (16 nitrogen atoms for every phosphorus atom) (United Nations Educational, Scientific, and Cultural Organization, 1989). If nutrient concentrations are measured in milligrams per liter, the atomic ratio of 16 moles/L of nitrogen to 1 mole/L of phosphorus converts to 224 g/L of nitrogen and 31 g/L of phosphorus, a mass ratio of 7.2:1 (United Nations Educational, Scientific, and Cultural Organization, 1989). Assuming the algal populations use the nutrients in this ideal ratio, a mass ratio of less than 5:1 indicates nitrogen is the limiting algal nutrient and a ratio above 10:1 indicates phosphorus is the limiting algal nutrient (Marsden, 1989, p. 153). During the investigation, the mass ratios of the mean values of N:P for the samples collected near the surface of Lake Catherine and Channel Lake (table 16) were greater than 7.2:1 for the samples collected, indicating phosphorus is the nutrient limiting algal biomass. Phosphorus was suggested to be the limiting algal nutrient in the Chain of Lakes during previous investigations (Kothandaraman and Evans, 1978b).

The trophic state indices (TSI) devised by Carlson (1977) utilize Secchi depths, total phosphorus concentrations at the lake surface, and chlorophyll *a* concentrations at the lake surface to determine the trophic status of lakes with nonalgal turbidity and minimal aquatic vegetation. The higher the TSI, the more eutrophic, or nutrient enriched, the lake. The index is based on the amount of algal biomass in the water on the basis of a scale of 0 to 110, with each major division of the index (10, 20, 30) representing a theoretical doubling of the algal biomass. Lakes with TSI values greater than 50 are classified as eutrophic (high algal production). Lakes with a mean TSI greater than 60 and less than 70 are characterized as being moderately to highly eutrophic (Illinois Environmental Protection Agency, 1990). This index is not strictly applicable to lakes with water coloration or suspended materials other than algae.

The TSI determined from the Secchi readings ranged from 40 to 64, with a mean value of about 54 (table 17). The TSI determined from the total phosphorus in the surface samples ranged from 48 to 66, with a mean value of about 57. The TSI calculated from the corrected chlorophyll a concentrations ranged from 43 to 75, with a mean value of about 61. TSI values were similar for both lakes. All TSI values indicate the lakes are marginally to moderately eutrophic.

The temperature and dissolved oxygen profiles over the period of measurement indicate Lake Catherine and Channel Lake are subject to thermal stratification (fig. 14). On April 21, 1998, the water temperature of Lake Catherine and Channel Lake varied by less than 3°C and dissolved oxygen concentrations exceeded 5.0 mg/L at almost all levels in the lakes. These conditions are representative of the well-mixed water of uniform temperature and high dissolved oxygen concentration associated with the spring turnover stage.

Rising air temperatures and increased inputs of solar radiation increased the surface temperature of Lake Catherine and Channel Lake from about 12°C on April 21 to about 20°C by May 15 and to more than 26°C on August 11, 1998 (fig. 14). Water at depth was heated more slowly. Beginning in May and probably continuing through early September, the upper part of Lake Catherine and Channel Lake (the epilimnion) typically was more than 10°C warmer than the lower part of the lakes (the hypolimnion). The epilimnion and hypolimnion are separated by the thermocline, a zone of water characterized by a large temperature gradient. These temperature patterns are characteristic of the summer stratification stage. Water is at its maximum density at about 4°C and the large temperature difference between the upper and lower parts of the lakes produces a difference in the density of the water in the epilimnion and the hypolimnion, resulting in the thermal stratification of the lake water. Thermal stratification prevents the warmer, less dense, oxygenated water near the top of the lakes (dissolved oxygen concentrations in the upper part of the lakes were greater than 9.0 mg/L during almost all of the measurement period) from mixing with cooler, denser water near the bottom of the lakes. Oxygen consumption during the bacterial decomposition of organic material in the bottom sediments at Lake Catherine and Channel Lake exceeded oxygen replenishment by molecular diffusion during the stratification period. This oxygen deficit resulted in a decrease in the concentration of dissolved oxygen below about 22 ft in Channel Lake and below about 26 ft in Lake Catherine to less than 1.0 mg/L by June 17, 1998 (fig. 14). The depth at which less than 1.0 mg/L of dissolved oxygen was detected in Channel Lake decreased to about 12 ft by July and varied from about 12–18 ft by August 1998. The depth at which less than 1.0 mg/L of dissolved oxygen was detected in Lake Catherine decreased to about 16 ft by July and increased to about 20 ft by August 1998. Stratification of the lake water can be overcome by high winds or storms, which can mix the water (Mortimer, 1941, p. 287–88). High winds may have produced the comparatively uniform temperature and dissolved oxygen profiles observed on June 15, 1998 (appendix 4). Destratification of the lake water associated with storms can result in the redistribution of nutrients from the hypolimnion to the epilimnion, producing algal blooms (Stauffer and Lee, 1973).

As dissolved oxygen concentrations in lake water above the bottom sediments decrease below about 2.0 mg/L, the conditions for bacterially mediated reduction of organic matter and chemical reduction of metal phosphate complexes can release ammonia nitrogen and dissolved phosphorus from the bottom sediments into the overlying water (Mortimer, 1971; Marsden, 1989). Release of nitrogen and phosphorus compounds from bottom sediments is the probable cause of the buildup of ammonia and phosphorus in the deeper parts of Lake Catherine and Channel Lake, observed during June–August 1998 (table 14).

Bathymetric data were used to determine that the volume of water in Channel Lake below 12 ft of depth on July 15, 1998, was 2,101 acre-ft, or about 41 percent of the total volume of water in the lake at that time. Bathymetric data indicate that the volume of water in Lake Catherine below 16 ft of depth on July 15, 1998, was 951 acre-ft, or about 38 percent of the total

Table 16. Ratios of the concentration of total nitrogen to total phosphorus in water from Lake Catherine and Channel Lake, near Antioch, Ill., April 21–November 27, 1998

Constituent	Mean concentration of shallow samples by date										
	April 21, 1998	May 15, 1998	June 15, 1998	July 13, 1998	August 11, 1998	August 31, 1998	September 15, 1998	September 30, 1998	October 14, 1998	October 26, 1998	November 27, 1998
Nitrate and nitrite, as total nitrogen (milligram per liter)	0.316	0.116	0.005	0.005	0.007	0.005	0.006	0.005	0.005	0.019	0.060
Nitrogen, total Kjeldahl (milligrams per liter)	.681	.531	.799	.627	.921	1.063	1.379	1.049	1.608	1.47	.409
Nitrogen, total (TN) (milligrams per liter)	.997	.648	.804	.632	.928	1.068	1.386	1.054	1.613	1.49	.468
Phosphorus, total (TP) (milligram per liter)	.0375	.0223	.0346	.052	.0325	.0333	.0401	.0387	.0523	.0591	.0422
Ratio TN:TP (rounded)	18	24	13	12	29	32	35	27	31	25	11

Table 17. Calculated trophic state indices for Lake Catherine and Channel Lake, near Antioch, Ill., April 21–November 27, 1998
[ns, not sampled; na, not applicable]

Constituent	Date of sample collection											
	April 21, 1998	May 15, 1998	June 17, 1998	July 13, 1998	August 11, 1998	August 31, 1998	September 15, 1998	September 30, 1998	October 14, 1998	October 26, 1998	November 9, 1998	November 27, 1998
						Channel Lake						
Secchi depth (inches)	89	156	74	46	30	ns	37	ns	48	58	ns	ns
Trophic state indice	48	40	51	58	64	na	61	na	57	54	na	na
Phosphorus, total (milligrams per cubic meter)	31	21	38	73	36	na	44	39	52	53	na	44
Trophic state indice	54	48	57	66	56	na	59	57	61	61	na	59
Chlorophyll-*a* (milligrams per cubic meter)	6.9	4.6	ns	26.0	52.8	50.4	49.5	51.2	ns	76	19.8	27.3
Trophic state indice	50	45	na	63	69	69	69	69	na	73	60	63
						Lake Catherine						
Secchi depth (inches)	65	156	75	46	41	45	56	ns	ns	54	ns	ns
Trophic state indice	53	40	51	58	59	58	55	na	na	55	na	na
Phosphorus, total (milligrams per cubic meter)	44	23	30	37	29	33	36	ns	ns	66	ns	41
Trophic state indice	59	49	53	56	53	55	56	na	na	65	na	58
Chlorophyll-*a* (milligrams per cubic meter)	9.1	3.5	na	28.8	35.6	28.7	31.7	58.7	87.8	88.7	17.7	10.2
Trophic state indice	52	43	na	64	66	63	64	71	74	75	59	53

Mean trophic state indice	Channel Lake	Lake Catherine
Secchi depth	54	53
Shallow phosphorus data	58	56
Chlorophyll-*a* data	62	61

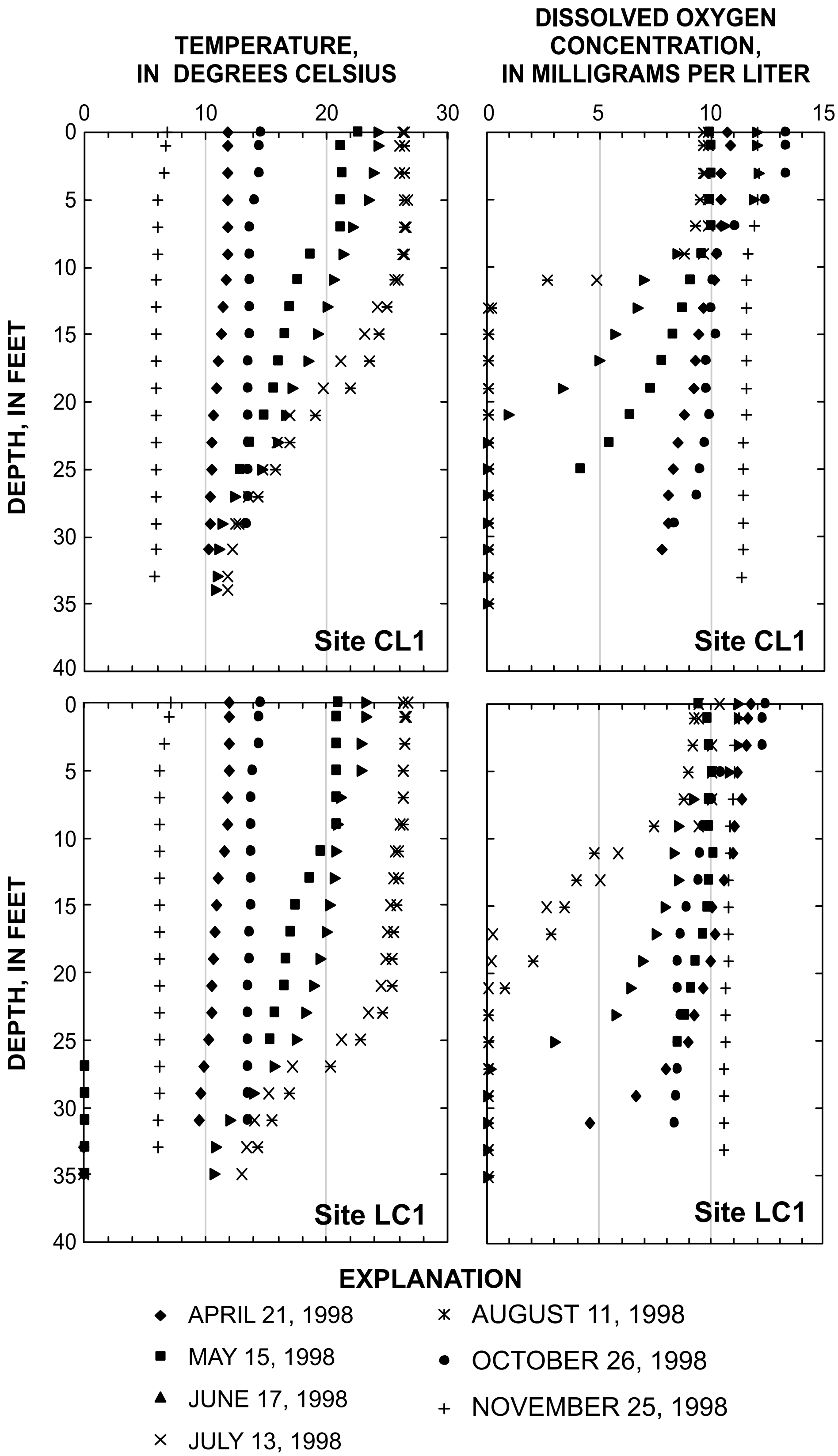

Figure 14. Selected temperature and dissolved oxygen profiles in Lake Catherine and Channel Lake, near Antioch, Ill., April 21–November 25, 1998.

volume of water in the lake at that time. These depths are the approximate minimum depths where less than 1.0 mg/L was present in the lakes on July 15, 1998, and represent the maximum volumes of low-oxygen water in the lakes during the investigation.

Lower air temperatures in the fall cooled the shallow water in Lake Catherine and Channel Lake from more than 26°C in August 1998 to about 7°C in late November 1998. The decrease in the temperature of the shallow water resulted in equilibration of the temperature throughout the lakes, and by October 26, 1998, the difference in temperature between the top and bottom of the lakes was about 1°C. Under these nearly isothermal conditions the difference in water density between the upper and lower parts of the lakes decreased to a point where the lakes were unstratified in October and November 1998. The loss of thermal stratification resulted in increasingly well-mixed water, with a dissolved oxygen concentration above 7.5 mg/L. Dissolved oxygen concentrations varied by less than 5.0 mg/L with depth on October 26 and varied by about 1.0 mg/L with depth on November 25, 1998 (fig. 14).

Oxygenated water and uniform temperatures throughout the lakes is characteristic of the fall turnover stage. Under these conditions, water with high nutrient concentrations near the bottom of the lakes can be mixed with nutrient poor water in the upper parts of the lakes. The decrease in concentrations of total phosphorus and ammonia nitrogen near the bottom of Lake Catherine and Channel Lake between August 11 and September 30, 1998, and the increase in the concentration of these constituents (ammonia nitrogen more than phosphorus) in the shallow part of the lakes indicate the fall turnover occurred during this period.

Although temperature and dissolved oxygen data are unavailable for Lake Catherine and Channel Lake after November 25, 1998, probably as air temperature decreased through the fall and ice covered the lakes in winter, the lower part of the lakes had a uniform temperature of about 3–4°C, with temperatures of 0–2°C present below the ice (Mortimer, 1941). The lakes may have stratified into an upper, less dense layer with a temperature below 4°C and a lower, denser layer with a temperature near 4°C. Assuming this temperature was reached, the lakes would have entered the winter stratification stage. The winter stratification stage is characterized by an overall increase in water temperature at depth coupled with a decrease in the concentration of dissolved oxygen near the bottom of the lake. Concentrations of dissolved oxygen in the lower parts of a lake during winter stratification tend to be higher than concentrations during summer stratification, and whether dissolved oxygen concentrations near the bottom of the lakes were below 2.0 mg/L from December 1998 to March 1999 is uncertain.

Sediment Budget

Sediment enters Lake Catherine and Channel Lake as TSS in surface water flowing into the lakes from Trevor Creek, the unnamed creek in the northeast part of Channel Lake, the storm drains, and the bridge openings on the southern part of Channel Lake. Sediment exits Channel Lake as TSS in surface water flowing out of the lakes through the bridge openings on the southern part of Channel Lake. The sediment budget as TSS for the lakes was estimated by extrapolating the TSS load calculations developed from the transport curves at the TC (table 8) and FS (table 10) gages to the ungaged drainage area for the storm drains and the total watershed (table 18). Calculation of the sediment budget assumes the TSS load through the west opening of Channel Lake was 10 percent of the load through the east opening (table 12). The VSS budget for Lake Catherine and Channel Lake was determined on the basis of the same methods as the TSS budget.

During the investigation, the calculated mass of sediment as TSS leaving Lake Catherine and Channel Lake exceeded the calculated mass of sediment as TSS entering the lakes by approximately 80 tons (table 18). The calculated mass of VSS exiting the lakes exceeded the mass entering by about 50 tons (table 18). If the VSS load is subtracted from the TSS load, about 31 tons more inorganic material was calculated to have exited than entered Lake Catherine and Channel Lake. VSS constitute about 25 percent of the TSS load into the lakes from surface water in the watershed and from the storm drains. VSS constitute about 34 percent of the TSS load entering and exiting the lakes through the State Highway 173 bridge openings. These patterns indicate increased suspension of organic matter in the lakes.

Given the variability of the sampling methods, the variable amount and direction of flow at the CLE gage, the effects of increased VSS in the lake water on the TSS load exiting the lake, and the potential for boat traffic at the CLE gage to increase TSS concentrations and bias the transport curve, the amount of sediment as TSS leaving the lakes during

Table 18. Sediment budget for Lake Catherine and Channel Lake, near Antioch, Ill., May 1998–April 1999

Month and year	Mass of total suspended solids flowing into lakes from surface water in watershed (tons)	Mass of total suspended solids flowing into lakes from storm drains (tons)	Mass of total suspended solids flowing into lakes through Route 173 bridge openings (tons)	Total mass of total suspended solids added to the lakes (tons)	Mass of total suspended solids exiting lakes through Route 173 bridge openings (tons)
May 1998	34.3	2.1	3.6	39.9	51.8
June 1998	12.5	2.0	6.7	21.1	12.3
July 1998	5.4	2.1	3.9	11.3	32.1
August 1998	1.1	2.1	8.7	11.8	6.1
September 1998	1.7	2.0	9.1	12.8	9.2
October 1998	7.1	2.1	6.8	16.3	28.5
November 1998	8.2	2.0	36.3	46.3	62.5
December 1998	7.1	2.1	6.0	15.3	34.3
January 1999	41.9	3.2	24.0	69.1	43.6
February 1999	48.5	2.0	.7	51.0	110.7
March 1999	22.3	2.0	10.9	35.3	32.0
April 1999	78.4	2.1	4.7	85.6	70.2
Total	268.5	25.8	121.4	415.8	493.3

Month and year	Mass of volatile suspended solids flowing into lakes from surface water in watershed (tons)	Mass of volatile suspended solids flowing into lakes from storm drains (tons)	Mass of volatile suspended solids flowing into lakes through Route 173 bridge openings (tons)	Total mass of volatile suspended solids added to the lakes (tons)	Mass of volatile suspended solids exiting lakes through Route 173 bridge openings (tons)
May 1998	8.8	0.62	1.2	10.6	17.4
June 1998	3.3	.62	2.2	6.1	4.1
July 1998	1.5	.62	1.3	3.4	10.8
August 1998	.3	.62	2.9	3.8	2.0
September 1998	.5	.61	3.1	4.2	3.1
October 1998	2.0	.64	2.3	4.9	9.5
November 1998	2.2	.61	12.6	15.3	21.2
December 1998	2.0	.63	2.0	4.6	11.7
January 1999	10.5	.65	8.2	19.4	14.7
February 1999	12.3	.37	.2	13.0	37.4
March 1999	5.9	.36	3.7	10.0	10.7
April 1999	19.3	.38	1.6	21.3	23.5
Total	68.6	6.73	41.3	116.6	166.1

the period of the investigation was approximately equal to the amount entering the lakes. This interpretation is consistent with the data from the bathymetric survey, which indicates minimal change in the maximum depth of the lakes during the past 10 years.

NUTRIENT LOADS

Nutrients are added to Lake Catherine and Channel Lake from internal sources, including regeneration of nutrients from decomposing organic matter and external sources, including precipitation, surface- and ground-water inflow to the lake, waterfowl, and sediment from erosion. Nutrients are removed from the lakes by surface-water outflow, outflow to ground water, denitrification, and nutrient uptake from algae and aquatic macrophytes. Nutrients taken up by plants are recycled to the lake sediments and the water column when the plants die. Calculation of the amount of nutrient derived from each source and the amount of the nutrients entering and exiting the lakes will help determine the overall water quality of Lake Catherine and Channel Lake and the most effective methods for improving the quality of the lakes.

External Loads

Precipitation falling on the surface of the lakes contains nitrogen and smaller amounts of phosphorus derived from atmospheric gasses. Data on the concentrations of nitrate and ammonia in precipitation were obtained on the World Wide Web for a National Atmospheric Deposition Program (NADP) monitoring station in Lake Geneva, Wisconsin for 1994–97 at *http://nadp.sws.uiuc.edu/nadpdata/seasRequest.asp?site=WI99*. During the 1994–98 period, an average of 3.36 (lbs/acre)/yr of ammonia nitrogen, and 12.03 (lbs/acre)/yr of nitrogen as nitrate was deposited from precipitation at Lake Geneva, Wisconsin. Lake Geneva is about 30 mi west of the investigation area. This deposition rate indicates about 1,636 lbs of ammonia and 5,858 lbs of nitrate (for a total of 7,494 lbs of nitrogen compounds) were added to Lake Catherine and Channel Lake from precipitation directly onto the surface of the lakes during the investigation (table 19). Isopleth maps of the concentration of nitrogen and ammonia in precipitation (available on the NADP site on the World Wide Web at *http://nadp.sws.uiuc.edu/isopleths/maps1998/)* indicate the Lake Geneva data are representative of conditions in the investigation area. The NADP did not measure phosphorus concentrations in precipitation, so the mean concentration of phosphorus in the precipitation samples collected for this investigation was used to calculate the phosphorus load from precipitation. Combination of the mean concentration of total phosphorus in precipitation with the volume of precipitation added to the surface of the lakes indicates about 74 lbs of total phosphorus was deposited on Lake Catherine and Channel Lake directly from precipitation from May 1998 through April 1999.

Particulate matter in the atmosphere that settles on the lake (dry deposition) also is a source of nutrients to the lake water. The loading rates of total phosphorus and total nitrogen from dry deposition at Lake Catherine and Channel Lake were assumed to be 0.37 and 5.9 (lbs/acre)/yr, respectively, on the basis of measurements of air in northeast Illinois with total suspended particulates at a concentration of 50 μg/L (Quon, 1977). Because Lake Catherine and Channel Lake have a combined area of 487 acres, the calculation of input to the lakes from dry deposition, during the 1-year period of the investigation, was 180 lbs of phosphorus and 2,873 lbs of nitrogen (table 19).

Waterfowl excrement is another source of nutrients to Lake Catherine and Channel Lake. Volunteer observers counted the number of waterfowl in Lake Catherine and Channel Lake approximately on a weekly basis during the investigation. The number of

Table 19. Nutrient budget for Lake Catherine and Channel Lake, near Antioch, Ill., May 1998–April 1999
[<, less than; na, not applicable]

Nutrient loads entering/exiting lakes	Phosphorus compounds		Nitrogen compounds	
	Load (pounds)	Percent of total load to lake	Load (pounds)	Percent of total load to lake
Precipitation	74	1.4	7,494	7.0
Particulate matter	180	3.5	2,873	2.7
Waterfowl	20	.4	32	<.1
Inflow of ground water	68	1.3	720	.7
Internal regeneration	2,095	40.2	20,951	19.5
Inflow from surface water in watershed	1,603	30.9	56,641	52.9
Inflow from storm drains	646	12.5	6,970	6.5
Inflow through Route 173 bridge openings	510	9.8	11,499	10.7
Total input	5,196	100	107,180	100
Outflow to ground water	156	7.0	2,767	5.3
Outflow through Route 173 bridge openings	2,059	93.0	48,934	93.5
Denitrification	na	na	640	1.2
Total output	2,215	100	52,341	100
Net load to lakes	2,981	na	54,839	na

individual geese (primarily Canada geese) and ducks (primarily mallards) were totaled and normalized to obtain the number of effective user days per month (table 20).

The average dry weights of mallard and Canada goose droppings are 0.059 and 0.18 lb/d, respectively (Sanderson and Anderson, 1978; Terres, 1987). The nitrogen concentration in the droppings is assumed to be 3.0 percent of the dry weight (Johnson, 1989). The phosphorus concentration in the droppings is assumed to be 1.87 percent of the dry weight (Scherer and others, 1995). Using these values, the average duck excretes 0.0018 lb of nitrogen and 0.0011 lb of phosphorus per day, whereas the average Canada goose excretes 0.0054 lb of nitrogen and 0.0034 lb of phosphorus per day. The daily load of nitrogen and phosphorus in waterfowl droppings were multiplied by 0.75 when nutrient loads to the lake were calculated because some of the daily droppings are not into the lakes. Multiplying the normalized monthly waterfowl count at the lake by the adjusted daily nutrient content of the droppings resulted in an estimate of about 32 lbs of nitrogen and about 20 lbs of phosphorus being added to Lake Catherine and Channel Lake from waterfowl droppings during the investigation (tables 19, 20).

The nutrient load resulting from ground-water recharge to the lakes was calculated by multiplying the total volume of ground-water inflow by the mean concentration of dissolved phosphorus, total phosphorus, ammonia nitrogen, TKN, and nitrate and nitrite as nitrogen in ground-water samples collected during the investigation (table 21). From May 1, 1998, to April 30, 1999, about 46 lbs of nitrate and nitrite as nitrogen, 674 lbs of TKN (about 268 lbs is ammonia), and 68 lbs of total phosphorus (about 18 lbs is dissolved) were calculated to have been added to Lake Catherine and Channel Lake from inflowing ground water.

The nutrient loss resulting from the flow of water from Lake Catherine and Channel Lake to ground water was calculated by multiplying the volume of flow from the lakes to ground water by the geometric mean concentration of total phosphorus, ammonia nitrogen, TKN, and nitrate and nitrite as nitrogen in the lakes for the period from May through November 1998 (table 21). The mean concentration of total phosphorus, ammonia nitrogen, TKN, and nitrate and nitrite as nitrogen in the samples from the east outlet of Channel Lake was considered representative of the lake-water quality during the period December 1998–April 1999. A calculation of 308 lbs of nitrate and nitrite as nitrogen, 2,459 lbs of TKN (of which about 780 lbs is ammonia), and 156 lbs of total phosphorus were removed from Lake Catherine and Channel Lake by flowing out to ground water.

Nutrient loads to Lake Catherine and Channel Lake from inflow of surface water within the watershed were calculated by extrapolating the nutrient-load calculations developed from the transport curves at the TC gage to the ungaged drainage area in the watershed (tables 8, 19). About 38,400 lbs of nitrate and nitrite as nitrogen, about 18,100 lbs of TKN, (about 3,040 lbs is ammonia nitrogen) and about 1,600 lbs of total phosphorus (about 828 lbs is dissolved) were calculated to have been added to Lake Catherine and Channel Lake by inflow of surface water from Trevor Creek and the unnamed creek during the period of investigation.

Nutrient loads to the lakes from inflow through storm drains were calculated by extrapolating the nutrient-load calculations developed from the transport curves at the FS gage to the ungaged drainage area for the storm drains (extrapolation factor of 7.34 for May through December and 2.5 for January through April) (tables 10, 19). About 4,116 lbs of nitrate and nitrite as total nitrogen, 2,854 lbs of TKN, (978 lbs is ammonia nitrogen), and about 646 lbs of total phosphorus (406 lbs is dissolved) were calculated to have been added to Lake Catherine and Channel Lake by inflow from storm drains during the period of investigation.

Nutrient loads to Lake Catherine and Channel Lake from inflow through the State Highway 173 bridge openings were calculated by taking the nutrient-load calculations developed from the transport curves at the CLE gage and adding 10 percent to account for the load at the west outlet (tables 12, 19). About 970 lbs of nitrate and nitrite as nitrogen, about 10,500 lbs of TKN, (about 2,580 lbs is ammonia nitrogen) and 510 lbs of total phosphorus (about 130 lbs is dissolved) were calculated to have been added to Lake Catherine and Channel Lake by inflow through the State Highway 173 bridge openings during the period of investigation.

The nutrient load exiting Lake Catherine and Channel Lake by outflow through the State Highway 173 bridge openings also was calculated by adding 10 percent to the nutrient load calculated from the transport curves developed from the CLE gage data (tables 12, 19). Calculations indicate about 4,000 lbs of nitrate and nitrite as nitrogen, about 44,950 lbs of TKN, (about 11,420 lbs is ammonia nitrogen), and about 2,060 lbs of total phosphorus (about 565 lbs is dissolved) were removed from Lake Catherine and

Table 20. Estimated nutrient loads from waterfowl to Lake Catherine and Channel Lake, near Antioch, Ill., May 1998–April 1999

[na, not applicable]

Type of waterfowl	Effective user days	Estimated daily load of nitrogen to lake from droppings (pound)	Estimated daily load of phosphorus to lake from droppings (pound)	Total nitrogen input (pound)	Total phosphorus input (pound)
		May 1998			
Ducks	62	0.0013	0.00081	0.081	0.05
Geese	46	.0040	.0025	.184	.115
Monthly total	108	na	na	0.265	0.165
		June 1998			
Ducks	12	.0013	.00081	.016	.0097
Geese	108	.004	.0025	.432	.27
Monthly total	120	na	na	0.448	0.2797
		July 1998			
Ducks	26	.0013	.00081	.034	.0211
Geese	796	.004	.0025	3.18	1.99
Monthly total	822	na	na	3.214	2.0111
		August 1998			
Ducks	62	.0013	.00081	.081	.0502
Geese	0	.004	.0025	.00	.00
Monthly total	62	na	na	0.081	0.0502
		September 1998			
Ducks	30	.0013	.00081	.039	.02
Geese	885	.004	.0025	3.54	2.21
Monthly total	915	na	na	3.579	2.23
		October 1998			
Ducks	174	.0013	.00081	.23	.14
Geese	980	.004	.0025	3.92	2.45
Monthly total	1,154	na	na	4.15	2.59
		November 1998			
Ducks	233	.0013	.00081	.30	.19
Geese	1,530	.004	.0025	6.12	3.83
Monthly total	1,763	na	na	6.42	4.02
		December 1998			
Ducks	101	.0013	.00081	.13	.08
Geese	3,232	.004	.0025	12.93	8.08
Monthly total	3,333	na	na	13.06	8.16
		January 1999			
Ducks	0	.0013	.00081	.00	.00
Geese	0	.004	.0025	.00	.00
Monthly total	0	na	na	0.00	0.00
		February 1999			
Ducks	0	.0013	.00081	.00	.00
Geese	0	.004	.0025	.00	.00
Monthly total	0	na	na	0.00	0.00
		March 1999			
Ducks	205	.0013	.00081	.27	.17
Geese	81	.004	.0025	.32	.20
Monthly total	286	na	na	0.59	0.37
		April 1999			
Ducks	45	.0013	.00081	.06	.04
Geese	20	.004	.0025	.08	.05
Monthly total	65	na	na	0.14	0.09
Annual total (May 1998–April 1999)	8,628	na	na	31.947	19.966

Table 21. Load of nutrients flowing into Lake Catherine and Channel Lake from ground water and flowing out of the lakes to ground water, near Antioch, Ill., May 1998–April 1999

[na, not applicable]

Period of calculation	Mean concentration of total nitrogen as nitrate and nitrite in ground water (milligram per liter)	Mean concentration of ammonia in ground water (milligram per liter)	Mean concentration of total Kjeldahl nitrogen in ground water (milligram per liter)	Mean concentration of dissolved phosphorus in ground water (milligram per liter)	Mean concentration of total phosphorus in ground water (milligram per liter)
May 1, 1998–April 30, 1999	0.047	0.275	0.692	0.0189	0.0698

Period of calculation	Volume of ground water flowing into the lake (acre-feet)	Load of total nitrogen as nitrate and nitrite to lakes from ground water (pounds)	Load of ammonia nitrogen to lakes from ground water (pounds)	Load of total Kjeldahl nitrogen to lakes from ground water (pounds)	Load of dissolved phosphorus to lakes from ground water (pounds)	Load of total phosphorus to lakes from ground water (pounds)
May 1, 1998–April 30, 1999	358.4	46	268	674	18	68

Period of calculation	Volume of lake water flowing out to ground water (acre-feet)	Mean concentration of nitrate and nitrite in lake water (milligram per liter)	Load of nitrate and nitrite to gound water from lake water (pounds)	Mean concentration of ammonia in lake water (milligram per liter)	Load of ammonia to ground water from lake water (pounds)	Mean concentration of total Kjeldahl nitrogen in lake water (milligrams per liter)	Load of total Kjeldahl nitrogen to ground water from lake water (pounds)	Mean concentration of total phosphorus in lake water (milligram per liter)	Load of total phosphorus to ground water from lake water (pounds)
May 1998	23	0.09	5	0.13	8	0.56	34	0.022	1
June 1998	46	.01	1	.01	1	.80	100	.107	13
July 1998	58	.01	1	.24	38	.86	136	.09	14
August 1998	118	.01	2	.36	116	.92	297	.112	36
September 1998	180	.01	2	.13	66	1.14	561	.05	25
October 1998	166	.02	10	.36	164	1.02	459	.045	21
November 1998	64	.06	10	.54	94	1.80	315	.14	24
December 1998	34	.50	46	.31	28	.71	65	.027	2
January 1999	52	.50	71	.52	73	1.60	226	.073	10
February 1999	47	.80	103	.91	117	1.20	154	.036	5
March 1999	20	.67	37	.90	50	.95	52	.033	2
April 1999	22	.36	21	.41	24	1.00	59	.031	2
Total	830	na	309	na	779	na	2,458	na	155

Channel Lake by outflow through the State Highway 173 bridge openings.

Internal Loads

If the concentration of dissolved oxygen in lake water above the bottom sediment falls below 2.0 mg/L, bacterially mediated anaerobic reduction of organic matter and chemical reduction of metal phosphate complexes can release dissolved phosphorus to the water column (Mortimer, 1971; Marsden, 1989). This process is called internal regeneration. Concentrations of dissolved oxygen at or below 1.0 mg/L were measured in the lower part of Lake Catherine and Channel Lake during most of the period from June 17 to August 11, 1998. Internal regeneration probably continued through mid-September 1998. An order of magnitude increase in concentrations of total or dissolved phosphorus near the bottom of Lake Catherine and Channel Lake was measured during this period (table 14). It appears, therefore, that phosphorus was being produced from internal regeneration during the investigation.

An internal dissolved-phosphorus regeneration rate of 1.07×10^{-1} lb/acre was assumed for each day that dissolved oxygen concentrations were less than 0.5 mg/L at the bottom of the lakes, on the basis of the median value reported from investigations at other lakes (Nurnberg, 1984). Analysis of the bathymetric and dissolved-oxygen profile data using ARC/INFO indicates the surface area of the bottom of Lake Catherine and Channel Lake, which is subject to anoxic conditions during the summer of 1998, averaged about 64 and 119 acres, respectively. Assuming anoxic conditions were present from about June 1 to September 15, 1998 (107 days), about 733 and 1,362 lbs of phosphorus are calculated to have been released to the water column of Lake Catherine and Channel Lake, respectively, by internal regeneration during the investigation for a calculated total of 2,095 lbs (table 19).

Internal regeneration of ammonia nitrogen from lake sediment and the decomposition of plant and animal matter (ammonification) also has been noted during periods when concentrations of dissolved oxygen are low (Keeney, 1973). The concentration of ammonia detected in samples collected near the bottom of Lake Catherine increased by more than an order of magnitude during the period of low dissolved oxygen. Comparison of dissolved oxygen concentrations for May 15 through August 11 in figure 14 to ammonia concentrations in the deep parts of the lakes for the same time period in table 14 indicates regeneration of nitrogen by ammonification was occurring in Lake Catherine and Channel Lake. If an internal regeneration rate of 1.07 (lbs/acre)/d is assumed, a total of 7,327 and 13,624 lbs of ammonia nitrogen was calculated to have been produced by internal regeneration in Lake Catherine and Channel Lake, respectively, for a calculated total of 20,951 lbs during the period of investigation.

Some nitrogen in the lake water is lost to the atmosphere by denitrification—the bacterially mediated utilization of nitrate or nitrite during the oxidation of organic matter. This process takes place in conditions of low dissolved oxygen concentrations and results in the formation of nitrogen gas (Goering and Dugdale, 1966). Because most lakes are saturated or nearly saturated with nitrogen gas, which can diffuse in from the atmosphere, all nitrogen produced by denitrification is assumed to be lost to the atmosphere by volatilization from the lake. The rate of denitrification at Lake Catherine and Channel Lake was assumed to be 0.033 (lb/acre)/d on the basis of values from other moderately eutrophic lakes reported by Seitzinger (1988). The amount of nitrogen gas calculated to have been produced by denitrification was 640 lbs (224 lbs for Lake Catherine and 416 lbs for Channel Lake) during the period of investigation (table 19).

Data obtained from this investigation indicate about 5,200 lbs of phosphorus and about 107,200 lbs of nitrogen compounds entered Lake Catherine and Channel Lake from May 1, 1998, to April 30, 1999 (table 19). Phosphorus compounds were derived primarily from internal regeneration (40.2 percent), inflow from surface water in the watershed (30.9 percent), inflow from storm drains (12.5 percent), and inflow through the State Highway 173 bridge openings (9.8 percent). Precipitation, inflow from ground water, waterfowl excrement, and particulate matter deposited from the atmosphere combined for 6.6 percent of the phosphorus load to the lakes. Nitrogen compounds were derived from inflow of surface water from within the watershed (52.9 percent), internal regeneration (19.5 percent), inflow through the State Highway 173 bridge openings (10.7 percent), precipitation (7 percent), and inflow from storm drains (6.5 percent). Inflowing ground water, waterfowl, and atmospheric deposition of particulate matter account for about 3.4 percent of the nitrogen load (table 19). About 2,220 lbs of total phosphorus and 52,300 lbs of nitrogen compounds were removed from Lake Catherine and Channel Lake from May 1, 1998, to April 30, 1999, primarily in outflow through the State Highway 173 bridge openings, resulting in an addition of more than 2,900 lbs of phosphorus and 54,800 lbs of nitrogen compounds to the lakes during the period of investigation.

Nitrogen and phosphorus compounds that enter Lake Catherine and Channel Lake are utilized by algae and aquatic macrophytes. The growth of these plants appears to be limited by the availability of phosphorus in the lake water. The amount of nutrients entering the lakes exceeds the amount exiting the lakes. Probably, some of the nutrient load is incorporated into plant material and attached to particulate matter. Investigations at other lakes (Barko and Smart, 1980: Smith and Adams, 1986) indicate nutrient-rich particulate matter and decaying plant material become part of the sediment at the lake bottom, where the nutrients appear to be recycled by rooted aquatic macrophytes, and released to the water column when dissolved oxygen concentrations are low.

The amount of phosphorus and nitrogen entering the lakes exceeds the amount exiting by about 2,900 and 54,800 lbs, respectively. The net addition of nutrients to the lakes may result in the proliferation of plants and algae that may eventually degrade the fishery and detract from the aesthetic quality of Lake Catherine and Channel Lake and other lakes in the Fox Chain of Lakes system.

SUMMARY AND CONCLUSIONS

The U.S. Geological Survey, in cooperation with the Fox Waterway Agency, conducted an investigation of the hydrology and water quality in and around Lake Catherine and Channel Lake near Antioch, in Lake County, Illinois, from May 1, 1998, to April 30, 1999. These lakes are part of the Fox Chain of Lakes system. This investigation was done as part of the Illinois Environmental Protection Agency's Conservation 2000 Clean Lakes initiative. The investigation was designed to provide the data that will form the basis for future lake-management strategies. Lake Catherine has a surface area of about 150 acres, a mean depth of about 16.7 feet (ft), and a volume of about 2,500 acre-feet (acre-ft). Channel Lake has a surface area of about 337 acres, a mean depth of about 14.5 ft, and a volume of about 4,895 acre-ft. The watershed for both lakes occupies an area of about 12,379 acres.

Lake Catherine and Channel Lake receive over 80 percent of their water by inflow from surface water in the watershed (almost 62 percent) and inflow through the State Highway 173 bridge openings (nearly 21 percent). Precipitation and inflow from storm drains account for slightly more than 15 percent of the water added to the lakes, and inflow to the lakes from ground water account for 2 percent of the water added to the lakes. More than 85 percent of the water removed from the lakes was outflow through the State Highway 173 bridge openings. Evaporation (about 7 percent) and outflow to ground water (5 percent) account for the remainder of the water removed from the lakes. The residence time of water in the lakes was calculated to be about 0.44 years. Trophic state indices indicate the lakes are marginally to moderately eutrophic. Phosphorus appears to be the limiting algal nutrient.

Lake Catherine and Channel Lake are subject to thermal stratification. During the summer stratification period, about 40 percent of the volume of water in the lakes had a dissolved oxygen concentration of less than 1.0 milligrams per liter (mg/L). Thermal stratification also was accompanied by large increases in the concentration of phosphorus and ammonia in the lower part of the lakes, indicating internal regeneration of these compounds from lake sediments during conditions of low dissolved oxygen. About 5,200 pounds (lbs) of phosphorus and 107,200 lbs of nitrogen compounds entered Lake Catherine and Channel Lake from May 1, 1998, through April 30, 1999. About 40 percent of the phosphorus compounds were derived from internal regeneration. Inflow to the lakes from surface water in the watershed and through the State Highway 173 bridge openings accounted for more than 40 percent of the phosphorus load. Inflow of water from storm drains accounted for 12.5 percent of the total phosphorus load. Particulate matter, precipitation, waterfowl, and inflowing ground water contribute about 6.6 percent of the phosphorus load to the lakes. The single largest source of nitrogen compounds to the lakes was inflow from surface water in the watershed (52.9 percent). Internal regeneration (19.5 percent), inflow of water through the State Highway 173 bridge openings (10.7 percent), precipitation (7.0 percent), and inflow from storm drains (6.5 percent) also contribute substantial quantities of nitrogen to the lakes. Particulate matter, waterfowl, and inflow of ground water combine to contribute about 3.4 percent of the nitrogen load to the lakes. About 2,220 lbs of phosphorus and 52,300 lbs of nitrogen compounds leave the lake, primarily by outflow through the State Highway 173 bridge opening, with substantially smaller amounts of outflow to ground water. A net addition of 2,981 lbs of phosphorus and 54,839 lbs of nitrogen was calculated entering the lake during the 1-year period of investigation. The net addition of nitrogen and phosphorus compounds in the lakes has the potential, over time, to stimulate algal and plant growth to nuisance levels that have the potential to affect the fishery and detract from the aesthetic quality of these lakes.

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APPENDIXES

Appendix 1. Calculated hydraulic properties in the geologic deposits along lines of flow transect near Lake Catherine and Channel Lake, near Antioch, Illinois, April 29, 1998–April 24, 1999

Table 1–1. Calculated hydraulic properties in the geologic deposits along lines of flow transect near Lake Catherine and Channel Lake, April 29, 1998–April 24, 1999

[negative sign (-) denotes flow from lake to ground water]

Line and direction of flow (figure 2)	Ground-water level (feet above sea level)	Lake stage (feet above sea level)	Ground-water level-lake stage (feet)	Length of flow line (feet)	Horizontal hydraulic gradient (foot per foot)	Horizontal hydraulic conductivity (feet per day)	Product of horizontal hydraulic gradient and horizontal hydraulic conductivity (feet squared per day)	Length of lakeshore through which flow is occurring along flow transect (feet)	Depth of lake (feet)	Area of lake through which flow is occurring along flow transect (square feet)	Specific discharge (cubic feet per day)	Volume of flow along flow transect between measurement periods (cubic feet)
						April 29, 1998						
Well 1-Lake	741.38	737.52	3.86	230	0.0168	0.0197	0.000331	6,000	39	234,000	77	155
Well 3-Lake	739.27	737.52	1.75	83	.0211	36	.759	7,925	36	285,300	216,553	433,106
Well 4-Lake	745.78	737.52	8.26	300	.0275	.0197	.000542	1,500	39	58,500	32	63
Well 5-Lake	739.50	737.52	1.98	149	.0133	.0197	.000262	3,700	39	144,300	38	76
Well 6-Lake	745.46	737.52	7.94	133	.0597	.0197	.00118	3,200	36	115,200	135	271
Well 7-Lake	741.60	737.52	4.08	210	.0194	.0197	.000383	5,100	36	183,600	70	141
Lake-Well 8	736.03	737.52	-1.49	4.8	-.310	36	-11.175	75	36	2,700	-30,173	-60,345
						May 3, 1998						
Well 1-Lake	741.00	737.30	3.70	230	0.0161	0.0197	0.000317	6,000	39	234,000	74	222
Well 3-Lake	738.31	737.30	1.01	83	.0122	36	.4381	7,925	36	285,300	124,982	374,946
Well 4-Lake	745.96	737.30	8.66	300	.0289	.0197	.000569	1,500	39	58,500	33	100
Well 5-Lake	739.39	737.30	2.09	149	.014	.0197	.000276	3,700	39	144,300	40	120
Well 6-Lake	745.02	737.30	7.72	133	.058	.0197	.00114	3,200	36	115,200	132	395
Well 7-Lake	741.11	737.30	3.81	210	.0181	.0197	.000357	5,100	36	183,600	66	197
Lake-Well 8	735.96	737.30	-1.34	4.8	-.27917	36	-10.05	75	36	2,700	-27,135	-81,405.
						May 9, 1998						
Well 1-Lake	741.49	737.62	3.87	230	0.0168	0.0197	0.000331	6,000	39.4	236,400	78	470
Well 3-Lake	738.47	737.62	.85	83	.0102	36	.3687	7,925	36.4	288,470	106,352	638,110
Well 4-Lake	746.23	737.62	8.61	300	.0287	.0197	.0006	1,500	39.4	59,100	33	200
Well 5-Lake	740.15	737.62	2.53	149	.017	.0197	.0003	3,700	39.4	145,780	49	293
Well 6-Lake	744.67	737.62	7.05	133	.053	.0197	.001	3,200	36.4	116,480	122	730
Well 7-Lake	741.19	737.62	3.57	210	.017	.0197	.0003	5,100	36.4	185,640	62	373
Lake-Well 8	736.13	737.62	-1.49	4.8	-.3104	36	-11.175	75	36.4	2,730	-30,508	-183,047

Table 1–1. Calculated hydraulic properties in the geologic deposits along lines of flow transect near Lake Catherine and Channel Lake, April 29, 1998–April 24, 1999—Continued

Line and direction of flow (figure 2)	Ground-water level (feet above sea level)	Lake stage (feet above sea level)	Ground-water level-lake stage (feet)	Length of flow line (feet)	Horizontal hydraulic gradient (foot per foot)	Horizontal hydraulic conductivity (feet per day)	Product of horizontal hydraulic gradient and horizontal hydraulic conductivity (feet squared per day)	Length of lakeshore through which flow is occurring along flow transect (feet)	Depth of lake (feet)	Area of lake through which flow is occurring along flow transect (square feet)	Specific discharge (cubic feet per day)	Volume of flow along flow transect between measurement periods (cubic feet)
						May 16, 1998						
Well 1-Lake	741.02	737.59	3.43	230	0.0149	0.0197	0.000294	6,000	38.8	232,800	68	479
Well 3-Lake	738.46	737.59	.87	83	.0105	36	.3773	7,925	35.8	283,715	107,060	749,418
Well 4-Lake	746.02	737.59	8.43	300	.0281	.0197	.0006	1,500	38.8	58,200	32	226
Well 5-Lake	739.19	737.59	1.60	149	.0107	.0197	.0002	3,700	38.8	143,560	30	213
Well 6-Lake	744.75	737.59	7.16	133	.0538	.0197	.0011	3,200	35.8	114,560	121	850
Well 7-Lake	741.49	737.59	3.90	210	.0186	.0197	.0004	5,100	35.8	182,580	67	468
Lake-Well 8	736.07	737.59	-1.52	4.8	-.3167	36	-11.4	75	35.8	2,685	-30,609	-214,263
						May 21, 1998						
Well 1-Lake	740.68	737.19	3.49	230	0.0152	0.0197	0.000299	6,000	39.5	237,000	71	354
Well 3-Lake	738.18	737.19	.99	83	.0119	36	.4294	7,925	36.5	289,263	124,209	621,043
Well 4-Lake	745.34	737.19	8.15	300	.0272	.0197	.0005	1,500	39.5	59,250	32	159
Well 5-Lake	737.90	737.19	.71	149	.0048	.0197	.0001	3,700	39.5	146,150	14	69
Well 6-Lake	743.86	737.19	6.67	133	.0502	.0197	.001	3,200	36.5	116,800	115	577
Well 7-Lake	740.83	737.19	3.64	210	.0173	.0197	.0003	5,100	36.5	186,150	64	318
Lake-Well 8	735.71	737.19	-1.48	4.8	-.3083	36	-11.1	75	36.5	2,738	-30,386	-151,931
						May 30, 1998						
Well 1-Lake	737.42	737.21	0.21	230	0.0009	0.0197	0.000018	6,000	38.9	233,400	4	38
Well 3-Lake	737.88	737.21	.67	83	.0081	36.	.2906	7,925	35.9	284,508	82,679	744,107
Well 4-Lake	741.30	737.21	4.09	300	.0136	.0197	.0003	1,500	38.9	58,350	16	141
Lake-Well 5	737.19	737.21	-.02	149	-.0001	.0197	-.000003	3,700	38.9	143,930	-.4	-3
Well 6-Lake	744.13	737.21	6.92	133	.052	.0197	.001	3,200	35.9	114,880	118	1,060
Well 7-Lake	739.42	737.21	2.21	210	.0105	.0197	.0002	5,100	35.9	183,090	38	342
Lake-Well 8	735.54	737.21	-1.67	4.8	-.3479	36	-12.525	75	35.9	2,693	-33,724	-303,512
						June 6, 1998						
Well 1-Lake	739.56	737.18	2.38	230	0.0103	0.0197	0.000204	6,000	39	234,000	48	334
Well 3-Lake	744.23	737.18	7.05	83	.0849	36	3.0578	7,925	36	285,300	872,399	6,106,795
Well 4-Lake	744.23	737.18	7.05	300	.0235	.0197	.0005	1,500	39	58,500	27	190
Well 5-Lake	737.20	737.18	.02	149	.0001	.0197	.0	3,700	39	144,300	0	3
Well 6-Lake	744.24	737.18	7.06	133	.0531	.0197	.001	3,200	36	115,200	120	843
Well 7-Lake	739.25	737.18	2.07	210	.0099	.0197	.0002	5,100	36	183,600	36	250
Lake-Well 8	735.36	737.18	-1.82	4.8	-.3792	36	-13.65	75	36	2,700	-36,855	-257,985

Table 1–1. Calculated hydraulic properties in the geologic deposits along lines of flow transect near Lake Catherine and Channel Lake, April 29, 1998–April 24, 1999—Continued

Line and direction of flow (figure 2)	Ground-water level (feet above sea level)	Lake stage (feet above sea level)	Ground-water level-lake stage (feet)	Length of flow line (feet)	Horizontal hydraulic gradient (foot per foot)	Horizontal hydraulic conductivity (feet per day)	Product of horizontal hydraulic gradient and horizontal hydraulic conductivity (feet squared per day)	Length of lakeshore through which flow is occurring along flow transect (feet)	Depth of lake (feet)	Area of lake through which flow is occurring along flow transect (square feet)	Specific discharge (cubic feet per day)	Volume of flow along flow transect between measurement periods (cubic feet)
						June 13, 1998						
Well 1-Lake	739.83	737.35	2.48	230	0.0108	0.0197	0.000212	6,000	39.15	234,900	50	349
Well 3-Lake	737.63	737.35	.28	83	.0034	36	.1214	7,925	36.15	286,489	34,793	243,550
Well 4-Lake	744.71	737.35	7.36	300	.0245	.0197	.0005	1,500	39.15	58,725	28	199
Lake-Well 5	736.69	737.35	-.66	149	-.0044	.0197	-.0001	3,700	39.15	144,855	-13	-88
Well 6-Lake	745.51	737.35	8.16	133	.0614	.0197	.0012	3,200	36.15	115,680	140	979
Well 7-Lake	739.05	737.35	1.70	210	.0081	.0197	.0002	5,100	36.15	184,365	29	206
Lake-Well 8	735.43	737.35	-1.92	4.8	-.4	36	-14.4	75	36.15	2,711	-39,042	-273,294
						June 20, 1998						
Well 1-Lake	739.99	737.33	2.66	230	0.0116	0.0197	0.000228	6,000	39.15	234,900	54	375
Well 3-Lake	737.52	737.33	.19	83	.0023	36	.0824	7,925	36.15	286,489	23,609	165,266
Well 4-Lake	744.96	737.33	7.63	300	.0254	.0197	.0005	1,500	39.15	58,725	29	206
Lake-Well 5	736.39	737.33	-.94	149	-.0063	.0197	-.0001	3,700	39.15	144,855	-18	-126
Well 6-Lake	744.46	737.33	7.13	133	.0536	.0197	.0011	3,200	36.15	115,680	122	855
Well 7-Lake	738.85	737.33	1.52	210	.0072	.0197	.0001	5,100	36.15	184,365	26	184
Lake-Well 8	735.24	737.33	-2.09	4.8	-.4354	36	-15.675	75	36.15	2,711	-42,499	-297,492
						June 27, 1998						
Well 1-Lake	740.41	737.53	2.88	230	0.0125	0.0197	0.000247	6,000	39.3	235,800	58	407
Lake-Well 3	737.43	737.53	-.10	83	-.0012	36	-.0434	7,925	36.3	287,678	-12,478	-87,343
Well 4-Lake	745.91	737.53	8.38	300	.0279	.0197	.0006	1,500	39.3	58,950	32	227
Lake-Well 5	736.46	737.53	-1.07	149	-.0072	.0197	-.0001	3,700	39.3	145,410	-21	-144
Well 6-Lake	745.39	737.53	7.86	133	.0591	.0197	.0012	3,200	36.3	116,160	135	947
Well 7-Lake	738.89	737.53	1.36	210	.0065	.0197	.0001	5,100	36.3	185,130	24	165
Lake-Well 8	735.27	737.53	-2.26	4.8	-.4708	36	-16.95	75	36.3	2,723	-46,146	-323,025
						July 5, 1998						
Well 1-Lake	740.71	737.66	3.05	230	0.0133	0.0197	0.000261	6,000	39.4	236,400	62	494
Lake-Well 3	737.46	737.66	-.20	83	-.0024	36	-.0867	7,925	36.4	288,470	-25,024	-200,191
Well 4-Lake	745.99	737.66	8.33	300	.0278	.0197	.0005	1,500	39.4	59,100	32	259
Lake-Well 5	736.77	737.66	-.89	149	-.006	.0197	-.0001	3,700	39.4	145,780	-17	-137
Well 6-Lake	744.90	737.66	7.24	133	.0544	.0197	.0011	3,200	36.4	116,480	125	999
Well 7-Lake	739.27	737.66	1.61	210	.0077	.0197	.0002	5,100	36.4	185,640	28	224
Lake-Well 8	735.42	737.66	-2.24	4.8	-.4667	36	-16.8	75	36.4	2,730	-45,864	-366,912

Table 1–1. Calculated hydraulic properties in the geologic deposits along lines of flow transect near Lake Catherine and Channel Lake, April 29, 1998–April 24, 1999—Continued

Line and direction of flow (figure 2)	Ground-water level (feet above sea level)	Lake stage (feet above sea level)	Ground-water level-lake stage (feet)	Length of flow line (feet)	Horizontal hydraulic gradient (foot per foot)	Horizontal hydraulic conductivity (feet per day)	Product of horizontal hydraulic gradient and horizontal hydraulic conductivity (feet squared per day)	Length of lakeshore through which flow is occurring along flow transect (feet)	Depth of lake (feet)	Area of lake through which flow is occurring along flow transect (square feet)	Specific discharge (cubic feet per day)	Volume of flow along flow transect between measurement periods (cubic feet)
						July 13, 1998						
Well 1-Lake	739.51	737.13	2.38	230	0.0103	0.0197	0.000204	6,000	39	234,000	48	382
Well 3-Lake	737.28	737.13	.15	83	.0018	36	.0651	7,925	36	285,300	18,562	148,493
Well 4-Lake	744.96	737.13	7.83	300	.0261	.0197	.0005	1,500	39	58,500	30	241
Lake-Well 5	736.14	737.13	-.99	149	-.0066	.0197	-.0001	3,700	39	144,300	-19	-151
Well 6-Lake	743.69	737.13	6.56	133	.0493	.0197	.001	3,200	36	115,200	112	895
Well 7-Lake	738.70	737.13	1.57	210	.0075	.0197	.0001	5,100	36	183,600	27	216
Lake-Well 8	734.96	737.13	-2.17	4.8	-.4521	36	-16.275	75	36	2,700	-43,942	-351,540
						July 19, 1998						
Well 1-Lake	739.11	737.18	1.93	230	0.00839	0.0197	0.000165	6,000	39	234,000	39	232
Lake-Well 3	737.12	737.18	-.06	83	-.000723	36	-.026	7,925	36	285,300	-7,425	-44,548
Well 4-Lake	744.25	737.18	7.07	300	.0236	.0197	.0005	1,500	39	58,500	27	163
Lake-Well 5	735.36	737.18	-1.82	149	-.0122	.0197	-.0002	3,700	39	144,300	-35	-208
Well 6-Lake	743.15	737.18	5.97	133	.0449	.0197	.0009	3,200	36	115,200	102	611
Well 7-Lake	738.54	737.18	1.36	210	.00648	.0197	.0001	5,100	36	183,600	23	141
Lake-Well 8	734.77	737.18	-2.41	4.8	-.502	36.	-18.075	75	36	2,700	-48,802	-292,815
						July 25, 1998						
Well 1-Lake	739.04	737.20	1.84	230	0.0080	0.0197	0.000158	6,000	39	234,000	37	221
Lake-Well 3	736.90	737.20	-.30	83	-.0036	36	-.1301	7,925	36	285,300	-37,123	-222,740
Well 4-Lake	744.45	737.20	7.25	300	.0242	.0197	.0005	1,500	39	58,500	28	167
Lake-Well 5	735.08	737.20	-2.12	149	-.0142	.0197	-.0003	3,700	39	144,300	-40	-243
Well 6-Lake	742.97	737.20	5.77	133	.0434	.0197	.0009	3,200	36	115,200	98	591
Well 7-Lake	738.27	737.20	1.07	210	.0051	.0197	.0001	5,100	36	183,600	18	111
Lake-Well 8	734.70	737.20	-2.50	4.8	-.5208	36	-18.75	75	36	2,700	-50,625	-303,750
						August 1, 1998						
Well 1-Lake	738.79	737.05	1.74	230	0.0076	0.0197	0.000149	6,000	38.85	233,100	35	243
Lake-Well 3	736.63	737.05	-.42	83	-.0051	36	-.1822	7,925	35.85	284,111	-51,756	-362,293
Well 4-Lake	743.84	737.05	6.79	300	.0226	.0197	.0004	1,500	38.85	58,275	26	182
Lake-Well 5	734.61	737.05	-2.44	149	-.0164	.0197	-.0003	3,700	38.85	143,745	-46	-325
Well 6-Lake	742.41	737.05	5.36	133	.0403	.0197	.0008	3,200	35.85	114,720	91	638
Well 7-Lake	737.97	737.05	.92	210	.0044	.0197	.0001	5,100	35.85	182,835	16	110
Lake-Well 8	734.33	737.05	-2.72	4.8	-.5667	36	-20.4	75	35.85	2,689	-54,850	-383,953

Table 1–1. Calculated hydraulic properties in the geologic deposits along lines of flow transect near Lake Catherine and Channel Lake, April 29, 1998–April 24, 1999—Continued

Line and direction of flow (figure 2)	Ground-water level (feet above sea level)	Lake stage (feet above sea level)	Ground-water level-lake stage (feet)	Length of flow line (feet)	Horizontal hydraulic gradient (foot per foot)	Horizontal hydraulic conductivity (feet per day)	Product of horizontal hydraulic gradient and horizontal hydraulic conductivity (feet squared per day)	Length of lakeshore through which flow is occurring along flow transect (feet)	Depth of lake (feet)	Area of lake through which flow is occurring along flow transect (square feet)	Specific discharge (cubic feet per day)	Volume of flow along flow transect between measurement periods (cubic feet)
						August 8, 1998						
Well 1-Lake	739.07	737.35	1.72	230	0.0075	0.0197	0.000147	6,000	39.15	234,900	35	242
Lake-Well 3	736.49	737.35	-.86	83	-.0104	36	-.373	7,925	36.15	286,489	-106,864	-748,046
Well 4-Lake	744.62	737.35	7.27	300	.0242	.0197	.000477	1,500	39.15	58,725	28	196
Lake-Well 5	734.60	737.35	-2.75	149	-.0185	.0197	-.000364	3,700	39.15	144,855	-53	-369
Well 6-Lake	743.72	737.35	6.37	133	.0479	.0197	.000944	3,200	36.15	115,680	109	764
Well 7-Lake	737.70	737.35	.35	210	.0017	.0197	.0000328	5,100	36.15	184,365	6	42
Lake-Well 8	734.46	737.35	-2.89	4.8	-.6021	36	-21.7	75	36.15	2,711	-58,766	-411,364
						August 15, 1998						
Well 1-Lake	738.80	737.23	1.57	230	0.0068	0.0197	0.000134	6,000	39	234,000	31	220
Lake-Well 3	736.39	737.23	-.84	83	-.0101	36	-.364	7,925	36	285,300	-103,945	-727,618
Well 4-Lake	743.57	737.23	6.34	300	.0211	.0197	.000416	1,500	39	58,500	24	170
Lake-Well 5	733.98	737.23	-3.25	149	-.0218	.0197	-.000430	3,700	39	144,300	-62	-434
Well 6-Lake	742.66	737.23	5.43	133	.0408	.0197	.000804	3,200	36	115,200	93	649
Well 7-Lake	737.56	737.23	.33	210	.0016	.0197	.000031	5,100	36	183,600	6	40
Lake-Well 8	734.36	737.23	-2.87	4.8	-.5979	36	-21.5	75	36	2,700	-58,118	-406,823
						August 22, 1998						
Well 1-Lake	738.59	737.16	1.43	230.	0.0062	0.0197	0.000122	6,000	39	234,000	29	201
Lake-Well 3	736.19	737.16	-.97	83	-.0117	36	-.421	7,875	36	283,500	-119,275	-834,925
Well 4-Lake	742.86	737.16	5.70	300	.019	.0197	.000374	1,500	39	58,500	22	153
Lake-Well 5	733.66	737.16	-3.50	149	-.0235	.0197	-.000463	3,700	39	144,300	-67	-467
Well 6-Lake	741.86	737.16	4.70	133	.0353	.0197	.000696	3,200	36	115,200	80	561
Well 7-Lake	737.44	737.16	.28	210	.0013	.0197	.0000263	5,100	36	183,600	5	34
Lake-Well 8	734.13	737.16	-3.03	4.8	-.6312	36	-22.7	125	36	4,500	-102,262	-715,837
						August 29, 1998						
Well 1-Lake	739.30	737.33	1.97	230	0.0086	0.0197	0.000169	6,000	39.1	234,600	40	277
Lake-Well 3	736.15	737.33	-1.18	83	-.0142	36	-.512	7,875	36.1	284,288	-145,500	-1,018,503
Well 4-Lake	744.79	737.33	7.46	300	.0249	.0197	.000490	1,500	39.1	58,650	29	201
Lake-Well 5	733.80	737.33	-3.53	149	-.0237	.0197	-.000467	3,700	39.1	144,670	-68	-473
Well 6-Lake	743.33	737.33	6.00	133	.0451	.0197	.000889	3,200	36.1	115,520	103	719
Lake-Well 7	737.30	737.33	-.03	210	-.0001	.0197	-.00000281	5,100	36.1	184,110	-1	-4
Lake-Well 8	734.32	737.33	-3.01	4.8	-.6271	36	-22.6	125	36.1	4,513	-101,870	-713,088

Table 1–1. Calculated hydraulic properties in the geologic deposits along lines of flow transect near Lake Catherine and Channel Lake, April 29, 1998–April 24, 1999—Continued

Line and direction of flow (figure 2)	Ground-water level (feet above sea level)	Lake stage (feet above sea level)	Ground-water level-lake stage (feet)	Length of flow line (feet)	Horizontal hydraulic gradient (foot per foot)	Horizontal hydraulic conductivity (feet per day)	Product of horizontal hydraulic gradient and horizontal hydraulic conductivity (feet squared per day)	Length of lakeshore through which flow is occurring along flow transect (feet)	Depth of lake (feet)	Area of lake through which flow is occurring along flow transect (square feet)	Specific discharge (cubic feet per day)	Volume of flow along flow transect between measurement periods (cubic feet)
September 5, 1998												
Well 1-Lake	738.68	737.17	1.51	230	0.0066	0.0197	0.000129	6,000	39	234,000	30	212
Lake-Well 3	736.04	737.17	-1.13	83	-.0136	36	-.490	7,875	36	283,500	-138,949	-972,644
Well 4-Lake	743.39	737.17	6.22	300	.0207	.0197	.000408	1,500	39	58,500	24	167
Lake-Well 5	733.52	737.17	-3.65	149	-.0245	.0197	-.000483	3,700	39	144,300	-70	-487
Well 6-Lake	742.19	737.17	5.02	133	.0377	.0197	.000744	3,200	36	115,200	86	600
Lake-Well 7	737.10	737.17	-.07	210	-.0003	.0197	-.0000656	5,100	36	183,600	-12	-84
Lake-Well 8	734.09	737.17	-3.08	4.8	-.6417	36	-23.1	125	36	4,500	-103,950	-727,650
September 12, 1998												
Well 1-Lake	738.60	737.12	1.48	230	0.0064	0.0197	0.000127	6,000	38.95	233,700	30	207
Lake-Well 3	735.92	737.12	-1.20	83	-.0145	36	-.520	7,875	35.95	283,106	-147,352	-1,031,462
Well 4-Lake	742.93	737.12	5.81	300	.0194	.0197	.000382	1,500	38.95	58,425	22	156
Lake-Well 5	733.53	737.12	-3.59	149	-.0241	.0197	-.000475	3,700	38.95	144,115	-68	-479
Well 6-Lake	741.79	737.12	4.67	133	.0351	.0197	.000692	3,200	35.95	115,040	80	557
Lake-Well 7	736.96	737.12	-.16	210	-.0008	.0197	-.0000150	5,100	35.95	183,345	-3	-19
Lake-Well 8	733.80	737.12	-3.32	4.8	-.6917	36	-24.9	125	35.95	4,494	-111,894	-783,261
September 19, 1998												
Well 1-Lake	739.76	737.26	2.50	230	0.0109	0.0197	0.000214	6,000	39.05	234,300	50	351
Lake-Well 3	735.97	737.26	-1.29	83	-.0155	36	-.560	7,875	36.05	283,894	-158,844	-1,111,906
Well 4-Lake	745.18	737.26	7.92	300	.0264	.0197	.000520	1,500	39.05	58,575	30	213
Lake-Well 5	733.98	737.26	-3.28	149	-.022	.0197	-.000434	3,700	39.05	144,485	-63	-439
Well 6-Lake	743.54	737.26	6.28	133	.0472	.0197	.000930	3,200	36.05	115,360	107	751
Lake-Well 7	736.94	737.26	-.32	210	-.0015	.0197	.00003	5,100	36.05	183,855	6	39
Lake-Well 8	734.12	737.26	-3.14	4.8	-.6542	36	-23.5	125	36.05	4,506	-106,122	-742,855
September 26, 1998												
Well 1-Lake	739.08	737.19	1.89	230	0.0082	0.0197	0.000162	6,000	39	234,000	38	265
Lake-Well 3	735.86	737.19	-1.33	83	-.016	36	-.577	7,875	36	283,500	-163,542	-1,144,793
Well 4-Lake	744.51	737.19	7.32	300	.0244	.0197	.000481	1,500	39	58,500	28	197
Lake-Well 5	734.08	737.19	-3.11	149	-.0209	.0197	-.000411	3,700	39	144,300	-59	-415
Well 6-Lake	742.82	737.19	5.63	133	.0423	.0197	.000834	3,200	36	115,200	96	672
Lake-Well 7	736.80	737.19	-.39	210	-.0019	.0197	-.0000366	5,100	36	183,600	-7	-47
Lake-Well 8	733.99	737.19	-3.20	4.8	-.6667	36	-24	125	36	4,500	-108,000	-756,000

Table 1–1. Calculated hydraulic properties in the geologic deposits along lines of flow transect near Lake Catherine and Channel Lake, April 29, 1998–April 24, 1999—Continued

Line and direction of flow (figure 2)	Ground-water level (feet above sea level)	Lake stage (feet above sea level)	Ground-water level-lake stage (feet)	Length of flow line (feet)	Horizontal hydraulic gradient (foot per foot)	Horizontal hydraulic conductivity (feet per day)	Product of horizontal hydraulic gradient and horizontal hydraulic conductivity (feet squared per day)	Length of lakeshore through which flow is occurring along flow transect (feet)	Depth of lake (feet)	Area of lake through which flow is occurring along flow transect (square feet)	Specific discharge (cubic feet per day)	Volume of flow along flow transect between measurement periods (cubic feet)
						October 4, 1998						
Well 1-Lake	739.84	737.09	2.75	230	0.0120	0.0197	0.000236	6,000	38.9	233,400	55	440
Lake-Well 3	735.78	737.09	-1.31	83	-.0158	36	-.568	7,875	35.9	282,713	-160,635	-1,285,082
Well 4-Lake	744.87	737.09	7.78	300	.0259	.0197	.000511	1,500	38.9	58,350	30	238
Lake-Well 5	734.01	737.09	-3.08	149	-.0207	.0197	-.000407	3,700	38.9	143,930	-59	-469
Well 6-Lake	743.26	737.09	6.17	133	.0464	.0197	.000914	3,200	35.9	114,880	105	840
Lake-Well 7	736.61	737.09	-.48	210	-.0023	.0197	-.0000450	5,100	35.9	183,090	-8	-66
Lake-Well 8	733.93	737.09	-3.16	4.8	-.6583	36	-23.7	125	35.9	4,488	-106,354	-850,830
						October 10, 1998						
Well 1-Lake	740.91	737.19	3.72	230	0.0162	0.0197	0.000319	6,000	39	234,000	75	447
Lake-Well 3	735.98	737.19	-1.21	83	-.0146	36	-.525	7,875	36	283,500	-148,786	-892,718
Well 4-Lake	745.11	737.19	7.92	300	.0264	.0197	.000520	1,500	39	58,500	30	183
Lake-Well 5	734.81	737.19	-2.38	149	-.016	.0197	-.000315	3,700	39	144,300	-45	-272
Well 6-Lake	744.19	737.19	7.00	133	.0526	.0197	.00104	3,200	36	115,200	119	717
Lake-Well 7	736.72	737.19	-.47	210	-.0022	.0197	-.0000440	5,100	36	183,600	-8	-48
Lake-Well 8	734.01	737.19	-3.18	4.8	-.6625	36	-23.9	125	36	4,500	-107,325	-643,950
						October 18, 1998						
Well 1-Lake	741.70	737.51	4.19	230	0.0182	0.0197	0.000359	6,000	39.4	236,400	85	679
Lake-Well 3	736.16	737.51	-1.35	83	-.0163	36	-.586	7,875	36.4	286,650	-167,846	-1,342,765
Well 4-Lake	745.52	737.51	8.01	300	.0267	.0197	.000526	1,500	39.4	59,100	31	249
Lake-Well 5	736.81	737.51	-.70	149	-.0047	.0197	-.0000922	3,700	39.4	145,780	-13	-108
Well 6-Lake	745.67	737.51	8.16	133	.0614	.0197	.00121	3,200	36.4	116,480	141	1,126
Lake-Well 7	736.75	737.51	-.76	210	-.0036	.0197	-.0000712	5,100	36.4	185,640	-13	-106
Lake-Well 8	734.40	737.51	-3.11	4.8	-.6479	36	-23.3	125	36.4	4,550	-106,129	-849,030
						October 24, 1998						
Well 1-Lake	740.57	737.22	3.35	230	0.0146	0.0197	0.000287	6,000	39	234,000	67	403
Lake-Well 3	736.29	737.22	-.93	83	-.0112	36	-.403	7,900	36	284,400	-114,719	-688,317
Well 4-Lake	745.60	737.22	8.38	300	.0279	.0197	.000550	1,500	39	58,500	32	193
Lake-Well 5	737.00	737.22	-.22	149	-.0015	.0197	-.0000291	3,700	39	144,300	-4	-25
Well 6-Lake	744.39	737.22	7.17	133	.0539	.0197	.00106	3,200	36	115,200	122	734
Lake-Well 7	737.02	737.22	-.20	210	-.001	.0197	-.0000187	5,100	36	183,600	-3	-21
Lake-Well 8	734.26	737.22	-2.96	4.8	-.6167	36	-22.2	100	36	3,600	-79,920	-479,520

Table 1–1. Calculated hydraulic properties in the geologic deposits along lines of flow transect near Lake Catherine and Channel Lake, April 29, 1998–April 24, 1999—Continued

Line and direction of flow (figure 2)	Ground-water level (feet above sea level)	Lake stage (feet above sea level)	Ground-water level-lake stage (feet)	Length of flow line (feet)	Horizontal hydraulic gradient (foot per foot)	Horizontal hydraulic conductivity (feet per day)	Product of horizontal hydraulic gradient and horizontal hydraulic conductivity (feet squared per day)	Length of lakeshore through which flow is occurring along flow transect (feet)	Depth of lake (feet)	Area of lake through which flow is occurring along flow transect (square feet)	Specific discharge (cubic feet per day)	Volume of flow along flow transect between measurement periods (cubic feet)
						October 31, 1998						
Well 1-Lake	740.61	737.14	3.47	230	0.0151	0.0197	0.000297	6,000	38.95	233,700	69	486
Lake-Well 3	736.30	737.14	-.84	83	-.0101	36	-.364	7,900	35.95	284,005	-103,474	-724,315
Well 4-Lake	745.52	737.14	8.38	300	.0279	.0197	.000550	1,500	38.95	58,425	32	225
Well 5-Lake	740.76	737.14	3.62	149	.0243	.0197	.000479	3,700	38.95	144,115	69	483
Well 6-Lake	744.88	737.14	7.74	133	.0582	.0197	.001146	3,200	35.95	115,040	132	923
Well 7-Lake	745.67	737.14	8.53	210	.0406	.0197	.000800	5,100	35.95	183,345	147	1,027
Lake-Well 8	734.25	737.14	-2.89	4.8	-.6021	36	-21.7	100	35.95	3,595	-77,922	-545,451
						November 7, 1998						
Well 1-Lake	739.93	736.79	3.14	230	0.0137	0.0197	0.000269	6,000	38.6	231,600	62	436
Lake-Well 3	736.19	736.79	-.60	83	-.0072	36	-.260	7,900	35.6	281,240	-73,190	-512,331
Well 4-Lake	744.82	736.79	8.03	300	.0268	.0197	.000527	1,500	38.6	57,900	31	214
Well 5-Lake	737.08	736.79	.29	149	.0019	.0197	.0000380	3,700	38.6	142,820	5	38
Well 6-Lake	744.23	736.79	7.44	133	.0559	.0197	.001102	3,200	35.6	113,920	126	879
Well 7-Lake	736.78	736.79	-.01	210	-.000048	.0197	-.000000938	5,100	35.6	181,560	0	-1
Lake-Well 8	734.03	736.79	-2.76	4.8	-.575	36	-20.7	100	35.6	3,560	-73,692	-515,844
						November 14, 1998						
Well 1-Lake	740.98	737.21	3.77	230	0.0164	0.0197	0.000323	6,000	37.8	226,800	73	513
Lake-Well 3	736.46	737.21	-.75	83	-.009	36	-.325	7,900	34.8	274,920	-89,432	-626,023
Well 4-Lake	745.78	737.21	8.57	300	.0286	.0197	.000563	1,500	37.8	56,700	32	223
Well 5-Lake	738.64	737.21	1.43	149	.0096	.0197	.000189	3,700	37.8	139,860	26	185
Well 6-Lake	745.08	737.21	7.87	133	.0592	.0197	.001166	3,200	34.8	111,360	130	909
Well 7-Lake	737.40	737.21	.19	210	.0009	.0197	.0000178	5,100	34.8	177,480	3	22
Lake-Well 8	734.45	737.21	-2.76	4.8	-.575	36	-20.7	100	34.8	3,480	-72,036	-504,252
						November 21, 1998						
Well 1-Lake	740.22	736.26	3.96	230	0.0172	0.0197	0.000339	6,000	38	228,000	77	541
Well 3-Lake	736.37	736.26	.11	83	.0013	36	.0477	7,900	35	276,500	13,192	92,344
Well 4-Lake	745.77	736.26	9.51	300	.0317	.0197	.000624	1,500	38	57,000	36	249
Well 5-Lake	737.76	736.26	1.50	149	.0101	.0197	.000198	3,700	38	140,600	28	195
Well 6-Lake	744.44	736.26	8.18	133	.0615	.0197	.00121	3,200	35	112,000	136	950
Well 7-Lake	737.30	736.26	1.04	210	.005	.0197	.0000976	5,100	35	178,500	17	122
Lake-Well 8	734.11	736.26	-2.15	4.8	-.4479	36	-16.1	100	35	3,500	-56,437	-395,062

Table 1–1. Calculated hydraulic properties in the geologic deposits along lines of flow transect near Lake Catherine and Channel Lake, April 29, 1998–April 24, 1999—Continued

Line and direction of flow (figure 2)	Ground-water level (feet above sea level)	Lake stage (feet above sea level)	Ground-water level-lake stage (feet)	Length of flow line (feet)	Horizontal hydraulic gradient (foot per foot)	Horizontal hydraulic conductivity (feet per day)	Product of horizontal hydraulic gradient and horizontal hydraulic conductivity (feet squared per day)	Length of lakeshore through which flow is occurring along flow transect (feet)	Depth of lake (feet)	Area of lake through which flow is occurring along flow transect (square feet)	Specific discharge (cubic feet per day)	Volume of flow along flow transect between measurement periods (cubic feet)
November 29, 1998												
Well 1-Lake	739.66	735.76	3.90	230	0.0170	0.0197	0.000334	6,000	37.6	225,600	75	603
Well 3-Lake	736.16	735.76	.40	83	.0048	36	.173	7,950	34.6	275,070	47,723	381,784
Well 4-Lake	745.66	735.76	9.90	300	.033	.0197	.000650	1,500	37.6	56,400	37	293
Well 5-Lake	737.44	735.76	1.68	149	.0113	.0197	.000222	3,700	37.6	139,120	31	247
Well 6-Lake	744.39	735.76	8.63	133	.0649	.0197	.00128	3,200	34.6	110,720	142	1,132
Well 7-Lake	737.21	735.76	1.45	210	.0069	.0197	.000136	5,100	34.6	176,460	24	192
Lake-Well 8	733.85	735.76	-1.91	4.8	-.3979	36	-14.3	50	34.6	1,730	-24,782	-198,258
December 5, 1998												
Well 1-Lake	740.20	735.71	4.49	230	0.0195	0.0197	0.000385	6,000	37.5	225,000	87	519
Well 3-Lake	736.20	735.71	.49	83	.0059	36	.213	7,950	34.5	274,275	58,292	349,750
Well 4-Lake	745.68	735.71	9.97	300	.0332	.0197	.000655	1,500	37.5	56,250	37	221
Well 5-Lake	737.72	735.71	2.01	149	.0135	.0197	.000266	3,700	37.5	138,750	37	221
Well 6-Lake	744.67	735.71	8.96	133	.0674	.0197	.00133	3,200	34.5	110,400	147	879
Well 7-Lake	737.14	735.71	1.43	210	.0068	.0197	.000134	5,100	34.5	175,950	24	142
Lake-Well 8	733.81	735.71	-1.90	4.8	-.3958	36	-14.3	50	34.5	1,725	-24,581	-147,488
December 12, 1998												
Well 1-Lake	740.86	736.06	4.80	230	0.0209	0.0197	0.000411	6,000	37.9	227,400	93	654
Well 3-Lake	736.29	736.06	.23	83	.0028	36	.0998	7,900	34.9	275,710	27,505	192,532
Well 4-Lake	745.83	736.06	9.77	300	.0326	.0197	.000642	1,500	37.9	56,850	36	255
Well 5-Lake	738.80	736.06	2.74	149	.0184	.0197	.000362	3,700	37.9	140,230	51	356
Well 6-Lake	744.93	736.06	8.87	133	.0667	.0197	.00131	3,200	34.9	111,680	147	1,027
Well 7-Lake	737.38	736.06	1.32	210	.0063	.0197	.000124	5,100	34.9	177,990	22	154
Lake-Well 8	734.02	736.06	-2.04	4.8	-.425	36	-15.3	100	34.9	3,490	-53,397	-373,779
December 19, 1998												
Well 1-Lake	740.27	735.8	4.47	230	0.0194	0.0197	0.000383	6,000	37.6	225,600	86	605
Well 3-Lake	736.22	735.8	.42	83	.0051	36	.182	7,900	34.6	273,340	49,794	348,558
Well 4-Lake	745.78	735.8	9.98	300	.0333	.0197	.000655	1,500	37.6	56,400	37	259
Well 5-Lake	738.08	735.8	2.28	149	.0153	.0197	.000301	3,700	37.6	139,120	42	294
Well 6-Lake	744.48	735.8	8.68	133	.0653	.0197	.00129	3,200	34.6	110,720	142	996
Well 7-Lake	737.26	735.8	1.46	210	.007	.0197	.000137	5,100	34.6	176,460	24	169
Lake-Well 8	733.90	735.8	-1.90	4.8	-.3958	36	-14.25	100	34.6	3,460	-49,305	-345,135

Table 1–1. Calculated hydraulic properties in the geologic deposits along lines of flow transect near Lake Catherine and Channel Lake, April 29, 1998–April 24, 1999—Continued

Line and direction of flow (figure 2)	Ground-water level (feet above sea level)	Lake stage (feet above sea level)	Ground-water level-lake stage (feet)	Length of flow line (feet)	Horizontal hydraulic gradient (foot per foot)	Horizontal hydraulic conductivity (feet per day)	Product of horizontal hydraulic gradient and horizontal hydraulic conductivity (feet squared per day)	Length of lakeshore through which flow is occurring along flow transect (feet)	Depth of lake (feet)	Area of lake through which flow is occurring along flow transect (square feet)	Specific discharge (cubic feet per day)	Volume of flow along flow transect between measurement periods (cubic feet)
December 26, 1998												
Well 1-Lake	739.87	735.7	4.17	230	0.0181	0.0197	0.000357	6,000	37.5	225,000	80	563
Well 3-Lake	736.04	735.7	.34	83	.0041	36	.147	7,900	34.5	272,550	40,193	281,350
Well 4-Lake	745.49	735.7	9.79	300	.0326	.0197	.000643	1,500	37.5	56,250	36	253
Well 5-Lake	737.50	735.7	1.80	149	.0121	.0197	.000238	3,700	37.5	138,750	33	231
Well 6-Lake	743.81	735.7	8.11	133	.061	.0197	.00120	3,200	34.5	110,400	133	928
Well 7-Lake	737.17	735.7	1.47	210	.007	.0197	.000138	5,100	34.5	175,950	24	170
Lake-Well 8	733.71	735.7	-1.99	4.8	-.4146	36	-14.9	100	34.5	3,450	-51,491	-360,439
January 16, 1999												
Well 1-Lake	740.00	735.65	4.35	230	0.0189	0.0197	0.000373	6,000	37.4	224,400	84	1,756
Well 3-Lake	735.74	735.65	.09	83	.0011	36	.0390	7,900	34.4	271,760	10,608	222,778
Well 4-Lake	744.77	735.65	9.12	300	.0304	.0197	.000599	1,500	37.4	56,100	34	706
Well 5-Lake	736.59	735.65	.94	149	.0063	.0197	.000124	3,700	37.4	138,380	17	361
Well 6-Lake	743.73	735.65	8.08	133	.0608	.0197	.00120	3,200	34.4	110,080	132	2,767
Well 7-Lake	737.90	735.65	2.25	210	.0107	.0197	.000211	5,100	34.4	175,440	37	778
Lake-Well 8	733.45	735.65	-2.20	4.8	-.4583	36	-16.5	100	34.4	3,440	-56,760	-1,191,960
January 24, 1999												
Well 1-Lake	740.00	735.62	4.38	230	0.0190	0.0197	0.000375	6,000	38.3	229,800	86	690
Well 3-Lake	736.30	735.62	.68	83	.0082	36	.295	7,950	35.3	280,635	82,770	662,163
Well 4-Lake	746.51	735.62	10.89	300	.0363	.0197	.000715	1,500	38.3	57,450	41	329
Well 5-Lake	739.17	735.62	3.55	149	.0238	.0197	.000469	3,700	38.3	141,710	67	532
Well 6-Lake	745.89	735.62	10.27	133	.0772	.0197	.00152	3,200	35.3	112,960	172	1,375
Well 7-Lake	737.64	735.62	2.02	210	.0096	.0197	.000189	5,100	35.3	180,030	34	273
Lake-Well 8	734.10	735.62	-1.52	4.8	-.3167	36	-11.4	50	35.3	1,765	-20,121	-160,968
January 30, 1999												
Well 1-Lake	741.22	737.37	3.85	230	0.0167	0.0197	0.000330	6,000	39.2	235,200	78	465
Lake-Well 3	736.60	737.37	-.77	83	-.0093	36	-.334	7,900	36.2	285,980	-95,510	-573,063
Well 4-Lake	746.41	737.37	9.04	300	.0301	.0197	.000594	1,500	39.2	58,800	35	209
Well 5-Lake	739.48	737.37	2.11	149	.0142	.0197	.000279	3,700	39.2	145,040	40	243
Well 6-Lake	745.54	737.37	8.17	133	.0614	.0197	.00121	3,200	36.2	115,840	140	841
Well 7-Lake	737.97	737.37	.60	210	.0029	.0197	.0000563	5,100	36.2	184,620	10	62
Lake-Well 8	734.58	737.37	-2.79	4.8	-.5812	36	-20.9	100	36.2	3,620	-75,748	-454,491

Table 1–1. Calculated hydraulic properties in the geologic deposits along lines of flow transect near Lake Catherine and Channel Lake, April 29, 1998–April 24, 1999—Continued

Line and direction of flow (figure 2)	Ground-water level (feet above sea level)	Lake stage (feet above sea level)	Ground-water level-lake stage (feet)	Length of flow line (feet)	Horizontal hydraulic gradient (foot per foot)	Horizontal hydraulic conductivity (feet per day)	Product of horizontal hydraulic gradient and horizontal hydraulic conductivity (feet squared per day)	Length of lakeshore through which flow is occurring along flow transect (feet)	Depth of lake (feet)	Area of lake through which flow is occurring along flow transect (square feet)	Specific discharge (cubic feet per day)	Volume of flow along flow transect between measurement periods (cubic feet)
February 6, 1999												
Well 1-Lake	741.52	737.67	3.85	230	0.0167	0.0197	0.000330	6,000	39.4	236,400	78	546
Lake-Well 3	736.94	737.67	-.73	83	-.0088	36	-.317	7,900	36.4	287,560	-91,049	-637,344
Well 4-Lake	746.51	737.67	8.84	300	.0295	.0197	.000580	1,500	39.4	59,100	34	240
Well 5-Lake	739.84	737.67	2.17	149	.0146	.0197	.000287	3,700	39.4	145,780	42	293
Well 6-Lake	745.79	737.67	8.12	133	.0611	.0197	.00120	3,200	36.4	116,480	140	981
Well 7-Lake	739.27	737.67	1.60	210	.0076	.0197	.000150	5,100	36.4	185,640	28	195
Lake-Well 8	735.03	737.67	-2.64	4.8	-.55	36	-19.8	100	36.4	3,640	-72,072	-504,504
February 13, 1999												
Well 1-Lake	741.33	737.37	3.96	230	0.0172	0.0197	0.000339	6,000	39.2	235,200	80	558
Well 3-Lake	737.38	737.37	.01	83	.0001	36	.00434	7,900	36.2	285,980	1,240	8,683
Well 4-Lake	746.46	737.37	9.09	300	.0303	.0197	.000597	1,500	39.2	58,800	35	246
Well 5-Lake	739.09	737.37	1.72	149	.0115	.0197	.000227	3,700	39.2	145,040	33	231
Well 6-Lake	745.33	737.37	7.96	133	.0598	.0197	.00118	3,200	36.2	115,840	137	956
Well 7-Lake	739.86	737.37	2.49	210	.0119	.0197	.000234	5,100	36.2	184,620	43	302
Lake-Well 8	735.16	737.37	-2.21	4.8	-.4604	36	-16.6	100	36.2	3,620	-60,002	-420,011
February 20, 1999												
Well 1-Lake	740.85	736.93	3.92	230	0.0170	0.0197	0.000336	6,000	38.8	232,800	78	547
Well 3-Lake	737.43	736.93	.50	83	.006	36	.217	7,950	35.8	284,610	61,723	432,059
Well 4-Lake	746.32	736.93	9.39	300	.0313	.0197	.000617	1,500	38.8	58,200	36	251
Well 5-Lake	739.02	736.93	2.09	149	.014	.0197	.000276	3,700	38.8	143,560	40	278
Well 6-Lake	744.92	736.93	7.99	133	.0601	.0197	.00118	3,200	35.8	114,560	136	949
Well 7-Lake	739.98	736.93	3.05	210	.0145	.0197	.000286	5,100	35.8	182,580	52	366
Lake-Well 8	735.09	736.93	-1.84	4.8	-.3833	36	-13.8	50	35.8	1,790	-24,702	-172,914
February 27, 1999												
Well 1-Lake	740.81	737.31	3.50	230	0.0152	0.0197	0.000300	6,000	38.1	228,600	69	480
Lake-Well 3	737.29	737.31	-.02	83	-.0002	36	-.00867	7,900	35.1	277,290	-2,405	-16,838
Well 4-Lake	746.21	737.31	8.90	300	.0297	.0197	.000584	1,500	38.1	57,150	33	234
Well 5-Lake	738.64	737.31	1.33	149	.0089	.0197	.000176	3,700	38.1	140,970	25	174
Well 6-Lake	745.53	737.31	8.22	133	.0618	.0197	.00122	3,200	35.1	112,320	137	957
Well 7-Lake	739.60	737.31	2.29	210	.0109	.0197	.000215	5,100	35.1	179,010	38	269
Lake-Well 8	734.89	737.31	-2.42	4.8	-.5042	36	-18.1	100	35.1	3,510	-63,706	-445,945

Table 1–1. Calculated hydraulic properties in the geologic deposits along lines of flow transect near Lake Catherine and Channel Lake, April 29, 1998–April 24, 1999—Continued

Line and direction of flow (figure 2)	Ground-water level (feet above sea level)	Lake stage (feet above sea level)	Ground-water level-lake stage (feet)	Length of flow line (feet)	Horizontal hydraulic gradient (foot per foot)	Horizontal hydraulic conductivity (feet per day)	Product of horizontal hydraulic gradient and horizontal hydraulic conductivity (feet squared per day)	Length of lakeshore through which flow is occurring along flow transect (feet)	Depth of lake (feet)	Area of lake through which flow is occurring along flow transect (square feet)	Specific discharge (cubic feet per day)	Volume of flow along flow transect between measurement periods (cubic feet)
						March 14, 1999						
Well 1-Lake	741.47	736.43	5.04	230	0.0219	0.0197	0.000432	6,000	38.2	229,200	99	1,484
Well 3-Lake	737.14	736.43	.71	83	.0086	36	.308	7,950	35.2	279,840	86,177	1,292,659
Well 4-Lake	746.14	736.43	9.71	300	.0324	.0197	.000638	1,500	38.2	57,300	37	548
Well 5-Lake	737.57	736.43	1.14	149	.0077	.0197	.000151	3,700	38.2	141,340	21	320
Well 6-Lake	745.34	736.43	8.91	133	.067	.0197	.00132	3,200	35.2	112,640	149	2,230
Well 7-Lake	737.68	736.43	1.25	210	.006	.0197	.000117	5,100	35.2	179,520	21	316
Lake-Well 8	734.81	736.43	-1.62	4.8	-.3375	36	-12.2	50	35.2	1,760	-21,384	-320,760
						March 20, 1999						
Well 1-Lake	741.00	737.10	3.90	230	0.0170	0.0197	0.000334	6,000	38.9	233,400	78	468
Well 3-Lake	737.17	737.10	.07	83	.0008	36	.0304	7,950	35.9	285,405	8,665	51,992
Well 4-Lake	745.23	737.10	8.13	300	.0271	.0197	.000534	1,500	38.9	58,350	31	187
Well 5-Lake	739.77	737.10	2.67	149	.0179	.0197	.000353	3,700	38.9	143,930	51	305
Well 6-Lake	745.24	737.10	8.14	133	.0612	.0197	.00121	3,200	35.9	114,880	139	831
Well 7-Lake	738.87	737.10	1.77	210	.0084	.0197	.000166	5,100	35.9	183,090	30	182
Lake-Well 8	735.09	737.10	-2.01	4.8	-.4187	36	-15.1	50	35.9	1,795	-27,060	-162,358
						March 28, 1999						
Well 1-Lake	740.42	737.06	3.36	230	0.0146	0.0197	0.000288	6,000	38.9	233,400	67	537
Well 3-Lake	737.37	737.06	.31	83	.0037	36	.134	7,950	35.9	285,405	38,375	306,999
Well 4-Lake	745.44	737.06	8.38	300	.0279	.0197	.000550	1,500	38.9	58,350	32	257
Well 5-Lake	738.88	737.06	1.82	149	.0122	.0197	.000241	3,700	38.9	143,930	35	277
Well 6-Lake	744.75	737.06	7.69	133	.0578	.0197	.00114	3,200	35.9	114,880	131	1,047
Well 7-Lake	739.20	737.06	2.14	210	.0102	.0197	.000201	5,100	35.9	183,090	37	294
Lake-Well 8	735.17	737.06	-1.89	4.8	-.3937	36	-14.2	50	35.9	1,795	-25,444	-203,553
						April 3, 1999						
Well 1-Lake	740.07	737.12	2.95	230	0.0128	0.0197	0.000253	6,000	38.9	233,400	59	354
Well 3-Lake	737.35	737.12	.23	83	.0028	36	.0998	7,900	35.9	283,610	28,293	169,756
Well 4-Lake	745.64	737.12	8.52	300	.0284	.0197	.000559	1,500	38.9	58,350	33	196
Well 5-Lake	738.56	737.12	1.44	149	.0097	.0197	.000190	3,700	38.9	143,930	27	164
Well 6-Lake	744.46	737.12	7.34	133	.0552	.0197	.00109	3,200	35.9	114,880	125	749
Well 7-Lake	739.12	737.12	2.00	210	.0095	.0197	.000188	5,100	35.9	183,090	34	206
Lake-Well 8	734.45	737.12	-2.67	4.8	-.5562	36	-20.0	100	35.9	3,590	-71,890	-431,338

Table 1–1. Calculated hydraulic properties in the geologic deposits along lines of flow transect near Lake Catherine and Channel Lake, April 29, 1998–April 24, 1999—Continued

Line and direction of flow (figure 2)	Ground-water level (feet above sea level)	Lake stage (feet above sea level)	Ground-water level-lake stage (feet)	Length of flow line (feet)	Horizontal hydraulic gradient (foot per foot)	Horizontal hydraulic conductivity (feet per day)	Product of horizontal hydraulic gradient and horizontal hydraulic conductivity (feet squared per day)	Length of lakeshore through which flow is occurring along flow transect (feet)	Depth of lake (feet)	Area of lake through which flow is occurring along flow transect (square feet)	Specific discharge (cubic feet per day)	Volume of flow along flow transect between measurement periods (cubic feet)
						April 9, 1999						
Well 1-Lake	741.74	737.08	4.66	230	0.0203	0.0197	0.000399	6,000	38.9	233,400	93	559
Well 3-Lake	737.44	737.08	.36	83	.0043	36	.156	7,950	35.9	285,405	44,564	267,387
Well 4-Lake	745.92	737.08	8.84	300	.0295	.0197	.000580	1,500	38.9	58,350	34	203
Well 5-Lake	740.56	737.08	3.48	149	.0234	.0197	.000460	3,700	38.9	143,930	66	397
Well 6-Lake	745.89	737.08	8.81	133	.0662	.0197	.00130	3,200	35.9	114,880	150	899
Well 7-Lake	739.10	737.08	2.02	210	.0096	.0197	.000189	5,100	35.9	183,090	35	208
Lake-Well 8	735.27	737.08	-1.81	4.8	-.3771	36	-13.6	50	35.9	1,795	-24,367	-146,203
						April 18, 1999						
Well 1-Lake	741.29	737.32	3.97	230	0.0173	0.0197	0.000340	6,000	39.1	234,600	80	718
Well 3-Lake	737.55	737.32	.23	83	.0028	36	.0998	7,950	36.1	286,995	28,630	257,673
Well 4-Lake	746.04	737.32	8.72	300	.0291	.0197	.000573	1,500	39.1	58,650	34	302
Well 5-Lake	739.84	737.32	2.52	149	.0169	.0197	.000333	3,700	39.1	144,670	48	434
Well 6-Lake	745.75	737.32	8.43	133	.0634	.0197	.00125	3,200	36.1	115,520	144	1,298
Well 7-Lake	739.42	737.32	2.10	210	.01	.0197	.000197	5,100	36.1	184,110	36	326
Lake-Well 8	735.48	737.32	-1.84	4.8	-.3833	36	-13.8	50	36.1	1,805	-24,909	-224,181
						April 24, 1999						
Well 1-Lake	741.30	737.81	3.49	230	0.0152	0.0197	0.000299	6,000	39.6	237,600	71	426
Well 3-Lake	738.05	737.81	.24	83	.0029	36	.104	7,950	36.6	290,970	30,289	212,022
Well 4-Lake	746.16	737.81	8.35	300	.0278	.0197	.000548	1,500	39.6	59,400	33	228
Well 5-Lake	740.16	737.81	2.35	149	.0158	.0197	.000311	3,700	39.6	146,520	46	319
Well 6-Lake	745.60	737.81	7.79	133	.0586	.0197	.00115	3,200	36.6	117,120	135	946
Well 7-Lake	740.67	737.81	2.86	210	.0136	.0197	.000268	5,100	36.6	186,660	50	351
Lake-Well 8	735.91	737.81	-1.90	4.8	-.3958	36	-14.2	50	36.6	1,830	-26,077	-182,542

Appendix 2. Constituent loads for Trevor Creek at the TC gage, the storm drain at the FS gage, and the east opening of Channel Lake at the CLE gage, near Antioch, Illinois, May 1998–April 1999

Table 2–1. Constituent load for Trevor Creek at the TC gage, near Antioch, May 1998–April 1999

[nd, not determined]

Date (month/day/year)	Mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (ton per day)	Load, volatile suspended solids (ton per day)
5/1/98	4.4	0.0162	0.001274	0.00778	0.000355	0.000695	0.218	0.0569
5/2/98	3.7	.0138	.001076	.0067	.000306	.000601	.183	.0479
5/3/98	3.2	.0120	.000934	.0059	.00027	.000532	.157	.0415
5/4/98	3	.0113	.000877	.0055	.000256	.000504	.147	.0390
5/5/98	2.9	.0109	.000848	.0054	.000248	.00049	.142	.0377
5/6/98	2.8	.0106	.00082	.0052	.000241	.000475	.137	.0364
5/7/98	12	.0418	.003394	.0189	.000836	.001616	.610	.153
5/8/98	15	.0516	.00422	.0230	.001011	.001949	.767	.191
5/9/98	9.6	.0339	.00273	.0155	.000691	.001339	.485	.123
5/10/98	7.2	.0258	.002061	.0120	.00054	.001052	.361	.0924
5/11/98	5.8	.0210	.001669	.0099	.000449	.000877	.290	.0747
5/12/98	4.9	.0179	.001416	.0086	.000389	.000761	.244	.0632
5/13/98	7.2	.0258	.002061	.0120	.00054	.001052	.361	.0924
5/14/98	6.1	.0221	.001753	.0104	.000469	.000915	.305	.0785
5/15/98	5.2	.0190	.00150	.0090	.000409	.0008	.259	.0671
5/16/98	4.4	.0162	.001274	.0078	.000355	.000695	.218	.0569
5/17/98	3.5	.0131	.001019	.0064	.000292	.000573	.173	.0454
5/18/98	3	.0113	.000877	.0055	.000256	.000504	.147	.0390
5/19/98	2.4	.0091	.000705	.0046	.000211	.000418	.117	.0313
5/20/98	2	.0077	.00059	.0039	.000181	.000358	.097	.0261
5/21/98	1.7	.0066	.000504	.0034	.000157	.000312	.082	.0223
5/22/98	1.6	.0062	.000475	.0032	.000149	.000297	.077	.0210
5/23/98	1.6	.0062	.000475	.0032	.000149	.000297	.077	.0210
5/24/98	2.3	.0088	.000677	.0044	.000204	.000403	.112	.0300
5/25/98	2.1	.0081	.000619	.0040	.000188	.000373	.102	.0274
5/26/98	1.7	.0066	.000504	.0034	.000157	.000312	.082	.0223
5/27/98	1.5	.0059	.000446	.0030	.000141	.000281	.072	.0197
5/28/98	1.4	.0055	.000417	.0028	.000133	.000265	.067	.0184
5/29/98	1.4	.0055	.000417	.0028	.000133	.000265	.067	.0184
5/30/98	1.2	.0048	.000358	.0025	.000117	.000233	.058	.0158
5/31/98	1.2	.0048	.000358	.0025	.000117	.000233	.058	.0158
Total	nd	0.4601	0.036348	0.219	0.0100	0.0195	6.28	1.62

Table 2–1. Constituent load for Trevor Creek at the TC gage, near Antioch, May 1998–April 1999—Continued

Date (month/day/year)	Mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (ton per day)	Load, volatile suspended solids (ton per day)
6/1/98	1.1	0.00438	0.000329	0.00228	0.000108	0.000217	0.0527	0.0145
6/2/98	1.0	.004	.000300	.00210	.000100	.000200	.0478	.0132
6/3/98	1.0	.00381	.000285	.00201	.0000957	.000192	.0454	.0125
6/4/98	.9	.00377	.000282	.00199	.0000949	.000190	.0449	.0124
6/5/98	1.0	.00396	.000297	.00208	.0000991	.000198	.0473	.0131
6/6/98	1.0	.004	.000300	.00210	.000100	.000200	.0478	.0132
6/7/98	.9	.00373	.000279	.00197	.0000940	.000188	.0444	.0123
6/8/98	.8	.00335	.000250	.00178	.0000853	.000171	.0395	.0110
6/9/98	.9	.00377	.000282	.00199	.0000949	.000190	.0449	.0124
6/10/98	1.0	.004	.000300	.00210	.000100	.000200	.0478	.0132
6/11/98	1.9	.00733	.000561	.00370	.000173	.000343	.0923	.0249
6/12/98	2.1	.00806	.000619	.00405	.000188	.000373	.1022	.0274
6/13/98	1.9	.00733	.000561	.00370	.000173	.000343	.0923	.0249
6/14/98	1.4	.0055	.000417	.00283	.000133	.000265	.0675	.0184
6/15/98	1.1	.00438	.000329	.00228	.000108	.000217	.0527	.0145
6/16/98	.9	.00362	.000271	.00191	.0000914	.000183	.0429	.0119
6/17/98	.8	.00324	.000241	.00172	.0000826	.000166	.0380	.0106
6/18/98	1.0	.004	.000300	.00210	.000100	.000200	.0478	.0132
6/19/98	1.4	.0055	.000417	.00283	.000133	.000265	.0675	.0184
6/20/98	.8	.00324	.000241	.00172	.0000826	.000166	.0380	.0106
6/21/98	.6	.00259	.000191	.00140	.0000674	.000136	.0298	.00837
6/22/98	.6	.00227	.000167	.00124	.0000600	.000121	.0259	.00732
6/23/98	.5	.00212	.000155	.00116	.0000563	.000114	.0240	.00680
6/24/98	.5	.00188	.000138	.00104	.0000505	.000102	.0211	.00601
6/25/98	.9	.00343	.000256	.00182	.0000870	.000174	.0405	.0112
6/26/98	2.1	.00806	.000619	.00405	.000188	.000373	.102	.0274
6/27/98	2.0	.0077	.000590	.00387	.000181	.000358	.0973	.0261
6/28/98	9.3	.03288	.00265	.0151	.000672	.00130	.4698	.119
6/29/98	4.3	.01586	.00125	.00762	.000348	.000682	.2131	.0556
6/30/98	2.9	.01094	.000848	.00538	.000248	.000490	.1423	.0377
Total	nd	0.17871	0.013725	0.0899	0.00420	0.00832	2.27	0.608

Table 2–1. Constituent load for Trevor Creek at the TC gage, near Antioch, May 1998–April 1999—Continued

Date (month/day/year)	Mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (ton per day)	Load, volatile suspended solids (ton per day)
7/1/98	2.1	0.00806	0.000619	0.00405	0.000188	0.000373	0.102	0.0274
7/2/98	1.5	.00587	.000446	.00300	.000141	.000281	.072	.0197
7/3/98	2.1	.00806	.000619	.00405	.000188	.000373	.102	.0274
7/4/98	2.7	.0102	.000791	.00505	.000234	.000461	.132	.0351
7/5/98	1.8	.00697	.000533	.00353	.000165	.000328	.0873	.0236
7/6/98	1.4	.00550	.000417	.00283	.000133	.000265	.0675	.0184
7/7/98	1.3	.00512	.000388	.00265	.000125	.000249	.0625	.0171
7/8/98	1.1	.00438	.000329	.00228	.000108	.000217	.0527	.0145
7/9/98	.91	.00366	.000274	.00193	.0000923	.000185	.0434	.0120
7/10/98	.76	.00309	.000229	.00165	.0000791	.000159	.0361	.0101
7/11/98	.63	.00259	.000191	.00140	.0000674	.000136	.0298	.00837
7/12/98	.51	.00212	.000155	.00116	.0000563	.000114	.0240	.00680
7/13/98	.4	.00168	.000123	.0009345	.0000457	.0000926	.0187	.00535
7/14/98	.25	.00108	.0000775	.0006168	.0000306	.0000623	.0115	.00337
7/15/98	.21	.000916	.0000654	.0005288	.0000264	.0000538	.00966	.00283
7/16/98	.17	.000750	.0000532	.0004387	.0000220	.0000451	.00778	.00230
7/17/98	.25	.00108	.0000775	.0006168	.0000306	.0000623	.0115	.00337
7/18/98	.21	.000916	.0000654	.0005288	.0000264	.0000538	.0097	.00283
7/19/98	.39	.00164	.000120	.0009138	.0000447	.0000906	.0182	.00522
7/20/98	.26	.00112	.0000805	.0006386	.0000316	.0000644	.0120	.00350
7/21/98	.25	.00108	.0000775	.0006168	.0000306	.0000623	.0115	.00337
7/22/98	.22	.000957	.0000684	.0005501	.0000274	.0000560	.0101	.00297
7/23/98	.16	.000708	.0000501	.0004158	.0000209	.0000428	.00731	.00217
7/24/98	.12	.000540	.0000379	.0003225	.0000163	.0000336	.00544	.00163
7/25/98	.12	.000540	.0000379	.0003225	.0000163	.0000336	.00544	.00163
7/26/98	.12	.000540	.0000379	.0003225	.0000163	.0000336	.00544	.00163
7/27/98	.12	.000540	.0000379	.0003225	.0000163	.0000336	.00544	.00163
7/28/98	.12	.000540	.0000379	.0003225	.0000163	.0000336	.00544	.00163
7/29/98	.12	.000540	.0000379	.0003225	.0000163	.0000336	.00544	.00163
7/30/98	.12	.000540	.0000379	.0003225	.0000163	.0000336	.00544	.00163
7/31/98	.12	.000540	.0000379	.0003225	.0000163	.0000336	.00544	.00163
Total	nd	0.0819	0.00615	0.0430	0.00205	0.00410	0.984	0.271

Table 2–1. Constituent load for Trevor Creek at the TC gage, near Antioch, May 1998–April 1999—Continued

Date (month/day/year)	Mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (ton per day)	Load, volatile suspended solids (ton per day)
8/1/98	0.12	0.000540	0.0000379	0.0003225	0.0000163	0.0000336	0.00544	0.00163
8/2/98	.12	.000540	.0000379	.0003225	.0000163	.0000336	.00544	.00163
8/3/98	.13	.000582	.0000409	.0003461	.0000175	.0000360	.00591	.00177
8/4/98	.13	.000582	.0000409	.0003461	.0000175	.0000360	.00591	.00177
8/5/98	.13	.000582	.0000409	.0003461	.0000175	.0000360	.00591	.00177
8/6/98	.13	.000582	.0000409	.0003461	.0000175	.0000360	.00591	.00177
8/7/98	.13	.000582	.0000409	.0003461	.0000175	.0000360	.00591	.00177
8/8/98	.14	.000624	.0000440	.000370	.0000186	.0000383	.00637	.00190
8/9/98	.14	.000624	.0000440	.000370	.0000186	.0000383	.00637	.00190
8/10/98	.14	.000624	.0000440	.000370	.0000186	.0000383	.00637	.00190
8/11/98	.14	.000624	.0000440	.000370	.0000186	.0000383	.00637	.00190
8/12/98	.14	.000624	.0000440	.000370	.0000186	.0000383	.00637	.00190
8/13/98	.14	.000624	.0000440	.000370	.0000186	.0000383	.00637	.00190
8/14/98	.14	.000624	.0000440	.000370	.0000186	.0000383	.00637	.00190
8/15/98	.14	.000624	.0000440	.000370	.0000186	.0000383	.00637	.00190
8/16/98	.15	.000666	.0000471	.0003928	.0000198	.0000406	.00684	.00203
8/17/98	.15	.000666	.0000471	.0003928	.0000198	.0000406	.00684	.00203
8/18/98	.15	.000666	.0000471	.0003928	.0000198	.0000406	.00684	.00203
8/19/98	.16	.000708	.0000501	.0004158	.0000209	.0000428	.00731	.00217
8/20/98	.13	.000582	.0000409	.0003461	.0000175	.0000360	.00591	.00177
8/21/98	.10	.000454	.0000317	.0002745	.0000140	.0000289	.00451	.00136
8/22/98	.10	.000454	.0000317	.0002745	.0000140	.0000289	.00451	.00136
8/23/98	.11	.000497	.0000348	.0002986	.0000152	.0000313	.00498	.00150
8/24/98	.12	.000540	.0000379	.0003225	.0000163	.0000336	.00544	.00163
8/25/98	.38	.00160	.000117	.000893	.0000437	.0000887	.0177	.00509
8/26/98	.14	.000624	.0000440	.000370	.0000186	.0000383	.00637	.00190
8/27/98	.15	.000666	.0000471	.0003928	.0000198	.0000406	.00684	.00203
8/28/98	.20	.000875	.0000623	.0005065	.0000253	.0000517	.00919	.00270
8/29/98	.17	.000750	.0000532	.0004387	.0000220	.0000451	.00778	.00230
8/30/98	.18	.000792	.0000562	.0004614	.0000231	.0000473	.00825	.00243
8/31/98	.18	.000792	.0000562	.0004614	.0000231	.0000473	.00825	.00243
Total	nd	0.0203	0.00144	0.0120	0.000602	0.00124	0.209	0.0621

Table 2–1. Constituent load for Trevor Creek at the TC gage, near Antioch, May 1998–April 1999—Continued

Date (month/day/year)	Mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (ton per day)	Load, volatile suspended solids (ton per day)
9/1/98	0.18	0.000792	0.0000562	0.0004614	0.0000231	0.0000473	0.00825	0.00243
9/2/98	.18	.000792	.0000562	.0004614	.0000231	.0000473	.00825	.00243
9/3/98	.19	.000833	.0000593	.000484	.0000242	.0000495	.00872	.00257
9/4/98	.18	.000792	.0000562	.0004614	.0000231	.0000473	.00825	.00243
9/5/98	.19	.000833	.0000593	.000484	.0000242	.0000495	.00872	.00257
9/6/98	.19	.000833	.0000593	.000484	.0000242	.0000495	.00872	.00257
9/7/98	.23	.000998	.0000714	.000573	.0000285	.0000581	.01060	.00310
9/8/98	.20	.000875	.0000623	.0005065	.0000253	.0000517	.00919	.00270
9/9/98	.20	.000875	.0000623	.0005065	.0000253	.0000517	.00919	.00270
9/10/98	.20	.000875	.0000623	.0005065	.0000253	.0000517	.00919	.00270
9/11/98	.20	.000875	.0000623	.0005065	.0000253	.0000517	.00919	.00270
9/12/98	.21	.000916	.0000654	.0005288	.0000264	.0000538	.00966	.00283
9/13/98	.21	.000916	.0000654	.0005288	.0000264	.0000538	.00966	.00283
9/14/98	.52	.00216	.000158	.00118	.0000572	.000115	.0245	.00693
9/15/98	.83	.00335	.000250	.00178	.0000853	.000171	.0395	.0110
9/16/98	.23	.000998	.0000714	.000573	.0000285	.0000581	.0106	.00310
9/17/98	.23	.000998	.0000714	.000573	.0000285	.0000581	.0106	.00310
9/18/98	.23	.000998	.0000714	.000573	.0000285	.0000581	.0106	.00310
9/19/98	.23	.000998	.0000714	.000573	.0000285	.0000581	.0106	.00310
9/20/98	.24	.001039	.0000745	.000595	.0000295	.0000602	.0111	.00323
9/21/98	.23	.000998	.0000714	.000573	.0000285	.0000581	.0106	.00310
9/22/98	.24	.00104	.0000745	.000595	.0000295	.0000602	.0111	.00323
9/23/98	.24	.00104	.0000745	.000595	.0000295	.0000602	.0111	.00323
9/24/98	.21	.000916	.0000654	.0005288	.0000264	.0000538	.00966	.00283
9/25/98	.14	.000624	.0000440	.000370	.0000186	.0000383	.00637	.00190
9/26/98	.14	.000624	.0000440	.000370	.0000186	.0000383	.00637	.00190
9/27/98	.14	.000624	.0000440	.000370	.0000186	.0000383	.00637	.00190
9/28/98	.14	.000624	.0000440	.000370	.0000186	.0000383	.00637	.00190
9/29/98	.14	.000624	.0000440	.000370	.0000186	.0000383	.00637	.00190
9/30/98	.14	.000624	.0000440	.000370	.0000186	.0000383	.00637	.00190
Total	nd	0.0295	0.00212	0.0168	0.000836	0.00170	0.316	0.0919

Table 2–1. Constituent load for Trevor Creek at the TC gage, near Antioch, May 1998–April 1999—Continued

Date (month/day/year)	Mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (ton per day)	Load, volatile suspended solids (ton per day)
10/1/98	0.14	0.000624	0.0000440	0.000370	0.0000186	0.0000383	0.00637	0.00190
10/2/98	.15	.000666	.0000471	.0003928	.0000198	.0000406	.00684	.00203
10/3/98	.27	.00116	.0000836	.000660	.0000327	.0000665	.0125	.00363
10/4/98	.15	.000666	.0000471	.0003928	.0000198	.0000406	.00684	.00203
10/5/98	2.8	.0106	.000820	.00522	.0002410	.000475	.137	.0364
10/6/98	.67	.00274	.000203	.00147	.0000710	.000143	.0317	.00889
10/7/98	.55	.00227	.000167	.00124	.0000600	.000121	.0259	.00732
10/8/98	.32	.00136	.0000986	.0007672	.0000378	.0000767	.0149	.00429
10/9/98	.23	.000998	.0000714	.000573	.0000285	.0000581	.0106	.00310
10/10/98	.20	.000875	.0000623	.0005065	.0000253	.0000517	.00919	.00270
10/11/98	.18	.000792	.0000562	.0004614	.0000231	.0000473	.00825	.00243
10/12/98	.17	.000750	.0000532	.0004387	.0000220	.0000451	.00778	.00230
10/13/98	.16	.000708	.0000501	.0004158	.0000209	.0000428	.00731	.00217
10/14/98	.16	.000708	.0000501	.0004158	.0000209	.0000428	.00731	.00217
10/15/98	.16	.000708	.0000501	.0004158	.0000209	.0000428	.00731	.00217
10/16/98	.16	.000708	.0000501	.0004158	.0000209	.0000428	.00731	.00217
10/17/98	4.8	.0176	.00139	.00840	.000382	.0007479	.239	.06196
10/18/98	6.9	.0248	.001977	.0116	.000521	.00101	.346	.08862
10/19/98	2.1	.00806	.000619	.00405	.000188	.000373	.102	.02743
10/20/98	1.1	.00438	.000329	.00228	.000108	.000217	.0527	.0145
10/21/98	.75	.00305	.000227	.00163	.0000782	.000157	.0356	.00994
10/22/98	.60	.00247	.000182	.00134	.0000646	.000130	.0283	.00798
10/23/98	.57	.00235	.000173	.00128	.0000619	.000125	.0269	.00758
10/24/98	.47	.00196	.000144	.00108	.0000525	.000106	.0220	.00627
10/25/98	.42	.00176	.000129	.0009756	.0000477	.0000964	.0196	.00561
10/26/98	.37	.00156	.000114	.0008722	.0000428	.0000867	.0173	.00495
10/27/98	.41	.00172	.000126	.0009551	.0000467	.0000945	.0192	.00548
10/28/98	.52	.00216	.000158	.00118	.0000572	.000115	.0245	.00693
10/29/98	.53	.00220	.000161	.00120	.0000581	.000117	.0249	.00706
10/30/98	.92	.00370	.000277	.00195	.0000931	.000186	.0439	.0122
10/31/98	.71	.00289	.000215	.00155	.0000746	.000150	.0337	.00942
Total	nd	0.107	0.00817	0.0545	0.00256	0.00509	1.34	0.36

Table 2–1. Constituent load for Trevor Creek at the TC gage, near Antioch, May 1998–April 1999—Continued

Date (month/day/year)	Mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (ton per day)	Load, volatile suspended solids (ton per day)
11/1/98	0.57	0.00235	0.000173	0.00128	0.0000619	0.000125	0.0269	0.00758
11/2/98	.46	.00192	.000141	.00106	.0000515	.000104	.0216	.00614
11/3/98	.43	.00180	.000132	.00100	.0000486	.0000984	.0201	.00574
11/4/98	.43	.00180	.000132	.00100	.0000486	.0000984	.0201	.00574
11/5/98	.39	.00164	.000120	.00091	.0000447	.0000906	.0182	.00522
11/6/98	.49	.00204	.000150	.00112	.0000544	.000110	.0230	.00653
11/7/98	.29	.00124	.0000896	.00070	.0000347	.0000706	.0134	.00390
11/8/98	.25	.00108	.0000775	.00062	.0000306	.0000623	.0115	.00337
11/9/98	.25	.00108	.0000775	.00062	.0000306	.0000623	.0115	.00337
11/10/98	6.2	.0224	.001781	.01053	.000475	.000927	.310	.0797
11/11/98	2.7	.0102	.000791	.00505	.000234	.000461	.132	.0351
11/12/98	1.8	.00697	.000533	.00353	.000165	.000328	.0873	.0236
11/13/98	1.5	.00587	.000446	.00300	.000141	.000281	.0724	.0197
11/14/98	1.2	.00475	.000358	.00247	.000117	.000233	.0576	.0158
11/15/98	1.2	.00475	.000358	.00247	.000117	.000233	.0576	.0158
11/16/98	1.0	.00400	.000300	.00210	.000100	.000200	.0478	.0132
11/17/98	1.0	.00400	.000300	.00210	.000100	.000200	.0478	.0132
11/18/98	.96	.00385	.000288	.00203	.0000966	.000193	.0458	.0127
11/19/98	.96	.00385	.000288	.00203	.0000966	.000193	.0458	.0127
11/20/98	1.0	.00400	.000300	.00210	.000100	.000200	.0478	.0132
11/21/98	.90	.00362	.000271	.00191	.0000914	.000183	.0429	.0119
11/22/98	.85	.00343	.000256	.00182	.0000870	.000174	.0405	.0112
11/23/98	.77	.00312	.000232	.00167	.0000800	.000161	.0366	.0102
11/24/98	.70	.00286	.000212	.00153	.0000737	.000148	.0332	.00929
11/25/98	.68	.00278	.000206	.00149	.0000719	.000145	.0322	.00903
11/26/98	.65	.00266	.000197	.00144	.0000692	.000139	.0307	.00863
11/27/98	.62	.00255	.000188	.00138	.0000665	.000134	.0293	.00824
11/28/98	.58	.00239	.000176	.00130	.0000628	.000127	.0274	.00772
11/29/98	.62	.00255	.000188	.00138	.0000665	.000134	.0293	.00824
11/30/98	.83	.00335	.000250	.00178	.0000853	.000171	.0395	.0110
Total	nd	0.119	0.00901	0.0614	0.00290	0.00579	1.46	0.398

Table 2–1. Constituent load for Trevor Creek at the TC gage, near Antioch, May 1998–April 1999—Continued

Date (month/day/year)	Mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (ton per day)	Load, volatile suspended solids (ton per day)
12/1/98	0.90	0.00362	0.000271	0.00191	0.0000914	0.000183	0.0429	0.0119
12/2/98	.77	.00312	.000232	.00167	.0000800	.000161	.0366	.0102
12/3/98	.75	.00305	.000227	.00163	.0000782	.000157	.0356	.00994
12/4/98	.74	.00301	.000224	.00161	.0000773	.000155	.0351	.00981
12/5/98	.76	.00309	.000229	.00165	.0000791	.000159	.0361	.0101
12/6/98	1.6	.00624	.000475	.00318	.000149	.000297	.0774	.0210
12/7/98	3.0	.0113	.000877	.00554	.000256	.000504	.147	.0390
12/8/98	2.1	.00806	.000619	.00405	.000188	.000373	.102	.0274
12/9/98	1.8	.00697	.000533	.00353	.000165	.000328	.0873	.0236
12/10/98	1.6	.00624	.000475	.00318	.000149	.000297	.0774	.0210
12/11/98	1.4	.00550	.000417	.00283	.000133	.000265	.0675	.0184
12/12/98	1.3	.00512	.000388	.00265	.000125	.000249	.0625	.0171
12/13/98	1.2	.00475	.000358	.00247	.000117	.000233	.0576	.0158
12/14/98	1.1	.00438	.000329	.00228	.000108	.000217	.0527	.0145
12/15/98	1.0	.00400	.000300	.00210	.000100	.000200	.0478	.0132
12/16/98	.90	.00362	.000271	.00191	.0000914	.000183	.0429	.0119
12/17/98	.80	.00324	.000241	.00172	.0000826	.000166	.0380	.0106
12/18/98	.60	.00247	.000182	.00134	.0000646	.000130	.0283	.00798
12/19/98	.52	.00216	.000158	.00118	.0000572	.000115	.0245	.00693
12/20/98	.48	.00200	.000147	.00110	.0000534	.000108	.0225	.00640
12/21/98	.43	.00180	.000132	.00100	.0000486	.0000984	.0201	.00574
12/22/98	.39	.00164	.000120	.000914	.0000447	.0000906	.0182	.00522
12/23/98	.36	.00152	.000111	.000851	.0000418	.0000847	.0168	.00482
12/24/98	.33	.00140	.000102	.000788	.0000388	.0000787	.0153	.00443
12/25/98	.33	.00140	.000102	.000788	.0000388	.0000787	.0153	.00443
12/26/98	.45	.00188	.000138	.00104	.0000505	.000102	.0211	.00601
12/27/98	.54	.00224	.000164	.00122	.0000591	.000119	.0254	.00719
12/28/98	.35	.00148	.000108	.000830	.0000408	.0000827	.0163	.00469
12/29/98	.31	.00132	.0000956	.000746	.0000368	.0000747	.0144	.00416
12/30/98	.31	.00132	.0000956	.000746	.0000368	.0000747	.0144	.00416
12/31/98	.30	.00128	.0000926	.0007247	.0000357	.0000727	.0139	.00403
Total	nd	0.109	0.00821	0.0572	0.00272	0.00544	1.31	0.362

Table 2–1. Constituent load for Trevor Creek at the TC gage, near Antioch, May 1998–April 1999—Continued

Date (month/day/year)	Mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (ton per day)	Load, volatile suspended solids (ton per day)
1/1/99	0.32	0.00136	0.0000986	0.0007672	0.0000378	0.0000767	0.0149	0.00429
1/2/99	.32	.00136	.0000986	.0007672	.0000378	.0000767	.0149	.00429
1/3/99	.30	.00128	.0000926	.0007247	.0000357	.0000727	.0139	.00403
1/4/99	.29	.00124	.0000896	.0007033	.0000347	.0000706	.0134	.00390
1/5/99	.29	.00124	.0000896	.0007033	.0000347	.0000706	.0134	.00390
1/6/99	.27	.00116	.0000836	.000660	.0000327	.0000665	.0125	.00363
1/7/99	.28	.00120	.0000866	.0006818	.0000337	.0000686	.0130	.00376
1/8/99	.29	.00124	.0000896	.0007033	.0000347	.0000706	.0134	.00390
1/9/99	.29	.00124	.0000896	.0007033	.0000347	.0000706	.0134	.00390
1/10/99	.28	.00120	.0000866	.0006818	.0000337	.0000686	.0130	.00376
1/11/99	.27	.00116	.0000836	.000660	.0000327	.0000665	.0125	.00363
1/12/99	.26	.00112	.0000805	.0006386	.0000316	.0000644	.0120	.00350
1/13/99	.26	.00112	.0000805	.0006386	.0000316	.0000644	.0120	.00350
1/14/99	.3	.00128	.0000926	.0007247	.0000357	.0000727	.0139	.00403
1/15/99	.35	.00148	.000108	.000830	.0000408	.0000827	.0163	.00469
1/16/99	.60	.00247	.000182	.00134	.0000646	.000130	.0283	.00798
1/17/99	1.1	.00438	.000329	.00228	.000108	.000217	.0527	.0145
1/18/99	2.0	.00770	.000590	.00387	.000181	.000358	.0973	.0261
1/19/99	1.7	.00660	.000504	.00336	.000157	.000312	.0823	.0223
1/20/99	1.4	.00550	.000417	.00283	.000133	.000265	.0675	.0184
1/21/99	2.5	.00951	.000734	.00472	.000219	.000432	.122	.0326
1/22/99	15	.0516	.00422	.0230	.00101	.00195	.767	.191
1/23/99	26	.0868	.00722	.0374	.00162	.00310	1.35	.328
1/24/99	25	.0837	.00695	.0361	.00156	.00300	1.29	.315
1/25/99	16	.0549	.00449	.0243	.00107	.00206	.819	.203
1/26/99	13	.0451	.00367	.0203	.000895	.00173	.662	.165
1/27/99	10	.0352	.00284	.0161	.000715	.00139	.506	.128
1/28/99	9.3	.0329	.00265	.0151	.000672	.00130	.470	.119
1/29/99	8.2	.0292	.00234	.0135	.000604	.00117	.413	.105
1/30/99	7.4	.0265	.00212	.0123	.000553	.00108	.372	.0949
1/31/99	7.2	.0258	.00206	.0120	.000540	.00105	.361	.0924
Total	nd	0.527	0.0427	0.239	0.0106	0.0206	7.66	1.92

Table 2–1. Constituent load for Trevor Creek at the TC gage, near Antioch, May 1998–April 1999—Continued

Date (month/day/year)	Mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (ton per day)	Load, volatile suspended solids (ton per day)
2/1/99	6.8	0.0245	0.00195	0.0114	0.000514	0.00100	0.341	0.0873
2/2/99	8.4	.0299	.00240	.0138	.000616	.00120	.423	.108
2/3/99	8.8	.0312	.00251	.0144	.000641	.00124	.444	.113
2/4/99	8.2	.0292	.00234	.0135	.000604	.00117	.413	.105
2/5/99	7.6	.0272	.00217	.0126	.000566	.00110	.382	.0975
2/6/99	7.5	.0268	.00215	.0125	.000559	.00109	.377	.0962
2/7/99	6.9	.0248	.00198	.0116	.000521	.00101	.346	.0886
2/8/99	5.7	.0207	.00164	.00978	.000442	.000864	.284	.0734
2/9/99	6.0	.0217	.00173	.0102	.000462	.000902	.300	.0772
2/10/99	5.8	.0210	.00167	.00993	.000449	.000877	.290	.0747
2/11/99	11	.0385	.00312	.0175	.000776	.00150	.558	.140
2/12/99	18	.0613	.00504	.0270	.00118	.00227	.924	.228
2/13/99	11	.0385	.00312	.0175	.000776	.00150	.558	.140
2/14/99	9.2	.0325	.00262	.0149	.000666	.00129	.465	.118
2/15/99	8.6	.0305	.00245	.0141	.000629	.00122	.434	.110
2/16/99	7.9	.0282	.00226	.0130	.000585	.00114	.397	.101
2/17/99	6.8	.0245	.00195	.0114	.000514	.00100	.341	.0873
2/18/99	5.3	.0193	.00153	.00917	.000416	.000813	.264	.0683
2/19/99	4.6	.0169	.00133	.00809	.000368	.000722	.228	.0594
2/20/99	3.6	.0134	.00105	.00651	.000299	.000587	.178	.0467
2/21/99	3.2	.0120	.000934	.0058698	.000270	.000532	.157	.0415
2/22/99	2.4	.00915	.000705	.00455	.000211	.000418	.117	.0313
2/23/99	2.2	.00842	.000648	.00422	.000196	.000388	.107	.0287
2/24/99	1.9	.00733	.000561	.00370	.000173	.000343	.092	.0249
2/25/99	1.9	.00733	.000561	.00370	.000173	.000343	.092	.0249
2/26/99	2.1	.00806	.000619	.00405	.000188	.000373	.102	.0274
2/27/99	2.4	.00915	.000705	.00455	.000211	.000418	.117	.0313
2/28/99	2.4	.00915	.000705	.00455	.000211	.000418	.117	.0313
Total	nd	0.631	0.0504	0.294	0.0132	0.0257	8.85	2.26

Table 2–1. Constituent load for Trevor Creek at the TC gage, near Antioch, May 1998–April 1999—Continued

Date (month/day/year)	Mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (ton per day)	Load, volatile suspended solids (ton per day)
3/1/99	2.3	0.00879	0.000677	0.00438	0.000204	0.000403	0.112	0.0300
3/2/99	2.4	.00915	.000705	.00455	.000211	.000418	.117	.0313
3/3/99	2.5	.00951	.000734	.00472	.000219	.000432	.122	.0326
3/4/99	2.2	.00842	.000648	.00422	.000196	.000388	.107	.0287
3/5/99	2.0	.00770	.000590	.00387	.000181	.000358	.0973	.0261
3/6/99	1.8	.00697	.000533	.00353	.000165	.000328	.0873	.0236
3/7/99	1.8	.00697	.000533	.00353	.000165	.000328	.0873	.0236
3/8/99	1.7	.00660	.000504	.00336	.000157	.000312	.0823	.0223
3/9/99	1.7	.00660	.000504	.00336	.000157	.000312	.0823	.0223
3/10/99	1.8	.00697	.000533	.00353	.000165	.000328	.0873	.0236
3/11/99	2.1	.00806	.000619	.00405	.000188	.000373	.102	.0274
3/12/99	2.2	.00842	.000648	.00422	.000196	.000388	.107	.0287
3/13/99	2.2	.00842	.000648	.00422	.000196	.000388	.107	.0287
3/14/99	2.2	.00842	.000648	.00422	.000196	.000388	.107	.0287
3/15/99	2.4	.00915	.000705	.00455	.000211	.000418	.117	.0313
3/16/99	3.2	.0120	.000934	.00587	.000270	.000532	.157	.0415
3/17/99	5.3	.0193	.00153	.00917	.000416	.000813	.264	.0683
3/18/99	5.5	.0200	.00158	.00947	.000429	.000839	.274	.0709
3/19/99	4.3	.0159	.00125	.00762	.000348	.000682	.213	.0556
3/20/99	4.0	.0148	.00116	.00715	.000327	.000642	.198	.0518
3/21/99	3.9	.0145	.00113	.00699	.000320	.000628	.193	.0505
3/22/99	3.6	.0134	.00105	.00651	.000299	.000587	.178	.0467
3/23/99	3.3	.0124	.000962	.00603	.000277	.000546	.162	.0428
3/24/99	2.9	.0109	.000848	.00538	.000248	.000490	.142	.0377
3/25/99	2.5	.00951	.000734	.00472	.000219	.000432	.122	.0326
3/26/99	2.3	.00879	.000677	.00438	.000204	.000403	.112	.0300
3/27/99	2.2	.00842	.000648	.00422	.000196	.000388	.107	.0287
3/28/99	2.2	.00842	.000648	.00422	.000196	.000388	.107	.0287
3/29/99	2.5	.00951	.000734	.00472	.000219	.000432	.122	.0326
3/30/99	2.5	.00951	.000734	.00472	.000219	.000432	.122	.0326
3/31/99	2.2	.00842	.000648	.00422	.000196	.000388	.107	.0287
Total	nd	0.316	0.0245	0.156	0.00719	0.0142	4.107	1.09

Table 2–1. Constituent load for Trevor Creek at the TC gage, near Antioch, May 1998–April 1999—Continued

Date (month/day/year)	Mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (ton per day)	Load, volatile suspended solids (ton per day)
4/1/99	2.2	0.00842	0.000648	0.00422	0.000196	0.000388	0.107	0.0287
4/2/99	2.2	.00842	.000648	.00422	.000196	.000388	.107	.0287
4/3/99	1.9	.00733	.000561	.00370	.000173	.000343	.092	.0249
4/4/99	2.1	.00806	.000619	.00405	.000188	.000373	.102	.0274
4/5/99	1.9	.00733	.000561	.00370	.000173	.000343	.092	.0249
4/6/99	1.7	.00660	.000504	.00336	.000157	.000312	.082	.0223
4/7/99	1.6	.00624	.000475	.00318	.000149	.000297	.077	.0210
4/8/99	1.6	.00624	.000475	.00318	.000149	.000297	.077	.0210
4/9/99	4.4	.0162	.00127	.00778	.000355	.000695	.218	.0569
4/10/99	4.3	.0159	.00125	.00762	.000348	.000682	.213	.0556
4/11/99	3.5	.0131	.00102	.00635	.000292	.000573	.173	.0454
4/12/99	2.8	.0106	.000820	.00522	.000241	.000475	.137	.0364
4/13/99	2.3	.00879	.000677	.00438	.000204	.000403	.112	.0300
4/14/99	2.0	.00770	.000590	.00387	.000181	.000358	.0973	.0261
4/15/99	1.9	.00733	.000561	.00370	.000173	.000343	.0923	.0249
4/16/99	4.8	.0176	.00139	.00840	.000382	.000748	.239	.0620
4/17/99	4.6	.0169	.00133	.00809	.000368	.000722	.228	.0594
4/18/99	3.7	.0138	.00108	.00667	.000306	.000601	.183	.0479
4/19/99	3.3	.0124	.000962	.00603	.000277	.000546	.162	.0428
4/20/99	3.0	.0113	.000877	.00554	.000256	.000504	.147	.0390
4/21/99	3.4	.0127	.000991	.00619	.000285	.000560	.168	.0441
4/22/99	15	.0516	.00422	.0230	.00101	.00195	.767	.191
4/23/99	73	.230	.0198	.0931	.00391	.00737	3.88	.907
4/24/99	40	.130	.0110	.0547	.00234	.00445	2.10	.501
4/25/99	27	.0900	.00749	.0386	.00167	.00320	1.40	.340
4/26/99	19	.0646	.00532	.0283	.00124	.00238	.977	.241
4/27/99	15	.0516	.00422	.0230	.00101	.00195	.767	.191
4/28/99	14	.0484	.00395	.0216	.000953	.00184	.714	.178
4/29/99	10	.0352	.00284	.0161	.000715	.00139	.506	.128
4/30/99	7.5	.0268	.00215	.0125	.000559	.00109	.377	.0962
Total	nd	0.952	0.0783	0.420	0.0185	0.0356	14.4	3.54

Table 2–2. Constituent load for the storm drain at the FS gage, near Antioch, May 1998–April 1999

[nd, not determined]

Date (month/day/year)	Mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (ton per day)	Load, volatile suspended solids (ton per day)
5/1/98	0.18	0.00094	0.00024	0.00071	0.000103	0.00016	0.00895	0.00275
5/2/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/3/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/4/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/5/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/6/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/7/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/8/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/9/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/10/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/11/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/12/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/13/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/14/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/15/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/16/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/17/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/18/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/19/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/20/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/21/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/22/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/23/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/24/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/25/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/26/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/27/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/28/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/29/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/30/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
5/31/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
Total	nd	0.2905	0.00741	0.02192	0.003193	0.00503	0.2774	0.08526

Table 2–2. Constituent load for the storm drain at the FS gage, near Antioch, May 1998–April 1999—Continued

Date (month/day/year)	Mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (ton per day)	Load, volatile suspended solids (ton per day)
6/1/98	0.18	0.00094	0.00024	0.00071	0.000103	0.00016	0.00895	0.00275
6/2/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
6/3/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
6/4/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
6/5/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
6/6/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
6/7/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
6/8/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
6/9/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
6/10/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
6/11/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
6/12/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
6/13/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
6/14/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
6/15/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
6/16/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
6/17/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
6/18/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
6/19/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
6/20/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
6/21/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
6/22/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
6/23/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
6/24/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
6/25/98	.2	.00104	.00027	.00079	.000115	.00018	.00970	.00300
6/26/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
6/27/98	.19	.00099	.00026	.00075	.000109	.00017	.00933	.00288
6/28/98	.24	.00124	.00034	.00095	.000138	.00022	.01114	.00349
6/29/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
6/30/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
Total	nd	0.02856	0.00732	0.02158	0.003143	0.00496	0.27178	0.08363

Table 2–2. Constituent load for the storm drain at the FS gage, near Antioch, May 1998–April 1999—Continued

Date (month/day/year)	Mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (ton per day)	Load, volatile suspended solids (ton per day)
7/1/98	0.18	0.00094	0.00024	0.00071	0.000103	0.00016	0.00895	0.00275
7/2/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/3/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/4/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/5/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/6/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/7/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/8/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/9/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/10/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/11/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/12/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/13/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/14/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/15/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/16/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/17/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/18/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/19/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/20/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/21/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/22/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/23/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/24/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/25/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/26/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/27/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/28/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/29/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/30/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
7/31/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
Total	nd	0.02905	0.00741	0.02192	0.003193	0.00503	0.2774	0.08526

Table 2–2. Constituent load for the storm drain at the FS gage, near Antioch, May 1998–April 1999—Continued

Date (month/day/year)	Mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (ton per day)	Load, volatile suspended solids (ton per day)
8/1/98	0.18	0.00094	0.00024	0.00071	0.000103	0.00016	0.00895	0.00275
8/2/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/3/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/4/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/5/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/6/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/7/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/8/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/9/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/10/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/11/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/12/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/13/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/14/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/15/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/16/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/17/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/18/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/19/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/20/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/21/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/22/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/23/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/24/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/25/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/26/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/27/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/28/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/29/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/30/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
8/31/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
Total	nd	0.02905	0.00741	0.02192	0.003193	0.00503	0.2774	0.08526

Table 2–2. Constituent load for the storm drain at the FS gage, near Antioch, May 1998–April 1999—Continued

Date (month/day/year)	Mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (ton per day)	Load, volatile suspended solids (ton per day)
9/1/98	0.18	0.00094	0.00024	0.00071	0.000103	0.00016	0.00895	0.00275
9/2/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
9/3/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
9/4/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
9/5/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
9/6/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
9/7/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
9/8/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
9/9/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
9/10/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
9/11/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
9/12/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
9/13/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
9/14/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
9/15/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
9/16/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
9/17/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
9/18/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
9/19/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
9/20/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
9/21/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
9/22/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
9/23/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
9/24/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
9/25/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
9/26/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
9/27/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
9/28/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
9/29/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
9/30/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
Total	nd	0.02811	0.00717	0.02121	0.00309	0.00487	0.26845	0.08251

Table 2–2. Constituent load for the storm drain at the FS gage, near Antioch, May 1998–April 1999—Continued

Date (month/day/year)	Mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (ton per day)	Load, volatile suspended solids (ton per day)
10/1/98	0.18	0.00094	0.00024	0.00071	0.000103	0.00016	0.00895	0.00275
10/2/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
10/3/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
10/4/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
10/5/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
10/6/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
10/7/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
10/8/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
10/9/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
10/10/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
10/11/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
10/12/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
10/13/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
10/14/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
10/15/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
10/16/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
10/17/98	.26	.00134	.00037	.00104	.000150	.00024	.01185	.00373
10/18/98	.21	.00109	.00029	.00083	.000121	.00019	.01007	.00313
10/19/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
10/20/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
10/21/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
10/22/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
10/23/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
10/24/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
10/25/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
10/26/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
10/27/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
10/28/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
10/29/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
10/30/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
10/31/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
Total	nd	0.0296	0.00759	0.02237	0.003258	0.00514	0.28142	0.08661

Table 2–2. Constituent load for the storm drain at the FS gage, near Antioch, May 1998–April 1999—Continued

Date (month/day/year)	Mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (ton per day)	Load, volatile suspended solids (ton per day)
11/1/98	0.18	0.00094	0.00024	0.00071	0.000103	0.00016	0.00895	0.00275
11/2/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
11/3/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
11/4/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
11/5/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
11/6/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
11/7/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
11/8/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
11/9/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
11/10/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
11/11/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
11/12/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
11/13/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
11/14/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
11/15/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
11/16/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
11/17/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
11/18/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
11/19/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
11/20/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
11/21/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
11/22/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
11/23/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
11/24/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
11/25/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
11/26/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
11/27/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
11/28/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
11/29/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
11/30/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
Total	nd	0.02811	0.00717	0.02121	0.00309	0.00487	0.26845	0.08251

Table 2–2. Constituent load for the storm drain at the FS gage, near Antioch, May 1998–April 1999—Continued

Date (month/day/year)	Mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (ton per day)	Load, volatile suspended solids (ton per day)
12/1/98	0.18	0.00094	0.00024	0.00071	0.000103	0.00016	0.00895	0.00275
12/2/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
12/3/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
12/4/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
12/5/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
12/6/98	.21	.00109	.00029	.00083	.000121	.00019	.01007	.00313
12/7/98	.22	.00114	.00030	.00087	.000127	.00020	.01043	.00325
12/8/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
12/9/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
12/10/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
12/11/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
12/12/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
12/13/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
12/14/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
12/15/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
12/16/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
12/17/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
12/18/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
12/19/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
12/20/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
12/21/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
12/22/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
12/23/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
12/24/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
12/25/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
12/26/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
12/27/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
12/28/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
12/29/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
12/30/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
12/31/98	.18	.00094	.00024	.00071	.000103	.00016	.00895	.00275
Total	nd	0.0294	0.00752	0.0222	0.003234	0.0051	0.280	0.08613

Table 2–2. Constituent load for the storm drain at the FS gage, near Antioch, May 1998–April 1999—Continued

Date (month/day/year)	Mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (ton per day)	Load, volatile suspended solids (ton per day)
1/1/99	0.18	0.000795	0.000107	0.000291	0.0000327	0.0000688	0.0256	0.00453
1/2/99	.18	.000795	.000107	.000291	.0000327	.00007	.02561	.00453
1/3/99	.18	.000795	.000107	.000291	.0000327	.00007	.02561	.00453
1/4/99	.18	.000795	.000107	.000291	.0000327	.00007	.02561	.00453
1/5/99	.18	.000795	.000107	.000291	.0000327	.00007	.02561	.00453
1/6/99	.18	.000795	.000107	.000291	.0000327	.00007	.02561	.00453
1/7/99	.18	.000795	.000107	.000291	.0000327	.00007	.02561	.00453
1/8/99	.18	.000795	.000107	.000291	.0000327	.00007	.02561	.00453
1/9/99	.18	.000795	.000107	.000291	.0000327	.00007	.02561	.00453
1/10/99	.18	.000795	.000107	.000291	.0000327	.00007	.02561	.00453
1/11/99	.18	.000795	.000107	.000291	.0000327	.00007	.02561	.00453
1/12/99	.18	.000795	.000107	.000291	.0000327	.00007	.02561	.00453
1/13/99	.18	.000795	.000107	.000291	.0000327	.00007	.02561	.00453
1/14/99	.18	.000795	.000107	.000291	.0000327	.00007	.02561	.00453
1/15/99	.18	.000795	.000107	.000291	.0000327	.00007	.02561	.00453
1/16/99	.18	.000795	.000107	.000291	.0000327	.00007	.02561	.00453
1/17/99	.18	.000795	.000107	.000291	.0000327	.00007	.02561	.00453
1/18/99	.18	.000795	.000107	.000291	.0000327	.00007	.02561	.00453
1/19/99	.18	.000795	.000107	.000291	.0000327	.00007	.02561	.00453
1/20/99	.18	.000795	.000107	.000291	.0000327	.00007	.02561	.00453
1/21/99	.18	.000795	.000107	.000291	.0000327	.00007	.02561	.00453
1/22/99	.9	.003622	.000624	.00161	.0001789	.00027	.0666	.01446
1/23/99	1.58	.006156	.001155	.002925	.0003242	.00044	.09303	.0217
1/24/99	2.81	.010592	.002171	.005391	.0005955	.00073	.13094	.03288
1/25/99	2.93	.011017	.002273	.005636	.0006224	.00075	.13424	.03389
1/26/99	1.48	.005788	.001076	.002729	.0003026	.00042	.08948	.0207
1/27/99	.81	.003279	.000556	.001439	.0001601	.00025	.06256	.0134
1/28/99	.78	.003165	.000533	.001383	.0001538	.00024	.06117	.01304
1/29/99	.25	.001083	.000153	.000413	.0000463	.00009	.03113	.00574
1/30/99	.22	.00096	.000133	.000361	.0000404	.00008	.02885	.00523
1/31/99	.23	.001001	.00014	.000378	.0000424	.00008	.02962	.0054
Total	nd	0.06335	0.01106	0.028385	0.0031533	0.00482	1.26546	0.26147

Table 2–2. Constituent load for the storm drain at the FS gage, near Antioch, May 1998–April 1999—Continued

Date (month/day/year)	Mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (ton per day)	Load, volatile suspended solids (ton per day)
2/1/99	0.21	0.000919	0.000127	0.000343	0.0000385	0.0000786	0.0281	0.00506
2/2/99	.59	.002433	.000393	.001028	.0001146	.0001907	.05183	.01066
2/3/99	.38	.001607	.000243	.000644	.000072	.0001307	.03991	.00776
2/4/99	.27	.001164	.000167	.000448	.0000502	.0000975	.03258	.00606
2/5/99	.18	.000795	.000107	.000291	.0000327	.0000688	.02561	.00453
2/6/99	.18	.000795	.000107	.000291	.0000327	.0000688	.02561	.00453
2/7/99	.18	.000795	.000107	.000291	.0000327	.0000688	.02561	.00453
2/8/99	.18	.000795	.000107	.000291	.0000327	.0000688	.02561	.00453
2/9/99	.18	.000795	.000107	.000291	.0000327	.0000688	.02561	.00453
2/10/99	.18	.000795	.000107	.000291	.0000327	.0000688	.02561	.00453
2/11/99	.41	.001726	.000264	.000698	.000078	.0001396	.04176	.0082
2/12/99	.57	.002355	.000378	.000991	.0001105	.0001852	.05078	.0104
2/13/99	.18	.000795	.000107	.000291	.0000327	.0000688	.02561	.00453
2/14/99	.18	.000795	.000107	.000291	.0000327	.0000688	.02561	.00453
2/15/99	.18	.000795	.000107	.000291	.0000327	.0000688	.02561	.00453
2/16/99	.18	.000795	.000107	.000291	.0000327	.0000688	.02561	.00453
2/17/99	.18	.000795	.000107	.000291	.0000327	.0000688	.02561	.00453
2/18/99	.18	.000795	.000107	.000291	.0000327	.0000688	.02561	.00453
2/19/99	.18	.000795	.000107	.000291	.0000327	.0000688	.02561	.00453
2/20/99	.18	.000795	.000107	.000291	.0000327	.0000688	.02561	.00453
2/21/99	.18	.000795	.000107	.000291	.0000327	.0000688	.02561	.00453
2/22/99	.18	.000795	.000107	.000291	.0000327	.0000688	.02561	.00453
2/23/99	.18	.000795	.000107	.000291	.0000327	.0000688	.02561	.00453
2/24/99	.18	.000795	.000107	.000291	.0000327	.0000688	.02561	.00453
2/25/99	.18	.000795	.000107	.000291	.0000327	.0000688	.02561	.00453
2/26/99	.18	.000795	.000107	.000291	.0000327	.0000688	.02561	.00453
2/27/99	.18	.000795	.000107	.000291	.0000327	.0000688	.02561	.00453
2/28/99	.18	.000795	.000107	.000291	.0000327	.0000688	.02561	.00453
Total	nd	0.027686	0.003924	0.010566	0.0011832	0.0023368	0.80837	0.14769

Table 2–2. Constituent load for the storm drain at the FS gage, near Antioch, May 1998–April 1999—Continued

Date (month/day/year)	Mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (ton per day)	Load, volatile suspended solids (ton per day)
3/1/99	0.18	0.000795	0.000107	0.000291	0.0000327	0.0000688	0.0256	0.00453
3/2/99	.18	.000795	.000107	.000291	.000033	.0000688	.0256	.00453
3/3/99	.18	.000795	.000107	.000291	.000033	.0000688	.0256	.00453
3/4/99	.18	.000795	.000107	.000291	.000033	.0000688	.0256	.00453
3/5/99	.18	.000795	.000107	.000291	.000033	.0000688	.0256	.00453
3/6/99	.18	.000795	.000107	.000291	.000033	.0000688	.0256	.00453
3/7/99	.18	.000795	.000107	.000291	.000033	.0000688	.0256	.00453
3/8/99	.18	.000795	.000107	.000291	.000033	.0000688	.0256	.00453
3/9/99	.18	.000795	.000107	.000291	.000033	.0000688	.0256	.00453
3/10/99	.18	.000795	.000107	.000291	.000033	.0000688	.0256	.00453
3/11/99	.18	.000795	.000107	.000291	.000033	.0000688	.0256	.00453
3/12/99	.18	.000795	.000107	.000291	.000033	.0000688	.0256	.00453
3/13/99	.18	.000795	.000107	.000291	.000033	.0000688	.0256	.00453
3/14/99	.18	.000795	.000107	.000291	.000033	.0000688	.0256	.00453
3/15/99	.18	.000795	.000107	.000291	.000033	.0000688	.0256	.00453
3/16/99	.18	.000795	.000107	.000291	.000033	.0000688	.0256	.00453
3/17/99	.42	.001766	.000271	.000717	.00008	.0001425	.0424	.00834
3/18/99	.22	.00096	.000133	.000361	.00004	.0000818	.0289	.00523
3/19/99	.18	.000795	.000107	.000291	.000033	.0000688	.0256	.00453
3/20/99	.18	.000795	.000107	.000291	.000033	.0000688	.0256	.00453
3/21/99	.18	.000795	.000107	.000291	.000033	.0000688	.0256	.00453
3/22/99	.18	.000795	.000107	.000291	.000033	.0000688	.0256	.00453
3/23/99	.18	.000795	.000107	.000291	.000033	.0000688	.0256	.00453
3/24/99	.18	.000795	.000107	.000291	.000033	.0000688	.0256	.00453
3/25/99	.18	.000795	.000107	.000291	.000033	.0000688	.0256	.00453
3/26/99	.18	.000795	.000107	.000291	.000033	.0000688	.0256	.00453
3/27/99	.18	.000795	.000107	.000291	.000033	.0000688	.0256	.00453
3/28/99	.18	.000795	.000107	.000291	.000033	.0000688	.0256	.00453
3/29/99	.18	.000795	.000107	.000291	.000033	.0000688	.0256	.00453
3/30/99	.18	.000795	.000107	.000291	.000033	.0000688	.0256	.00453
3/31/99	.18	.000795	.000107	.000291	.000033	.0000688	.0256	.00453
Total	nd	0.02577	0.003506	0.00953	0.001069	0.0022206	0.8139	0.14481

Table 2–2. Constituent load for the storm drain at the FS gage, near Antioch, May 1998–April 1999—Continued

Date (month/day/year)	Mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (ton per day)	Load, volatile suspended solids (ton per day)
4/1/99	0.18	0.000795	0.000107	0.000291	0.0000327	0.0000688	0.0256	0.00453
4/2/99	.18	.000795	.000107	.000291	.0000327	.0000688	.0256	.00453
4/3/99	.18	.000795	.000107	.000291	.0000327	.0000688	.0256	.00453
4/4/99	.99	.003962	.000692	.001781	.0001979	.0002974	.0705	.01549
4/5/99	.18	.000795	.000107	.000291	.0000327	.0000688	.0256	.00453
4/6/99	.18	.000795	.000107	.000291	.0000327	.0000688	.0256	.00453
4/7/99	.18	.000795	.000107	.000291	.0000327	.0000688	.0256	.00453
4/8/99	.18	.000795	.000107	.000291	.0000327	.0000688	.0256	.00453
4/9/99	.31	.001326	.000194	.000519	.0000581	.0001098	.0354	.0067
4/10/99	.18	.000795	.000107	.000291	.0000327	.0000688	.0256	.00453
4/11/99	.18	.000795	.000107	.000291	.0000327	.0000688	.0256	.00453
4/12/99	.18	.000795	.000107	.000291	.0000327	.0000688	.0256	.00453
4/13/99	.18	.000795	.000107	.000291	.0000327	.0000688	.0256	.00453
4/14/99	.18	.000795	.000107	.000291	.0000327	.0000688	.0256	.00453
4/15/99	.18	.000795	.000107	.000291	.0000327	.0000688	.0256	.00453
4/16/99	.18	.000795	.000107	.000291	.0000327	.0000688	.0256	.00453
4/17/99	.18	.000795	.000107	.000291	.0000327	.0000688	.0256	.00453
4/18/99	.18	.000795	.000107	.000291	.0000327	.0000688	.0256	.00453
4/19/99	.18	.000795	.000107	.000291	.0000327	.0000688	.0256	.00453
4/20/99	.18	.000795	.000107	.000291	.0000327	.0000688	.0256	.00453
4/21/99	.18	.000795	.000107	.000291	.0000327	.0000688	.0256	.00453
4/22/99	.28	.001205	.000174	.000466	.0000521	.0001006	.0333	.00622
4/23/99	.18	.000795	.000107	.000291	.0000327	.0000688	.0256	.00453
4/24/99	.18	.000795	.000107	.000291	.0000327	.0000688	.0256	.00453
4/25/99	.18	.000795	.000107	.000291	.0000327	.0000688	.0256	.00453
4/26/99	.18	.000795	.000107	.000291	.0000327	.0000688	.0256	.00453
4/27/99	.18	.000795	.000107	.000291	.0000327	.0000688	.0256	.00453
4/28/99	.18	.000795	.000107	.000291	.0000327	.0000688	.0256	.00453
4/29/99	.18	.000795	.000107	.000291	.0000327	.0000688	.0256	.00453
4/30/99	.18	.000795	.000107	.000291	.0000327	.0000688	.0256	.00453
Total	nd	0.027948	0.003948	0.010636	0.0011911	0.0023665	0.8306	0.1506

Table 2–3. Constituent load for the east opening of Channel Lake at the CLE gage, near Antioch, May 1998–April 1999

[m, month; d, day; y, year; -, denotes discharge into the lake; nd, not determined]

Date (m/d/y)	Mean daily discharge (cubic feet per second)	Absolute value of mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (tons per day)	Load, volatile suspended solids (ton per day)
5/1/98	39	39	0.00802	0.0302159	0.121	0.00152	0.00558	2.67	0.899
5/2/98	39	39	.00802	.0302	.121	.00152	.00558	2.67	.899
5/3/98	35	35	.00775	.027	.107	.00134	.00483	2.31	.777
5/4/98	42	42	.0082	.0326	.132	.00166	.00617	2.95	.993
5/5/98	36	36	.00782	.0278	.110	.00139	.00501	2.4	.807
5/6/98	36	36	.00782	.0278	.110	.00139	.00501	2.4	.807
5/7/98	30	30	.00739	.0231	.089	.00112	.00392	1.89	.632
5/8/98	3.3	3.3	.00375	.0024	.007	.00008	.0002	.1	.032
5/9/98	-17	17	.00621	.0129	.045	.00057	.00182	.89	.294
5/10/98	1.1	1.1	.00268	.0008	.002	.00002	.00005	.02	.007
5/11/98	38	38	.00795	.0294	.117	.00148	.00539	2.58	.868
5/12/98	39	39	.00802	.0302	.121	.00152	.00558	2.67	.899
5/13/98	49	49	.0086	.0382	.159	.002	.0076	3.62	1.222
5/14/98	46	46	.00843	.0358	.147	.00185	.00698	3.33	1.122
5/15/98	-10	10	.00528	.0075	.024	.0003	.00089	.44	.144
5/16/98	56	56	.00896	.0438	.186	.00234	.00909	4.32	1.463
5/17/98	33	33	.00761	.0254	.099	.00125	.00446	2.14	.718
5/18/98	20	20	.00653	.0152	.055	.00069	.00227	1.1	.366
5/19/98	52	52	.00876	.0406	.170	.00214	.00823	3.91	1.324
5/20/98	13	13	.00572	.0098	.033	.00042	.00127	.62	.205
5/21/98	14	14	.00585	.0105	.036	.00045	.0014	.69	.226
5/22/98	14	14	.00585	.0105	.036	.00045	.0014	.69	.226
5/23/98	26	26	.00708	.0199	.075	.00094	.00323	1.56	.521
5/24/98	12	12	.00558	.009	.030	.00038	.00114	.56	.184
5/25/98	8.2	8.2	.00496	.0061	.019	.00024	.00068	.34	.110
5/26/98	6.7	6.7	.00466	.0049	.015	.00019	.00052	.26	.084
5/27/98	- 1.8	1.8	.00311	.0013	.003	.00004	.00009	.04	.014
5/28/98	-26	26	.00708	.0199	.075	.00094	.00323	1.56	.521
5/29/98	10	10	.00528	.0075	.024	.0003	.00089	.44	.144
5/30/98	- 8.6	8.6	.00504	.0064	.020	.00026	.00073	.36	.118
5/31/98	17	17	.00621	.0129	.045	.00057	.00182	.89	.294
Total out of lake	nd	nd	0.17749	0.5518	2.168	0.02729	0.09833	47.12	15.830
Total into lake	nd	nd	0.02671	0.0479	0.168	0.00211	0.00676	3.29	1.091

Table 2–3. Constituent load for the east opening of Channel Lake at the CLE gage, near Antioch, May 1998–April 1999—Continued

Date (m/d/y)	Mean daily discharge (cubic feet per second)	Absolute value of mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (tons per day)	Load, volatile suspended solids (ton per day)
6/1/98	-9.6	9.6	0.00521	0.00715	0.0231	0.000290	0.000844	0.415	0.136
6/2/98	-10	10	.00528	.00746	.0243	.000305	.000892	.438	.144
6/3/98	-.52	.52	.00213	.000357	.0007	.000009	.0000166	.00864	.00270
6/4/98	15	15	.00598	.0113179	.0392	.000492	.00154	.751	.249
6/5/98	7.3	7.3	.00479	.00540	.0167	.000210	.000583	.289	.0943
6/6/98	11	11	.00543	.0082288	.0272	.000341	.00101	.498	.164
6/7/98	6.1	6.1	.00453	.0044893	.0135	.000170	.000458	.227	.0741
6/8/98	12	12	.00558	.00900	.0301	.000378	.00114	.558	.184
6/9/98	17	17	.00621	.0129	.0454	.000571	.00182	.887	.294
6/10/98	4.8	4.8	.00421	.0035092	.0102	.000128	.000331	.165	.0536
6/11/98	-35	35	.00775	.0270	.107	.00134	.00483	2.31	.777
6/12/98	14	14	.00585	.0105	.0361	.000454	.00140	.685	.226
6/13/98	-12	12	.00558	.00900	.0301	.000378	.00114	.558	.184
6/14/98	4.4	4.4	.00410	.003209	.00921	.000115	.000295	.147	.0477
6/15/98	6.7	6.7	.00466	.0049437	.0151	.000190	.000520	.258	.0840
6/16/98	4.9	4.9	.00424	.0035844	.0105	.000131	.000341	.170	.0552
6/17/98	4.6	4.6	.00416	.003359	.00970	.000122	.000313	.156	.0507
6/18/98	-27	27	.00716	.0207	.0785	.000987	.00340	1.64	.548
6/19/98	7.4	7.4	.00481	.0054753	.0170	.000213	.000594	.294	.0960
6/20/98	-37	37	.00789	.0286	.114	.00143	.00520	2.49	.837
6/21/98	6.7	6.7	.00466	.0049437	.0151	.000190	.000520	.258	.084
6/22/98	15	15	.00598	.0113	.0392	.000492	.00154	.751	.249
6/23/98	20	20	.00653	.0152	.0551	.000692	.00227	1.10	.366
6/24/98	17	17	.00621	.0129	.0454	.000571	.00182	.887	.294
6/25/98	-29	29	.00732	.0223	.0854	.00107	.00375	1.80	.603
6/26/98	-43	43	.00826	.0334	.136	.00171	.00637	3.04	1.03
6/27/98	-6	6	.00451	.0044137	.0133	.000167	.000448	.222	.0724
6/28/98	-14	14	.00585	.0105	.0361	.000454	.00140	.685	.226
6/29/98	7	7	.00473	.0051714	.0159	.000200	.000551	.273	.0891
6/30/98	34	34	.00768	.0262	.103	.00130	.00464	2.227	.747
Total out of lake	nd	nd	0.110	0.174	0.591	0.00743	0.0230	11.2	3.72
Total into lake	nd	nd	0.0482	0.0859	0.306	0.00385	0.0126	6.11	2.03

Table 2–3. Constituent load for the east opening of Channel Lake at the CLE gage, near Antioch, May 1998–April 1999—Continued

Date (m/d/y)	Mean daily discharge (cubic feet per second)	Absolute value of mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (tons per day)	Load, volatile suspended solids (ton per day)
7/1/98	50	50	0.00865	0.0390	0.162	0.00205	0.00781	3.72	1.26
7/2/98	45	45	.00838	.0350	.143	.00181	.00677	3.23	1.09
7/3/98	39	39	.00802	.0302	.121	.00152	.00558	2.67	.899
7/4/98	14	14	.00585	.0105	.036	.00045	.00140	.685	.226
7/5/98	16	16	.00610	.0121	.042	.00053	.00168	.818	.271
7/6/98	27	27	.00716	.0207	.0785	.00099	.00340	1.64	.548
7/7/98	33	33	.00761	.0254	.0995	.00125	.00446	2.14	.718
7/8/98	20	20	.00653	.0152	.0551	.00069	.00227	1.10	.366
7/9/98	44	44	.00832	.0342038	.140	.00176	.00657	3.14	1.06
7/10/98	31	31	.00747	.0239	.0924	.00116	.00410	1.97	.660
7/11/98	45	45	.00838	.0350	.143	.00181	.00677	3.23	1.09
7/12/98	12	12	.00558	.00900	.0301	.000378	.00114	.558	.184
7/13/98	17	17	.00621	.0129	.0454	.000571	.00182	.887	.294
7/14/98	1	1	.00260	.000700	.00160	.000020	.0000400	.021	.00650
7/15/98	-9	9	.00511	.00670	.0214	.000269	.000774	.381	.125
7/16/98	6	6	.00451	.0044137	.0133	.000167	.000448	.222	.0724
7/17/98	-3	3	.00364	.0021649	.00586	.000073	.000176	.089	.0285
7/18/98	10	10	.00528	.007461	.0243	.000305	.000892	.438	.144
7/19/98	2	2	.00322	.0014271	.00363	.000045	.000102	.0517	.0165
7/20/98	-14	14	.00585	.0105	.0361	.000454	.00140	.685	.226
7/21/98	-25	25	.00699	.0191	.0717	.000901	.00307	1.48	.494
7/22/98	5	5	.00426	.0036596	.0107	.000134	.00035	.175	.0567
7/23/98	14	14	.00585	.0105	.0361	.000454	.00140	.685	.226
7/24/98	-2.8	2.8	.00357	.0020167	.00540	.000068	.000160	.0809	.0260
7/25/98	2.1	2.1	.00327	.00150	.00384	.000048	.000109	.0552	.0176
7/26/98	-16	16	.00610	.0121	.0423	.000532	.00168	.818	.271
7/27/98	9.7	9.7	.00523	.0072311	.0234	.000294	.000856	.421	.138
7/28/98	6.1	6.1	.00453	.0044893	.0135	.000170	.000458	.227	.0741
7/29/98	6.2	6.2	.00455	.004565	.0138	.000173	.000468	.232	.0757
7/30/98	13	13	.00572	.0097701	.0331	.000416	.00127	.621	.205
7/31/98	7.4	7.4	.00481	.0054753	.0170	.000213	.000594	.294	.0960
Total out of lake	nd	nd	0.148	0.364	1.38	0.0174	0.0608	29.2	9.79
Total into lake	nd	nd	0.0313	0.0526	0.183	0.00230	0.00726	3.53	1.17

Table 2–3. Constituent load for the east opening of Channel Lake at the CLE gage, near Antioch, May 1998–April 1999—Continued

Date (m/d/y)	Mean daily discharge (cubic feet per second)	Absolute value of mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (tons per day)	Load, volatile suspended solids (ton per day)
8/1/98	-7.6	7.6	0.00485	0.0056274	0.0176	0.000220	0.000616	0.305	0.0996
8/2/98	-7	7	.00473	.0051714	.0159	.000200	.000551	.273	.0891
8/3/98	11	11	.00543	.0082288	.0272	.000341	.00101	.498	.164
8/4/98	8.8	8.8	.00507	.0065425	.0209	.000262	.000750	.370	.121
8/5/98	-3.1	3.1	.00368	.0022391	.00609	.0000763	.000184	.0926	.0298
8/6/98	-38	38	.00795	.0294	.117	.00148	.00539	2.58	.868
8/7/98	-10	10	.00528	.007461	.0243	.000305	.000892	.438	.144
8/8/98	2.1	2.1	.00327	.00150	.00384	.0000481	.000109	.0552	.0176
8/9/98	3.7	3.7	.00389	.0026856	.00750	.0000940	.000233	.117	.0378
8/10/98	12	12	.00558	.00900	.0301	.000378	.00114	.558	.184
8/11/98	13	13	.00572	.0097701	.0331	.000416	.00127	.621	.205
8/12/98	.65	.65	.00228	.000450	.000962	.0000120	.0000224	.0116	.00364
8/13/98	-5.3	5.3	.00434	.0038854	.0115	.000144	.000379	.189	.0613
8/14/98	-16	16	.00610	.0121	.0423	.000532	.00168	.818	.271
8/15/98	8.5	8.5	.00502	.0063134	.0200	.000251	.000716	.353	.116
8/16/98	-15	15	.00598	.0113	.0392	.000492	.00154	.751	.249
8/17/98	12	12	.00558	.00900	.0301	.000378	.00114	.558	.184
8/18/98	6.4	6.4	.00460	.0047164	.0143	.000180	.000489	.242	.0790
8/19/98	7.1	7.1	.00475	.0052473	.0162	.000203	.000562	.278	.0908
8/20/98	2.9	2.9	.00361	.0020908	.00563	.0000705	.000168	.0847	.0272
8/21/98	8.6	8.6	.00504	.0063897	.0203	.000255	.000728	.359	.118
8/22/98	-16	16	.00610	.0121	.0423	.000532	.00168	.818	.271
8/23/98	-12	12	.00558	.00900	.0301	.000378	.00114	.558	.184
8/24/98	15	15	.00598	.0113	.0392	.000492	.00154	.751	.249
8/25/98	-10	10	.00528	.007461	.0243	.000305	.000892	.438	.144
8/26/98	-11	11	.00543	.00823	.0272	.000341	.00101	.498	.164
8/27/98	-.8	.8	.00243	.000557	.00123	.0000154	.0000296	.0153	.00481
8/28/98	.1	.1	.00128	.000066	.000105	.00000131	.0000018	.00097	.000293
8/29/98	7.7	7.7	.00487	.00570	.0178	.000224	.000627	.310	.101
8/30/98	-4.2	4.2	.00404	.00306	.00871	.000109	.000277	.139	.0448
8/31/98	8.4	8.4	.00500	.00624	.0198	.000248	.000705	.348	.114
Total out of lake	nd	nd	0.0769	0.0953	0.307	0.00385	0.0112	5.52	1.81
Total into lake	nd	nd	0.0717	0.118	0.408	0.00513	0.0163	7.91	2.62

Table 2–3. Constituent load for the east opening of Channel Lake at the CLE gage, near Antioch, May 1998–April 1999—Continued

Date (m/d/y)	Mean daily discharge (cubic feet per second)	Absolute value of mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (tons per day)	Load, volatile suspended solids (ton per day)
9/1/98	5	5	0.00426	0.0036596	0.0107	0.000134	0.000350	0.175	0.0567
9/2/98	9.7	9.7	.00523	.00723	.0234	.000294	.000856	.421	.138
9/3/98	13	13	.00572	.0097701	.0331	.000416	.00127	.621	.205
9/4/98	5.8	5.8	.00446	.00426	.0128	.000160	.000428	.213	.0692
9/5/98	-4.1	4.1	.00401	.00298	.00847	.000106	.000268	.134	.0434
9/6/98	-6.6	6.6	.00464	.00487	.0149	.000186	.000509	.252	.0823
9/7/98	3.2	3.2	.00372	.00231	.00632	.0000792	.000192	.097	.0311
9/8/98	-13	13	.00572	.00977	.0331	.000416	.00127	.621	.205
9/9/98	1	1	.00260	.000700	.00160	.0000200	.0000400	.0206	.00650
9/10/98	-10	10	.00528	.00746	.0243	.000305	.000892	.438	.144
9/11/98	8	8	.00493	.00593	.0187	.000234	.000660	.326	.107
9/12/98	15	15	.00598	.0113	.0392	.000492	.00154	.751	.249
9/13/98	-11	11	.00543	.00823	.0272	.000341	.00101	.498	.164
9/14/98	-35	35	.00775	.0270	.107	.00134	.00483	2.31	.777
9/15/98	-13	13	.00572	.0097701	.0331	.000416	.00127	.621	.205
9/16/98	.29	.29	.00178	.0001962	.000371	.00000462	.0000075	.00398	.00123
9/17/98	12	12	.00558	.00900	.0301	.000378	.00114	.558	.184
9/18/98	7.2	7.2	.00477	.00532	.0165	.000207	.000573	.283	.0926
9/19/98	3.8	3.8	.00392	.0027602	.00774	.0000970	.000242	.121	.0392
9/20/98	6.8	6.8	.00469	.0050196	.0154	.000193	.000530	.263	.0857
9/21/98	19	19	.00643	.0144	.0518	.000651	.00212	1.03	.342
9/22/98	2.6	2.6	.00349	.00187	.00495	.0000619	.000145	.073	.0235
9/23/98	4	4	.00398	.0029096	.00823	.000103	.000259	.130	.0420
9/24/98	13	13	.00572	.0097701	.0331	.000416	.00127	.621	.205
9/25/98	3.4	3.4	.00379	.00246	.00679	.0000851	.000208	.105	.0337
9/26/98	-47	47	.00849	.0366	.151	.00190	.00718	3.42	1.16
9/27/98	28	28	.00724	.0215	.0819	.00103	.00357	1.72	.576
9/28/98	2.5	2.5	.00345	.00179	.00472	.0000591	.000138	.0696	.0223
9/29/98	8.2	8.2	.00496	.00608	.0192	.000241	.000682	.337	.110
9/30/98	9.7	9.7	.00523	.00723	.0234	.000294	.000856	.421	.138
Total out of lake	nd	nd	0.102	0.136	0.450	0.00565	0.0171	8.36	2.76
Total into lake	nd	nd	0.0470	0.107	0.399	0.00501	0.0172	8.30	2.78

Table 2–3. Constituent load for the east opening of Channel Lake at the CLE gage, near Antioch, May 1998–April 1999—Continued

Date (m/d/y)	Mean daily discharge (cubic feet per second)	Absolute value of mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (tons per day)	Load, volatile suspended solids (ton per day)
10/1/98	2.8	2.8	0.00357	0.00202	0.00540	0.0000676	0.000160	0.0809	0.0260
10/2/98	21	21	.00663	.0160	.0583	.000733	.00242	1.17	.391
10/3/98	24	24	.00690	.0183	.0683	.000859	.00290	1.40	.468
10/4/98	8.8	8.8	.00507	.00654	.0209	.000262	.000750	.370	.121
10/5/98	33	33	.00761	.0254	.0995	.00125	.00446	2.14	.718
10/6/98	-4	4	.00398	.00291	.00823	.000103	.000259	.130	.0420
10/7/98	23	23	.00681	.0176	.0649	.000816	.00274	1.33	.442
10/8/98	10	10	.00528	.00746	.0243	.000305	.000892	.438	.144
10/9/98	14	14	.00585	.0105	.0361	.000454	.00140	.685	.226
10/10/98	19	19	.00643	.0144	.0518	.000651	.00212	1.03	.342
10/11/98	13	13	.00572	.00977	.0331	.000416	.00127	.621	.205
10/12/98	18	18	.00632	.0137	.0486	.000611	.00197	.957	.318
10/13/98	11	11	.00543	.00823	.0272	.000341	.00101	.498	.164
10/14/98	14	14	.00585	.0105	.0361	.000454	.00140	.685	.226
10/15/98	5.2	5.2	.00432	.00381	.0112	.000141	.000369	.184	.0597
10/16/98	-19	19	.00643	.0144	.0518	.000651	.00212	1.03	.342
10/17/98	-62	62	.00924	.0487	.209	.00264	.01043	4.94	1.68
10/18/98	32	32	.00754	.0247	.0959	.00121	.00428	2.05	.689
10/19/98	-2.3	2.3	.00336	.00165	.00428	.0000536	.000123	.0623	.0199
10/20/98	26	26	.00708	.0199	.0750	.000944	.00323	1.56	.521
10/21/98	26	26	.00708	.0199	.0750	.000944	.00323	1.56	.521
10/22/98	42	42	.00820	.0326	.132	.00166	.00617	2.95	.993
10/23/98	31	31	.00747	.0239	.0924	.00116	.00410	1.97	.660
10/24/98	14	14	.00585	.0105	.0361	.000454	.00140	.685	.226
10/25/98	19	19	.00643	.0144	.0518	.000651	.00212	1.03	.342
10/26/98	6	6	.00451	.00441	.0133	.000167	.000448	.222	.0724
10/27/98	-2.4	2.4	.00340	.00172	.00450	.0000563	.000130	.0659	.0211
10/28/98	3.8	3.8	.00392	.00276	.00774	.0000970	.000242	.121	.0392
10/29/98	15	15	.00598	.0113	.0392	.000492	.00154	.751	.249
10/30/98	18	18	.00632	.0137	.0486	.000611	.00197	.957	.318
10/31/98	9.8	9.8	.00524	.00731	.0237	.000298	.000868	.427	.140
Total out of lake	nd	nd	0.157	0.350	1.28	0.0161	0.0535	25.9	8.62
Total into lake	nd	nd	0.0264	0.0694	0.278	0.00350	0.0131	6.23	2.10

Table 2–3. Constituent load for the east opening of Channel Lake at the CLE gage, near Antioch, May 1998–April 1999—Continued

Date (m/d/y)	Mean daily discharge (cubic feet per second)	Absolute value of mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (tons per day)	Load, volatile suspended solids (ton per day)
11/1/98	22	22	0.00672	0.0168	0.0616	0.000775	0.00258	1.25	0.416
11/2/98	31	31	.00747	.0239	.0924	.00116	.00410	1.97	.660
11/3/98	12	12	.00558	.00900	.0301	.000378	.00114	.558	.184
11/4/98	2.3	2.3	.00336	.00165	.0043	.0000536	.000123	.0623	.0199
11/5/98	5.2	5.2	.00432	.00381	.0112	.000141	.000369	.184	.0597
11/6/98	17	17	.00621	.0129	.0454	.000571	.00182	.887	.294
11/7/98	18	18	.00632	.0137	.0486	.000611	.00197	.957	.318
11/8/98	20	20	.00653	.0152	.0551	.000692	.00227	1.10	.366
11/9/98	20	20	.00653	.0152	.0551	.000692	.00227	1.10	.366
11/10/98	-235	235	.0139	.191	1.0106	.0128	.0629	29.0	10.1
11/11/98	179	179	.0128	.145	.7328	.00925	.0436	20.2	6.98
11/12/98	-3	3	.00364	.00216	.0059	.0000734	.000176	.0886	.0285
11/13/98	.44	.44	.00202	.000301	.0006	.00000757	.0000132	.00692	.00215
11/14/98	27	27	.00716	.0207	.0785	.000987	.00340	1.64	.548
11/15/98	9.4	9.4	.00518	.00700	.0226	.000283	.000820	.404	.133
11/16/98	29	29	.00732	.0223	.0854	.00107	.00375	1.80	.603
11/17/98	30	30	.00739	.0231	.0889	.00112	.00392	1.89	.632
11/18/98	-4.5	4.5	.00413	.00328	.0095	.000119	.000304	.152	.049
11/19/98	72	72	.00968	.0567	.2499	.00315	.0128	6.03	2.05
11/20/98	68	68	.00951	.0535	.2336	.00294	.0118	5.59	1.90
11/21/98	8.2	8.2	.00496	.00608	.0192	.000241	.000682	.337	.110
11/22/98	6	6	.00451	.00441	.0133	.000167	.000448	.222	.0724
11/23/98	47	47	.00849	.0366	.1510	.00190	.00718	3.42	1.16
11/24/98	18	18	.00632	.0137	.0486	.000611	.00197	.957	.318
11/25/98	16	16	.00610	.0121	.0423	.000532	.00168	.818	.271
11/26/98	21	21	.00663	.0160	.0583	.000733	.00242	1.17	.391
11/27/98	6.7	6.7	.00466	.00494	.0151	.000190	.000520	.258	.084
11/28/98	8.2	8.2	.00496	.00608	.0192	.000241	.000682	.337	.110
11/29/98	-50	50	.00865	.0390	.1625	.00205	.00781	3.72	1.26
11/30/98	49	49	.00860	.0382	.1586	.00200	.00760	3.62	1.22
Total out of lake	nd	nd	0.169	0.578	2.42	0.0305	0.120	56.8	19.3
Total into lake	nd	nd	0.0303	0.236	1.19	0.0150	0.0712	33.0	11.4

Table 2–3. Constituent load for the east opening of Channel Lake at the CLE gage, near Antioch, May 1998–April 1999—Continued

Date (m/d/y)	Mean daily discharge (cubic feet per second)	Absolute value of mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (tons per day)	Load, volatile suspended solids (ton per day)
12/1/98	-45	45	0.00838	0.0350	0.143	0.00181	0.00677	3.23	1.09
12/2/98	38	38	.00795	.0294	.117	.00148	.00539	2.58	.868
12/3/98	18	18	.00632	.0137	.0486	.000611	.00197	.957	.318
12/4/98	10	10	.00528	.0075	.0243	.000305	.000892	.438	.144
12/5/98	-17	17	.00621	.0129	.0454	.000571	.00182	.887	.294
12/6/98	17	17	.00621	.0129	.0454	.000571	.00182	.887	.294
12/7/98	-13	13	.00572	.00977	.0331	.000416	.00127	.621	.205
12/8/98	-1.3	1.3	.00282	.000917	.00218	.000027	.0000570	.0292	.00925
12/9/98	-1.2	1.2	.00275	.000844	.00198	.000025	.0000511	.0262	.00831
12/10/98	22	22	.00672	.0168	.0616	.000775	.00258	1.25	.416
12/11/98	8.1	8.1	.00494	.00601	.0189	.000238	.000671	.331	.108
12/12/98	26	26	.00708	.0199	.0750	.000944	.00323	1.56	.521
12/13/98	18	18	.00632	.0137	.0486	.000611	.00197	.957	.318
12/14/98	-14	14	.00585	.0105	.0361	.000454	.00140	.685	.226
12/15/98	40	40	.00808	.0310	.125	.001571	.00578	2.76	.930
12/16/98	31	31	.00747	.0239	.0924	.001162	.00410	1.97	.660
12/17/98	23	23	.00681	.0176	.0649	.000816	.00274	1.33	.442
12/18/98	12	12	.00558	.00900	.0301	.000378	.00114	.558	.184
12/19/98	40	40	.00808	.0310	.125	.001571	.00578	2.76	.930
12/20/98	36	36	.00782	.0278	.110	.001387	.00501	2.40	.807
12/21/98	29	29	.00732	.0223	.0854	.001074	.00375	1.80	.603
12/22/98	20	20	.00653	.0152	.0551	.000692	.00227	1.10	.366
12/23/98	16	16	.00610	.0121	.0423	.000532	.00168	.818	.271
12/24/98	18	18	.00632	.0137	.0486	.000611	.00197	.957	.318
12/25/98	11	11	.00543	.00823	.0272	.000341	.00101	.498	.164
12/26/98	24	24	.00690	.0183	.0683	.000859	.00290	1.40	.468
12/27/98	13	13	.00572	.00977	.0331	.000416	.00127	.621	.205
12/28/98	11	11	.00543	.00823	.0272	.000341	.00101	.498	.164
12/29/98	23	23	.00681	.0176	.0649	.000816	.00274	1.33	.442
12/30/98	20	20	.00653	.0152	.0551	.000692	.00227	1.10	.366
12/31/98	15	15	.00598	.0113	.0392	.000492	.00154	.751	.249
Total out of lake	nd	nd	0.164	0.412	1.53	0.0193	0.0655	31.6	10.6
Total into lake	nd	nd	0.0317	0.0699	0.262	0.00330	0.0114	5.48	1.83

Table 2–3. Constituent load for the east opening of Channel Lake at the CLE gage, near Antioch, May 1998–April 1999—Continued

Date (m/d/y)	Mean daily discharge (cubic feet per second)	Absolute value of mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (tons per day)	Load, volatile suspended solids (ton per day)
1/1/99	20	20	0.00653	0.0152	0.0551	0.000692	0.00227	1.10	0.366
1/2/99	7	7	.00473	.00517	.0159	.000200	.000551	.273	.089
1/3/99	20	20	.00653	.0152	.0551	.000692	.00227	1.10	.366
1/4/99	11	11	.00543	.00823	.0272	.000341	.00101	.498	.164
1/5/99	17	17	.00621	.0129	.0454	.000571	.00182	.887	.294
1/6/99	12	12	.00558	.00900	.0301	.000378	.00114	.558	.184
1/7/99	8	8	.00493	.00593	.0187	.000234	.000660	.326	.107
1/8/99	9	9	.00511	.00670	.0214	.000269	.000774	.381	.125
1/9/99	14	14	.00585	.0105	.0361	.000454	.00140	.685	.226
1/10/99	14	14	.00585	.0105	.0361	.000454	.00140	.685	.226
1/11/99	13	13	.00572	.00977	.0331	.000416	.00127	.621	.205
1/12/99	11	11	.00543	.00823	.0272	.000341	.00101	.498	.164
1/13/99	10	10	.00528	.00746	.0243	.000305	.000892	.438	.144
1/14/99	9	9	.00511	.00670	.0214	.000269	.000774	.381	.125
1/15/99	7	7	.00473	.00517	.0159	.000200	.000551	.273	.0891
1/16/99	17	17	.00621	.0129	.0454	.000571	.00182	.887	.294
1/17/99	12	12	.00558	.00900	.0301	.000378	.00114	.558	.184
1/18/99	16	16	.00610	.0121	.0423	.000532	.00168	.818	.271
1/19/99	12	12	.00558	.00900	.0301	.000378	.00114	.558	.184
1/20/99	9	9	.00511	.00670	.0214	.000269	.000774	.381	.125
1/21/99	14	14	.00585	.0105	.0361	.000454	.00140	.685	.226
1/22/99	20	20	.00653	.0152	.0551	.000692	.00227	1.10	.366
1/23/99	16	16	.00610	.0121	.0423	.000532	.00168	.818	.271
1/24/99	12	12	.00558	.00900	.0301	.000378	.00114	.558	.184
1/25/99	-35	35	.00775	.0270	.1066	.00134	.0048	2.31	.777
1/26/99	-130	130	.0116	.1041	.5022	.00634	.0283	13.2	4.54
1/27/99	-70	70	.00959	.0551	.2417	.00305	.0123	5.81	1.97
1/28/99	-10	10	.00528	.00746	.0243	.000305	.000892	.438	.144
1/29/99	110	110	.0110	.0877	.412	.00520	.0226	10.6	3.63
1/30/99	95	95	.0105	.0754	.347	.00437	.0185	8.72	2.98
1/31/99	65	65	.00938	.0511	.221	.00279	.0111	5.27	1.79
Total out of lake	nd	nd	0.167	0.447	1.78	0.0224	0.0831	39.6	13.4
Total into lakev	nd	nd	0.0342	0.194	0.875	0.0110	0.0463	21.8	7.44

Table 2–3. Constituent load for the east opening of Channel Lake at the CLE gage, near Antioch, May 1998–April 1999—Continued

Date (m/d/y)	Mean daily discharge (cubic feet per second)	Absolute value of mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (tons per day)	Load, volatile suspended solids (ton per day)
2/1/99	40	40	0.00808	0.0310	0.125	0.00157	0.00578	2.76	0.930
2/2/99	60	60	.00915	.0470	.202	.00254	.00998	4.73	1.60
2/3/99	70	70	.00959	.0551	.242	.00305	.0123	5.81	1.97
2/4/99	55	55	.00891	.0430	.182	.00229	.00888	4.22	1.43
2/5/99	31	31	.00747	.0239	.092	.00116	.00410	1.97	.660
2/6/99	50	50	.00865	.0390	.162	.00205	.00781	3.72	1.26
2/7/99	54	54	.00886	.0422	.178	.00224	.00866	4.12	1.39
2/8/99	47	47	.00849	.0366	.151	.00190	.00718	3.42	1.16
2/9/99	61	61	.00920	.0478	.205	.00259	.0102	4.84	1.64
2/10/99	59	59	.00910	.0462	.198	.00249	.00976	4.63	1.57
2/11/99	-12	12	.00558	.00900	.0301	.000378	.00114	.56	.184
2/12/99	109	109	.0110	.0869	.408	.00514	.0223	10.5	3.58
2/13/99	43	43	.00826	.0334	.136	.00171	.00637	3.04	1.03
2/14/99	25	25	.00699	.0191	.0717	.000901	.00307	1.48	.494
2/15/99	50	50	.00865	.0390	.162	.00205	.00781	3.72	1.26
2/16/99	78	78	.00992	.0616	.275	.00346	.0142	6.71	2.28
2/17/99	78	78	.00992	.0616	.275	.00346	.0142	6.71	2.28
2/18/99	49	49	.00860	.0382	.159	.00200	.00760	3.62	1.22
2/19/99	50	50	.00865	.0390	.162	.00205	.00781	3.72	1.26
2/20/99	48	48	.00854	.0374	.155	.00195	.00739	3.52	1.19
2/21/99	46	46	.00843	.0358	.147	.00185	.00698	3.33	1.12
2/22/99	44	44	.00832	.0342	.140	.00176	.00657	3.14	1.06
2/23/99	30	30	.00739	.0231	.0889	.00112	.00392	1.89	.632
2/24/99	27	27	.00716	.0207	.0785	.000987	.00340	1.64	.548
2/25/99	30	30	.00739	.0231	.0889	.00112	.00392	1.89	.632
2/26/99	26	26	.00708	.0199	.0750	.00094	.00323	1.56	.521
2/27/99	30	30	.00739	.0231	.0889	.00112	.00392	1.89	.632
2/28/99	32	32	.00754	.0247	.0959	.00121	.00428	2.05	.689
Total out of lake	nd	nd	0.2287	1.033	4.34	0.0547	0.212	101	34.0
Total into lake	nd	nd	0.00558	0.00900	0.0301	0.000378	0.00114	0.558	0.184

Table 2–3. Constituent load for the east opening of Channel Lake at the CLE gage, near Antioch, May 1998–April 1999—Continued

Date (m/d/y)	Mean daily discharge (cubic feet per second)	Absolute value of mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (tons per day)	Load, volatile suspended solids (ton per day)
3/1/99	40	40	0.00808	0.0310	0.125	0.00157	0.00578	2.76	0.930
3/2/99	15	15	.00598	.0113	.0392	.000492	.00154	.751	.249
3/3/99	45	45	.00838	.0350	.143	.00181	.00677	3.23	1.09
3/4/99	20	20	.00653	.0152	.0551	.000692	.00227	1.10	.366
3/5/99	30	30	.00739	.0231	.0889	.00112	.00392	1.89	.632
3/6/99	-6	6	.00451	.00441	.0133	.000167	.000448	.222	.0724
3/7/99	-20	20	.00653	.0152	.0551	.000692	.00227	1.10	.366
3/8/99	5	5	.00426	.00366	.0107	.000134	.000350	.175	.0567
3/9/99	-20	20	.00653	.0152	.0551	.000692	.00227	1.10	.366
3/10/99	45	45	.00838	.0350	.143	.00181	.00677	3.23	1.09
3/11/99	42	42	.00820	.0326	.132	.00166	.00617	2.95	.993
3/12/99	31	31	.00747	.0239	.0924	.00116	.00410	1.97	.660
3/13/99	25	25	.00699	.0191	.0717	.000901	.00307	1.48	.494
3/14/99	20	20	.00653	.0152	.0551	.000692	.00227	1.10	.366
3/15/99	21	21	.00663	.0160	.0583	.000733	.00242	1.17	.391
3/16/99	17	17	.00621	.0129	.0454	.000571	.00182	.887	.294
3/17/99	-26	26	.00708	.0199	.0750	.000944	.00323	1.56	.521
3/18/99	20	20	.00653	.0152	.0551	.000692	.00227	1.10	.366
3/19/99	-23	23	.00681	.0176	.0649	.000816	.00274	1.33	.442
3/20/99	5	5	.00426	.00366	.0107	.000134	.000350	.175	.0567
3/21/99	1.5	1.5	.00295	.00106	.00258	.0000323	.0000691	.0353	.0112
3/22/99	-.45	.45	.00203	.000308	.000623	.00000778	.0000136	.00713	.00222
3/23/99	11	11	.00543	.00823	.0272	.000341	.00101	.498	.164
3/24/99	13	13	.00572	.00977	.0331	.000416	.00127	.621	.205
3/25/99	18	18	.00632	.0137	.0486	.000611	.00197	.957	.318
3/26/99	20	20	.00653	.0152	.0551	.000692	.00227	1.10	.366
3/27/99	11	11	.00543	.00823	.0272	.000341	.00101	.498	.164
3/28/99	7	7	.00473	.00517	.0159	.000200	.000551	.273	.0891
3/29/99	21	21	.00663	.0160	.0583	.000733	.00242	1.17	.391
3/30/99	-33	33	.00761	.0254	.0995	.00125	.00446	2.14	.718
3/31/99	-37	37	.00789	.0286	.114	.00143	.00520	2.49	.837
Total out of lake	nd	nd	0.146	0.370	1.39	0.0175	0.0605	29.1	9.74
Total into lake	nd	nd	0.0490	0.127	0.477	0.00600	0.0206	9.95	3.32

Table 2–3. Constituent load for the east opening of Channel Lake at the CLE gage, near Antioch, May 1998–April 1999—Continued

Date (m/d/y)	Mean daily discharge (cubic feet per second)	Absolute value of mean daily discharge (cubic feet per second)	Load, total nitrogen as nitrate and nitrite (ton per day)	Load, ammonia nitrogen (ton per day)	Load, total Kjeldahl nitrogen (ton per day)	Load, dissolved phosphorus (ton per day)	Load, total phosphorus (ton per day)	Load, total suspended solids (tons per day)	Load, volatile suspended solids (ton per day)
4/1/99	24	24	0.00690	0.0183	0.0683	0.000859	0.00290	1.4	0.468
4/2/99	-5.9	5.9	.00449	.0043	.0130	.00016	.00044	.22	.071
4/3/99	10	10	.00528	.0075	.0243	.0003	.00089	.44	.144
4/4/99	23	23	.00681	.0176	.0649	.00082	.00274	1.33	.442
4/5/99	- .31	.31	.00181	.0002	.0004	.00001	.00001	.004	.001
4/6/99	-25	25	.00699	.0191	.0717	.0009	.00307	1.48	.494
4/7/99	- 8	8	.00493	.0059	.0187	.00023	.00066	.33	.107
4/8/99	66	66	.00942	.0519	.2255	.00284	.01135	5.37	1.824
4/9/99	- .23	.23	.00166	.0002	.0003	.000004	.00001	.003	.001
4/10/99	12	12	.00558	.0090	.0301	.00038	.00114	.56	.184
4/11/99	14	14	.00585	.0105	.0361	.00045	.0014	.69	.226
4/12/99	8.7	8.7	.00505	.0065	.0206	.00026	.00074	.36	.119
4/13/99	29	29	.00732	.0223	.0854	.00107	.00375	1.8	.603
4/14/99	40	40	.00808	.0310	.1248	.00157	.00578	2.76	.930
4/15/99	43	43	.00826	.0334	.1360	.00171	.00637	3.04	1.025
4/16/99	5.6	5.6	.00441	.0041	.0122	.00015	.00041	.2	.066
4/17/99	32	32	.00754	.0247	.0959	.00121	.00428	2.05	.689
4/18/99	41	41	.00814	.0318	.1285	.00162	.00597	2.86	.961
4/19/99	47	47	.00849	.0366	.1510	.0019	.00718	3.42	1.155
4/20/99	33	33	.00761	.0254	.0995	.00125	.00446	2.14	.718
4/21/99	47	47	.00849	.0366	.1510	.0019	.00718	3.42	1.155
4/22/99	58	58	.00905	.0454	.1936	.00244	.00954	4.53	1.533
4/23/99	61	61	.00920	.0478	.2055	.00259	.01021	4.84	1.641
4/24/99	- 2.9	2.9	.00361	.0021	.0056	.00007	.00017	.08	.027
4/25/99	-34	34	.00768	.0262	.1030	.0013	.00464	2.23	.747
4/26/99	23	23	.00681	.0176	.0649	.00082	.00274	1.33	.442
4/27/99	55	55	.00891	.0430	.1818	.00229	.00888	4.22	1.427
4/28/99	67	67	.00947	.0527	.2296	.00289	.01158	5.48	1.862
4/29/99	52	52	.00876	.0406	.1702	.00214	.00823	3.91	1.324
4/30/99	82	82	.01007	.0649	.2914	.00367	.01521	7.68	2.443
Total out of lake	nd	nd	0.17551	0.6792	2.7912	0.03515	0.13292	63.84	21.383
Total into lake	nd	nd	0.03116	0.0581	0.2127	0.00267	0.00899	4.34	1.448

Appendix 3. Ground-water-quality data near Lake Catherine and Channel Lake, near Antioch, Illinois, May 27, 1998–March 15, 1999

Table 3–1. Water-quality data for well 1 near Lake Catherine and Channel Lakes, May 27, 1998–March 15, 1999

[mg/L, milligrams per liter; K, constituent below detection limit; *, accuracy of value uncertain; na, not analyzed]

Constituent	Date of sample collection			
	May 27, 1998	August 8, 1998	November 2, 1998	March 15, 1999
Nitrate and nitrite, total nitrogen (mg/L)	0.03	0.07	0.01K	0.03
Nitrogen, ammonia (mg/L)	.16	.22	.12	.1
Nitrogen, total Kjeldahl (mg/L)	1.2	.59	.39	.11
Phosphorus, dissolved (mg/L)	.053*	.018	.02	.015
Phosphorus, total (mg/L)	.053*	.055	.05	.015
Solids, total suspended (mg/L)	45	11	na	na
Solids, volatile suspended (mg/L)	4	5	na	na
Turbidity (nephelometric turbidity units)	23	6.9	na	na

Table 3–2. Water-quality data for well 2 near Lake Catherine and Channel Lakes, May 27, 1998–March 15, 1999

[mg/L, milligrams per liter; K, constituent below detection limit; *, accuracy of value uncertain; na, not analyzed]

Constituent	Date of sample collection			
	May 27, 1998	August 8, 1998	November 2, 1998	March 15, 1999
Nitrate and nitrite, total nitrogen (mg/L)	0.12	1.58	0.01K	0.05
Nitrogen, ammonia (mg/L)	.31	.4	.21	.18
Nitrogen, total Kjeldahl (mg/L)	1.2	.65	1	.1K
Phosphorus, dissolved (mg/L)	.016	.029*	.01	.003
Phosphorus, total (mg/L)	.455	.029*	.03	.022
Solids, total suspended (mg/L)	1,191	6	na	na
Solids, volatile suspended (mg/L)	58	4	na	na
Turbidity (nephelometric turbidity units)	92	19	na	na

Table 3–3. Water-quality data for well 3 near Lake Catherine and Channel Lakes, May 27, 1998–March 15, 1999

[mg/L, milligrams per liter; K, constituent below detection limit; *, accuracy of value uncertain; na, not analyzed]

Constituent	Date of sample collection			
	May 27, 1998	August 8, 1998	November 2, 1998	March 15, 1999
Nitrate and nitrite, total nitrogen (mg/L)	0.12	0.01K	0.17	0.05
Nitrogen, ammonia (mg/L)	1.2	1.5	1.2	.48
Nitrogen, total Kjeldahl (mg/L)	4	2.7	40*	.62
Phosphorus, dissolved (mg/L)	.146	.008	.021	.008
Phosphorus, total (mg/L)	.968	2.43	1.79	.163
Solids, total suspended (mg/L)	244	4	na	na
Solids, volatile suspended (mg/L)	28	1K	na	na
Turbidity (nephelometric turbidity units)	370	15	na	na

Table 3–4. Water-quality data for well 4 near Lake Catherine and Channel Lakes, May 27, 1998–March 15, 1999

[mg/L, milligrams per liter; na, not analyzed]

Constituent	Date of sample collection			
	May 27, 1998	August 8, 1998	November 2, 1998	March 15, 1999
Nitrate and nitrite, total nitrogen (mg/L)	0.04	0.23	0.2	0.45
Nitrogen, ammonia (mg/L)	.16	.23	.13	.12
Nitrogen, total Kjeldahl (mg/L)	.5	.3	.62	.12
Phosphorus, dissolved (mg/L)	.013	.015	.018	.021
Phosphorus, total (mg/L)	.018	.024	.073	.03
Solids, total suspended (mg/L)	8	37	na	na
Solids, volatile suspended (mg/L)	2	15	na	na
Turbidity (nephelometric turbidity units)	7.9	5	na	na

Table 3–5. Water-quality data for well 5 near Lake Catherine and Channel Lakes, May 27, 1998–March 15, 1999

[mg/L, milligrams per liter; na, not analyzed]

Constituent	Date of sample collection			
	May 27, 1998	August 8, 1998	November 2, 1998	March 15, 1999
Nitrate and nitrite, total nitrogen (mg/L)	0.05	0.08	0.02	0.02
Nitrogen, ammonia (mg/L)	.18	.31	.1	.12
Nitrogen, total Kjeldahl (mg/L)	1.2	.65	.44	.34
Phosphorus, dissolved (mg/L)	.021	.021	.021	.011
Phosphorus, total (mg/L)	.068	.071	.026	.021
Solids, total suspended (mg/L)	34	20	na	na
Solids, volatile suspended (mg/L)	5	4	na	na
Turbidity (nephelometric turbidity units)	14	5.1	na	na

Table 3–6. Water-quality data for well 6 near Lake Catherine and Channel Lakes, May 27, 1998–March 15, 1999

[mg/L, milligrams per liter; K, constituent below detection limit; na, not analyzed]

Constituent	Date of sample collection			
	May 27, 1998	August 8, 1998	November 2, 1998	March 15, 1999
Nitrate and nitrite, total nitrogen (mg/L)	0.01	0.01K	0.06	0.02
Nitrogen, ammonia (mg/L)	.16	.19	.17	.11
Nitrogen, total Kjeldahl (mg/L)	.81	.54	.82	.2
Phosphorus, dissolved (mg/L)	.018	.017	.014	.013
Phosphorus, total (mg/L)	.029	.02	.015	.023
Solids, total suspended (mg/L)	37	12	na	na
Solids, volatile suspended (mg/L)	4	5	na	na
Turbidity (nephelometric turbidity units)	5.5	3.9	na	na

Table 3–7. Water-quality data for well 7 near Lake Catherine and Channel Lakes, May 27, 1998–March 15, 1999

[mg/L, milligrams per liter; na, not analyzed]

Constituent	Date of sample collection			
	May 27, 1998	August 8, 1998	November 2, 1998	March 15, 1999
Nitrate and nitrite, total nitrogen (mg/L)	0.38	0.25	0.12	0.08
Nitrogen, ammonia (mg/L)	.46	.3	.35	.34
Nitrogen, total Kjeldahl (mg/L)	.89	.59	.55	.34
Phosphorus, dissolved (mg/L)	.024	.022	.022	.047
Phosphorus, total (mg/L)	.106	.051	.054	.047
Solids, total suspended (mg/L)	384	42	na	na
Solids, volatile suspended (mg/L)	22	5	na	na
Turbidity (nephelometric turbidity units)	38	3.3	na	na

Table 3–8. Water-quality data for well 8 near Lake Catherine and Channel Lakes, May 27, 1998–March 15, 1999

[mg/L, milligrams per liter; K, constituent below detection limit; *, accuracy of value uncertain; na, not analyzed]

Constituent	Date of sample collection			
	May 27, 1998	August 8, 1998	November 2, 1998	March 15, 1999
Nitrate and nitrite, total nitrogen (mg/L)	0.05	0.01K	0.01K	0.06
Nitrogen, ammonia (mg/L)	.77	.73	.59	.45
Nitrogen, total Kjeldahl (mg/L)	2.2	.75	.98	.45*
Phosphorus, dissolved (mg/L)	.011	.127	.02	.015
Phosphorus, total (mg/L)	.34	.127	.102	.259
Solids, total suspended (mg/L)	582	210	na	900*
Solids, volatile suspended (mg/L)	32	24	na	46*
Turbidity (nephelometric turbidity units)	33	3.7	na	3.1

Appendix 4. Water-quality data from Lake Catherine and Channel Lake, near Antioch, Illinois, April 21–November 27, 1998

Table 4–1. Water-quality data trom site CL1 at a depth of 1 foot, Channel Lake, April 21–November 23, 1998

[mg/L, milligrams per liter; K, consituent below detection limit; na, not analyzed; q, holding time exceeded; NTU, nephelometric turbidity units; µS/cm, microSiemens per centimeter; alkalinity expressed as milligrams per liter of $CaCO_3$]

Constituent	Date of sample collection											
	April 21, 1998	May 15, 1998	June 15, 1998	June 17, 1998	July 13, 1998	Aug. 11, 1998	Aug. 31, 1998	Sept. 15, 1998	Sept. 30, 1998	Oct. 14, 1998	Oct. 26, 1998	Nov. 23, 1998
Nitrate and nitrite, as total nitrogen (mg/L)	0.27	na	0.01K	na	0.01K	0.01	na	0.01K	na	0.01K	0.03	0.09
Nitrogen, ammonia (mg/L)	.27	na	.01K	na	.08	.01	na	.22	na	.24	.27	.42
Nitrogen, total Kjeldahl (mg/L)	.75	na	.76	na	.67	1.1	na	1.5	na	.9	1.5	na
Phosphorus, dissolved (mg/L)	na	na	na	0 .01	.01	.009	na	na	na	na	.021	na
Phosphorus, total (mg/L)	.036	na	.031	.03	.026	.032	na	.038	na	.076	.058	.047
Solids, total suspended (mg/L)	4	na	5	na	6	14	na	2q	na	5q	2q	7.0
Solids, volatile suspended (mg/L)	3	na	3	na	5	8	na	1Kq	na	2q	1Kq	4.0
Turbidity (NTU)	4.2	na	14	na	3	50	na	3.9	na	na	3	na
Conductivity, field (µS/cm)	607	na	na	581	579	586	na	na	na	na	591	na
pH, field	8.46	na	na	8.7	8.62	8.59	na	na	na	na	8.6	na
Alkalinity, phenolphthalein (mg/L)	na	na	na	16	7	10	na	na	na	na	na	na
Alkalinity, total (mg/L)	na	na	na	200	204	194	na	na	na	na	na	na
Secchi reading (inches)	96	na	na	91	49	32	na	36	na	42	55	na

Table 4–2. Water-quality data from site CL1 at a depth of 4.4–22 feet, Channel Lake, April 21–November 25, 1998

[µg/L, micrograms per liter; na, not analyzed; K, constituent below detection limit; ml, milliliter]

Constituent	Date of sample collection										
	April 21, 1998	May 15, 1998	July 13, 1998	Aug. 11, 1998	Aug. 31, 1998	Sept. 15, 1998	Sept. 30, 1998	Oct. 14, 1998	Oct. 26, 1998	Nov. 9, 1998	Nov. 25, 1998
Chlorophyll-*a* (µg/L)	6.41	4.27	24.0	46.1	42.7	53.4	77.4	na	118	22	30
Chlorophyll-*a*-uncorrected (µg/L)	5.88	3.81	24.3	44.7	42.1	51.4	76.2	na	113	24.1	35.2
Chlorophyll-*b* (µg/L)	.75	.86	.06	2.69	1.18	1K	4.31	na	2.36	1.33	11.3
Chlorophyll-*c* (µg/L)	.00	.58	.87	3.17	2.63	4.62	12.9	na	20.2	3.58	15.6
Pheophytin-*a* (µg/L)	.00	.00	.00	.00	.00	1K	1K	na	1K	2.27	8.28
Chlorophyll filtered	500	1,000	300	434	200	300	400	na	450	400	400
Total algal density (per ml)	2,541	na	8,589	21,489	na	na	na	na	3,274	na	na
Depth of sample (feet)	16	22	8	5	4.4	6	6	na	9	10	10

Table 4–3. Water-quality data from site CL1 at a depth of 28–35 feet, Channel Lake, April 21–November 25, 1998

[mg/L, milligrams per liter; K, constituent below detection limit; na, not analyzed; q, holding time exceeded; NTU, nephelometric turbidity units; µS/cm, microSiemens per centimeter; alkalinity expressed as milligrams per liter of $CaCO_3$]

Constituent	Date of sample collection											
	April 21, 1998	May 15, 1998	June 15, 1998	June 17, 1998	July 13, 1998	Aug. 11, 1998	Aug. 31, 1998	Sept. 15, 1998	Sept. 30, 1998	Oct. 14, 1998	Oct. 26, 1998	Nov. 25, 1998
Nitrate and nitrite, as total nitrogen (mg/L)	0.25	0.04	na	na	0.01K	na	na	na	0.01K	na	0.03	na
Nitrogen, ammonia (mg/L)	.33	.15	na	na	2.2	na	na	na	.14	na	.29	na
Nitrogen, total Kjeldahl (mg/L)	.83	.7	na	na	2.7	na	na	na	1.2	na	.76	na
Phosphorus, dissolved (mg/L)	na	na	na	.28	.483	na	na	na	na	na	.017	na
Phosphorus, total (mg/L)	.038	.022	na	.3	.512	na	na	na	.06	na	.029	na
Solids, total suspended (mg/L)	5	2	na	na	5	na	na	na	6q	na	5q	16
Solids, volatile suspended (mg/L)	2	1K	na	na	5	na	na	na	3q	na	5q	16
Turbidity (NTU)	8	1.5	na	na	3.1	na	na	na	4.4	na	3.2	na
Conductivity, field (µS/cm)	613	na	na	650	579	630	na	na	na	na	598	na
pH, field	8.36	na	na	7.17	8.62	7.24	na	na	na	na	8.3	na
Alkalinity, phenolphthalein (mg/L)	na	na	na	0	7	0	na	na	na	na	na	na
Alkalinity, total (mg/L)	na	na	na	246	204	268	na	na	na	na	na	na
Depth of sample (feet)	31	35	na	35	35	35	na	na	39	na	28	33

Table 4–4. Water-quality data from site CL2 at a depth of 1 foot, Channel Lake, April 21–November 27, 1998

[mg/L, milligrams per liter; K, constituent below detection limit; na, not analyzed; q, holding time exceeded; NTU, nephelometric turbidity units; µS/cm, microSiemens per centimeter; alkalinity expressed as milligrams per liter of $CaCO_3$]

Constituent	Date of sample collection											
	April 21, 1998	May 15, 1998	June 15, 1998	June 17, 1998	July 13, 1998	Aug. 11, 1998	Aug. 31, 1998	Sept. 15, 1998	Sept. 30, 1998	Oct. 14, 1998	Oct. 26, 1998	Nov. 27, 1998
Nitrate and nitrite, as total nitrogen (mg/L)	0.26	0.07	0.01K	na	0.01K	0.01K	na	0.01K	0.01K	0.01K	0.03	0.09
Nitrogen, ammonia (mg/L)	.26	.12	.01K	na	.10	.22	na	.13	.09	.23	.29	.33
Nitrogen, total Kjeldahl (mg/L)	.72	.50	na	na	.67	1	na	1.6	1	1.4	1.5	na
Phosphorus, dissolved (mg/L)	na	na	na	.01	.01	.008	na	na	na	na	.016	na
Phosphorus, total (mg/L)	.033	.021	.033	.04	.36	.036	na	.039	.05	.046	.059	.045
Solids, total suspended (mg/L)	21	4	na	na	8	10	na	6q	7q	5q	5q	8
Solids, volatile suspended (mg/L)	15	2	na	na	5	3	na	2q	2q	2q	3q	4
Turbidity (NTU)	12	1.8	na	na	3.3	55	na	4.1	2.9	4.1	2.9	na
Conductivity, field (µS/cm)	605	na	na	579	578	586	na	na	na	na	591	na
pH, field	8.54	na	na	8.72	8.62	8.62	na	na	na	na	8.6	na
Alkalinity, phenolphthalein (mg/L)	na	na	na	12	8	8	na	na	na	na	na	na
Alkalinity, total (mg/L)	na	na	na	196	200	206	na	na	na	na	na	na
Secchi reading (inches)	83	156	60	70	47	30	na	36	na	54	53	na

Table 4–5. Water-quality data from site CL2 at a depth of 4.5–26 feet, Channel Lake, April 21–November 25, 1998

[µg/L, micrograms per liter; K, constituent below detection limit; ml, milliliter; na, not analyzed]

Constituent	Date of sample collection									
	April 21, 1998	May 15, 1998	July 13, 1998	Aug. 11, 1998	Aug. 31, 1998	Sept. 15, 1998	Sept. 30, 1998	Oct. 26, 1998	Nov. 9, 1998	Nov. 25, 1998
Chlorophyll-*a* (µg/L)	7.48	3.20	22.30	54.80	49.80	47.2	54.1	71	8.01	26.7
Chlorophyll-*a*-uncorrected (µg/L)	7.24	2.67	21.70	54.20	48.90	45	53.3	69.8	9.23	35.5
Chlorophyll-*b* (µg/L)	.94	.82	.01	2.32	.98	1K	3.69	9.5	1K	19.5
Chlorophyll-*c* (µg/L)	.00	.48	.94	4.19	4.44	2.74	6.92	23.3	1.34	28.2
Pheophytin-*a* (µg/L)	.00	.00	.00	.00	.00	1K	1K	1K	1.57	15.8
Chlorophyll filtered	500	1,000	300	390	300	300	400	440	800	400
Total algal density (per ml)	3,638	na	7,459	23,939	na	na	na	4,345	na	na
Depth of sample (feet)	14	26	8	5	4.5	6	5	9	6.25	12

Table 4–6. Water-quality data from site CL3 at a depth of 1 foot, Channel Lake, April 21–November 27, 1998

[mg/L, milligrams per liter; na, not analyzed; K, constituent below detection limit; q, holding time exceeded; NTU, nephelometric turbidity units; µS/cm, microSiemens per centimeter; alkalinity expressed as milligrams per liter of $CaCO_3$]

Constituent	Date of sample collection											
	April 21, 1998	May 15, 1998	June 15, 1998	June 17, 1998	July 13, 1998	Aug. 11, 1998	Aug. 31, 1998	Sept. 15, 1998	Sept. 30, 1998	Oct. 14, 1998	Oct. 26, 1998	Nov. 27, 1998
Nitrate and nitrite, as total nitrogen (mg/L)	0.26	na	0.01K	na	0.01K	0.01	na	0.01K	0.01K	0.01K	0.01K	0.07
Nitrogen, ammonia (mg/L)	.33	na	.01K	na	.01K	.01K	na	.18	.17	.45	.28	.37
Nitrogen, total Kjeldahl (mg/L)	.54	na	na	na	.62	1	na	1.6	1.1	3.3	1.1	na
Phosphorus, dissolved (mg/L)	na	na	na	.01	.008	.008	na	na	na	na	.015	na
Phosphorus, total (mg/L)	.027	na	.046	.03	.042	.042	na	.06	.03	.041	.043	.039
Solids, total suspended (mg/L)	3	na	na	na	8	12	na	6q	6q	4q	4q	8
Solids, volatile suspended (mg/L)	2	na	na	na	5	8	na	4q	3q	1q	1q	4
Turbidity (NTU)	7.9	na	na	na	5.1	52	na	4.5	3.1	3.3	3.1	na
Conductivity, field (µS/cm)	605	na	na	586	578	586	na	na	na	na	590	na
pH, field	8.52	na	na	8.68	8.63	8.61	na	na	na	na	8.6	na
Alkalinity, phenolphthalein (mg/L)	na	na	na	14	6	6	na	na	na	na	na	na
Alkalinity, total (mg/L)	na	na	na	222	200	192	na	na	na	na	na	na
Secchi reading (inches)	87	na	60	73	43	27	na	39	na	48	68	na

Table 4–7. Water-quality data from site CL3 at a depth of 4–17 feet, Channel Lake, April 21–November 25, 1998

[µg/L, micrograms per liter; K, constituent below detection limit; ml, milliliter; na, not analyzed]

Constituent	Date of sample collection									
	April 21, 1998	May 15, 1998	July 13, 1998	Aug. 11, 1998	Aug. 31, 1998	Sept. 15, 1998	Sept. 30, 1998	Oct. 26, 1998	Nov. 9, 1998	Nov. 25, 1998
Chlorophyll-*a* (µg/L)	6.94	6.94	32.9	58.1	60.1	48.1	32	52.4	44.1	25.4
Chlorophyll-*a*-uncorrected (µg/L)	7.03	6.06	33.8	54.8	61.4	46.1	32.9	51.5	43.7	26.4
Chlorophyll-*b* (µg/L)	.57	1.14	.52	3.14	1.4	1K	2.57	1K	1.94	1.88
Chlorophyll-*c* (µg/L)	.00	.69	3.17	5.27	5.79	2.32	3.26	9	6.52	2.06
Pheophytin-*a* (µg/L)	.00	.00	.00	0	0	1K	1K	1K	1K	1K
Chlorophyll filtered	500	1,000	300	354	200	300	400	632	400	400
Total algal density (per ml)	2,047	na	6,593	23,674	na	na	na	5,071	na	na
Depth of sample (feet)	13	17	7	4.5	4.5	6.5	4	13.5	6.25	10

Table 4–8. Water-quality data from site LC1 at a depth of 1 foot, Lake Catherine, April 21–November 27, 1998

[mg/L, milligrams per liter; na, not analyzed; K, constituent below detection limit; q, holding time exceeded; NTU, nephelometric turbidity units; µS/cm, microSiemens per centimeter; alkalinity expressed as milligrams per liter of $CaCO_3$]

Constituent	Date of sample collection											
	April 21, 1998	May 15, 1998	June 15, 1998	June 17, 1998	July 13, 1998	Aug. 11, 1998	Aug. 31, 1998	Sept. 15, 1998	Sept. 30, 1998	Oct. 14, 1998	Oct. 26, 1998	Nov. 27, 1998
Nitrate and nitrite, as total nitrogen (mg/L)	0.38	na	0.01K	na	0.01K	0.01	0.01K	0.02	na	na	0.02	0.04
Nitrogen, ammonia (mg/L)	.27	na	.23	na	.21	.09	.11	.29	na	na	.29	.35
Nitrogen, total Kjeldahl (mg/L)	.69	na	.84	na	.78	.88	1.2	1.38	na	na	1.7	na
Phosphorus, dissolved (mg/L)	na	na	na	0.01K	.009	.007	na	na	na	na	.017	na
Phosphorus, total (mg/L)	.039	na	.03	.03	.041	.027	.034	.038	na	na	.072	.041
Solids, total suspended (mg/L)	6	na	21	na	6	9	3	6q	na	na	2q	6.0
Solids, volatile suspended (mg/L)	3	na	3	na	2	5	1	3q	na	na	1Kq	3.0
Turbidity (NTU)	8.4	na	12	na	3	52	3.6	1.7	na	na	5	na
Conductivity, field (µS/cm)	605	na	na	597	595	599	na	na	na	na	589	na
pH, field	8.1	na	na	8.45	8.61	8.31	na	na	na	na	8.5	na
Alkalinity, phenolphthalein (mg/L)	na	na	na	10	7	8	na	na	na	na	12	na
Alkalinity, total (mg/L)	na	na	na	230	218	228	na	na	na	na	180	na
Secchi reading (inches)	59	na	84	79	45	48	48	72	na	na	58	na

Table 4–9. Water-quality data from site LC1 at a depth of 5.1–40 feet, Lake Catherine, April 21–November 25, 1998

[µg/L, micrograms per liter; na, not analyzed; K, constituent below detection limit; ml, milliliter]

Constituent	Date of sample collection											
	April 21, 1998	May 15, 1998	June 17, 1998	July 13, 1998	Aug. 11, 1998	Aug. 31, 1998	Sept. 15, 1998	Sept. 30, 1998	Oct. 14, 1998	Oct. 26, 1998	Nov. 9, 1998	Nov. 25, 1998
Chlorophyll-*a* (µg/L)	15.49	3.47	na	33.40	45.50	30.70	34.7	72.8	98.8	96.6	15.4	10.7
Chlorophyll-*a*-uncorrected (µg/L)	15.22	2.79	na	32.40	44.80	30.70	32	71.4	96.2	94.6	16.2	13.5
Chlorophyll-*b* (µg/L)	.97	.77	na	.87	2.30	1.29	1k	4.25	3.03	2.9	1K	8.57
Chlorophyll-*c* (µg/L)	.00	.46	na	2.88	3.63	2.09	3.11	12.1	18.4	17.3	2.17	10
Pheophytin-*a* (µg/L)	.00	.00	na	.00	.00	.00	1K	1K	1K	1K	1K	5.21
Chlorophyll filtered	500	1,000	na	400	464	400	400	400	300	412	400	400
Total algal density (per ml)	7,465	na	3,095	6,592	17,244	na	na	na	na	2,276	na	na
Depth of sample (feet)	10	40	na	8	8	8	12	8	5.1	5.6	10	10

Table 4–10. Water-quality data from site LC1 at a depth of 31–38 feet, Lake Catherine, April 21–November 25, 1998

[mg/L, milligrams per liter; na, not analyzed; K, constituent below detection limit; J, estimated concentration; q, holding time exceeded; NTU, nephelometric turbidity units; µS/cm, microSiemens per centimeter; alkalinity expressed as milligrams per liter of $CaCO_3$]

Constituent	Date of sample collection											
	April 21, 1998	May 15, 1998	June 15, 1998	June 17, 1998	July 13, 1998	Aug. 11, 1998	Aug. 31, 1998	Sept. 15, 1998	Sept. 30, 1998	Oct. 14, 1998	Oct. 26, 1998	Nov. 25, 1998
Nitrate and nitrite, as total nitrogen (mg/L)	0.24	0.11	na	na	0.01K	0.01K	na	na	0.01K	na	0.02	na
Nitrogen, ammonia (mg/L)	.36	.12	na	na	.32	2.6	na	na	.15	na	.51	na
Nitrogen, total Kjeldahl (mg/L)	.81	.5	na	na	.52	2.6J	na	na	1.3	na	.65	na
Phosphorus, dissolved (mg/L)	na	na	na	.36	.011	.362	na	na	na	na	.022	na
Phosphorus, total (mg/L)	.033	.023	na	.36	.048	.385	na	na	.072	na	.042	na
Solids, total suspended (mg/L)	5	1	na	na	5	8	na	na	6q	na	1Kq	6
Solids, volatile suspended (mg/L)	3	1K	na	na	1	4	na	na	5q	na	1Kq	3
Turbidity (NTU)	3.3	1.9	na	na	2.8	57	na	na	4.7	na	4.6	na
Conductivity, field (µS/cm)	630	na	na	657	652	687	na	na	na	na	594	na
pH, field	7.8	na	na	7.17	7.22	6.97	na	na	na	na	8.3	na
Alkalinity, phenolphthalein (mg/L)	na	na	na	0	0	8	na	na	na	na	na	na
Alkalinity, total (mg/L)	na	na	na	236	220	228	na	na	na	na	na	na
Depth of sample (feet)	na	na	na	na	35	na	na	38	31	na	33	na

Table 4–11. Water-quality data from site LC2 at a depth of 1 foot, Lake Catherine, April 21–November 27, 1998

[mg/L, milligrams per liter; na, not analyzed; K, constituent below detection limit; q, holding time exceeded; NTU, nephelometric turbidity units; µS/cm, microSiemens per centimeter; alkalinity expressed as milligrams per liter of $CaCO_3$]

Constituent	Date of sample collection											
	April 21, 1998	May 15, 1998	June 15, 1998	June 17, 1998	July 13, 1998	Aug. 11, 1998	Aug. 31, 1998	Sept. 15, 1998	Sept. 30, 1998	Oct. 14, 1998	Oct. 26, 1998	Nov. 27, 1998
Nitrate and nitrite, as total nitrogen (mg/L)	0.38	0.14	na	na	0.01K	0.01K	0.01K	0.01K	na	na	0.02	0.05
Nitrogen, ammonia (mg/L)	.45	.09	na	na	.12	.15	.04	.21	na	na	.47	.49
Nitrogen, total Kjeldahl (mg/L)	.68	.5	na	na	.54	1	1	1.3	na	na	1.6	na
Phosphorus, dissolved (mg/L)	na	na	na	.01	.007	.004	na	na	na	na	.018	na
Phosphorus, total (mg/L)	.033	.023	na	.03	.036	.03	.032	.036	na	na	.068	.043
Solids, total suspended (mg/L)	6	7	na	na	4	7	2	3q	na	na	4.7	3.0
Solids, volatile suspended (mg/L)	4	3	na	na	4	1	1K	1q	na	na	4q	2.0
Turbidity (NTU)	3.7	1.6	na	na	2.5	61	2.7	2	na	na	2q	na
Conductivity, field (µS/cm)	610	na	na	599	594	602	na	na	na	na	588	na
pH, field	8.3	na	na	8.53	8.71	8.45	na	na	na	na	8.6	na
Alkalinity, phenolphthalein (mg/L)	na	na	na	12	8	4	na	na	na	na	6.0	na
Alkalinity, total (mg/L)	na	na	na	214	200	208	na	na	na	na	184	na
Secchi reading (inches)	68	156	na	73	49	41	57	72	na	na	50	na

Table 4–12. Water-quality data from site LC2 at a depth of 7–26 feet, Lake Catherine, April 21–November 25, 1998

[µg/L, micrograms per liter; na, not analyzed; K, constituent below detection limit; ml, milliliter]

Constituent	Date of sample collection											
	April 21, 1998	May 15, 1998	June 17, 1998	July 13, 1998	Aug. 11, 1998	Aug. 31, 1998	Sept. 15, 1998	Sept. 30, 1998	Oct. 14, 1998	Oct. 26, 1998	Nov. 9, 1998	Nov. 25, 1998
Chlorophyll-*a* (µg/L)	na	na	na	27.60	38.40	28.70	32	68.1	90.1	107	26.7	6.68
Chlorophyll-*a*-uncorrected (µg/L)	na	na	na	27.30	36.20	29.30	30.9	66.1	89.3	101	27	11.6
Chlorophyll-*b* (µg/L)	na	na	na	1.15	1.87	1.05	1K	3.49	1.08	2.59	1K	7.55
Chlorophyll-*c* (µg/L)	na	na	na	1.86	3.39	1.46	3.04	11.2	17	17.2	3.4	9.86
Pheophytin-*a* (µg/L)	na	na	na	.00	.00	.00	1K	1K	1K	1K	1K	8.74
Chlorophyll filtered	500	1,000	na	300	452	400	400	400	400	440	400	400
Total algal density (per ml)	6,409	na	3,601	5,898	17,616	na	na	na	na	308	na	na
Depth of sample (feet)	11.5	26	na	8	7	9.5	12	10	8	9	10	12

Table 4–13. Water-quality data sampling from site LC3 at a depth of 1 foot, Lake Catherine, April 21–November 27, 1998

[mg/L, milligrams per liter; K, constituent below detection limit; na, not analyzed; q, holding time exceeded; NTU, nephelometric turbidity units; µS/cm, microSiemens per centimeter; alkalinity expressed as milligrams per liter of $CaCO_3$]

Constituent	Date of sample collection											
	April 21, 1998	May 15, 1998	June 15, 1998	June 17, 1998	July 13, 1998	Aug. 11, 1998	Aug. 31, 1998	Sept. 15, 1998	Sept. 30, 1998	Oct. 14, 1998	Oct. 26, 1998	Nov. 27, 1998
Nitrate and nitrite, as total nitrogen (mg/L)	0.38	0.16	0.01K	na	0.01K	0.01K	0.01K	0.01K	na	na	0.03	0.04
Nitrogen, ammonia (mg/L)	.31	.15	.01K	na	.12	.1	.23	.34	na	na	.54	.53
Nitrogen, total Kjeldahl (mg/L)	.73	.6	na	na	.52	.63	1.0	1.5	na	na	1.5	na
Phosphorus, dissolved (mg/L)	na	na	.021	0.01K	.008	.003	na	na	na	na	.015	na
Phosphorus, total (mg/L)	.067	.023	na	.03	.034	.03	.034	.017	na	na	.059	.039
Solids, total suspended (mg/L)	7	3	na	na	5	8	3	7q	na	na	3q	4.0
Solids, volatile suspended (mg/L)	4	1K	na	na	4	4	1	2q	na	na	1q	2.0
Turbidity (NTU)	3.5	1.3	na	na	na	52	9.8	1.8	na	na	5.5	na
Conductivity, field (µS/cm)	613	na	na	597	595	603	na	na	na	na	589	na
pH, field	8.31	na	na	8.5	8.61	8.39	na	na	na	na	8.6	na
Alkalinity, phenolphthalein (mg/L)	na	na	na	10	6	6	na	na	na	na	na	na
Alkalinity, total (mg/L)	na	na	na	200	220	198	na	na	na	na	na	na
Secchi reading (inches)	68	156	48	69	43	35	33	72	na	na	55	na

Table 4–14. Water-quality data from site LC3 at a depth of 5.5–28 feet, Lake Catherine, April 21–November 25, 1998

[µg/L, micrograms per liter; K, constituent below detection limit; ml, milliliter; na, not analyzed]

Constituent	Date of sample collection										
	April 21, 1998	May 15, 1998	July 13, 1998	Aug. 11, 1998	Aug. 31, 1998	Sept. 15, 1998	Sept. 30, 1998	Oct. 14, 1998	Oct. 26, 1998	Nov. 9, 1998	Nov. 25, 1998
Chlorophyll-*a* (µg/L)	5.34	3.47	25.80	35.50	26.70	28.7	40.7	76.1	67.6	13.4	14.7
Chlorophyll-*a*-uncorrected (µg/L)	5.44	2.79	25.50	33.80	25.40	27.1	40.2	74.2	67	13.6	18.7
Chlorophyll-*b* (µg/L)	.60	.80	.22	2.06	.83	1K	2.51	1K	1.35	1K	13.9
Chlorophyll-*c* (µg/L)	.00	.22	.44	1.93	1.01	2.93	7.4	13.7	12.4	1.89	19.3
Pheophytin-*a* (µg/L)	.00	.00	.00	.00	.00	1K	1K	1K	1K	1K	7.74
Chlorophyll filtered	500	1,000	300	436	300	400	400	400	446	400	400
Total algal density (per ml)	4,622	na	6,296	16,250	na	na	na	na	2,529	na	na
Depth of sample (feet)	11.5	28	7	6	5.5	12	12	10	9	10	12

Table 4–15. Temperature profiles for site CL1, Channel Lake, near Antioch, Illinois, April 21–November 25, 1998

[all temperatures are in degrees Celsius; -, data unavailable]

Depth (feet)	Date								
	April 21, 1998	May 15, 1998	June 15, 1998	June 17, 1998	July 13, 1998	July 15, 1998	Aug. 11, 1998	Oct. 26, 1998	Nov. 25, 1998
0	11.9	22.5	23.0	24.4	26.3	27.5	26.4	14.5	6.8
1	11.9	21.1	20.8	24.4	26.1	27.5	26.4	14.4	6.7
3	11.9	21.2	20.7	24.0	26.0	27.5	26.4	14.3	6.6
5	11.8	21.1	20.7	23.6	26.7	27.5	26.4	13.9	6.0
7	11.8	21.1	20.7	22.3	26.6	27.4	26.4	13.6	6.0
9	11.8	18.5	20.6	21.5	26.5	27.2	26.3	13.5	6.0
11	11.7	17.5	20.4	20.6	25.9	27.0	25.7	13.5	5.9
13	11.4	16.8	19.5	20.1	24.2	26.1	25.0	13.5	5.9
15	11.3	16.4	19.2	19.4	23.1	25.1	24.4	13.5	5.9
17	11.1	15.9	19.0	18.6	21.2	24.0	23.5	13.4	5.9
19	10.9	15.5	18.8	17.3	19.8	21.7	22.0	13.4	5.9
21	10.7	14.8	18.6	16.7	17.0	20.0	19.1	13.4	5.9
23	10.5	13.6	18.5	16.0	15.9	17.6	17.0	13.4	5.9
25	10.5	12.7	18.6	14.7	14.8	15.5	15.8	13.4	5.9
27	10.4	-	-	12.5	13.5	-	14.3	13.4	5.9
29	10.4	-	-	11.4	12.5	-	12.8	13.3	5.9
31	10.3	-	-	11.2	12.2	-	-	-	5.9
33	-	-	-	11.0	11.9	-	-	-	5.8
34	-	-	-	10.9	11.9	-	-	-	-

Table 4–16. Dissolved-oxygen profiles for site CL1, Channel Lake, near Antioch, Illinois, April 21–November 25, 1998

[all concentrations of dissolved oxygen are in milligrams per liter; -, data unavailable]

Depth (feet)	Date								
	April 21, 1998	May 15, 1998	June 15, 1998	June 17, 1998	July 13, 1998	July 15, 1998	Aug. 11, 1998	Oct. 26, 1998	Nov. 25, 1998
0	10.7	9.8	18.0	12.0	9.8	6.0	9.6	13.2	12.0
1	10.8	9.9	15.5	12.0	9.8	6.7	9.6	13.2	12.0
3	10.4	9.9	11.4	12.1	9.7	9.6	9.6	13.2	12.1
5	10.4	9.8	14.2	11.9	9.8	14.0	9.5	12.3	12.0
7	10.4	9.9	12.8	10.6	9.8	12.4	9.3	11.0	11.9
9	10.2	9.5	12.5	8.5	9.6	10.5	8.8	10.2	11.6
11	10.1	9.0	10.3	7.0	4.9	9.5	2.7	10.0	11.5
13	9.6	8.6	7.1	6.7	.1	14.2	.2	9.9	11.5
15	9.4	8.2	5.9	5.7	.1	15.4	.1	10.1	11.5
17	9.3	7.7	5.2	5.0	.1	16.6	.1	9.7	11.5
19	9.2	7.2	4.6	3.4	.1	16.6	.1	9.7	11.5
21	8.8	6.3	4.4	1.0	.1	17.5	.1	9.8	11.5
23	8.5	5.4	4.4	.1	.1	18.5	.1	9.6	11.4
25	8.3	4.1	4.3	.1	.1	24.6	.1	9.4	11.4
27	8.1	-	-	.1	.1	-	.1	9.3	11.4
29	8.1	-	-	.1	.1	-	.1	8.3	11.4
31	7.8	-	-	.1	.1	-	-	-	11.4
33	-	-	-	.1	.1	-	-	-	11.3
35	-	-	-	.1	.1	-	-	-	-

Table 4–17. Temperature profiles for site CL2, Channel Lake, near Antioch, Illinois, April 21–November 25, 1998

[all temperatures are in degrees Celsius; -, data unavailable]

Depth (feet)	Date								
	April 21, 1998	May 15, 1998	June 15, 1998	June 17, 1998	July 13, 1998	July 15, 1998	Aug. 11, 1998	Oct. 26, 1998	Nov. 25, 1998
0	12.3	21.5	22.0	24.5	27.1	27.1	26.8	14.3	6.4
1	12.3	21.5	20.9	24.4	27.1	27.1	26.8	14.3	6.3
3	12.3	21.5	20.9	23.9	26.8	27.1	26.8	14.2	6.2
5	12.3	21.3	20.7	22.6	26.3	27	26.8	13.8	6.2
7	12.3	19.5	20.6	21.7	26	26.9	26.6	13.4	6.0
9	12.3	18.1	20.5	21.5	25.9	26.4	26.6	13.4	5.9
11	12.2	17.1	20.5	20.9	24.9	25.7	26.6	13.3	5.9
13	12.1	16.8	20.4	20.1	24.5	25.1	26.6	13.3	5.9
15	11.9	16.1	20.3	19.2	24.0	23.3	26.4	13.3	5.9
17	11.7	15.5	19.2	18.7	22.4	22.5	23.3	13.2	5.9
19	11.7	14.7	18.7	18.4	19.3	21.1	21.9	13.2	5.9
21	11.7	14.4	18.4	17.5	-	19.3	20.0	13.2	-
23	-	13.0	17.5	14.8	-	18	16.4	13.2	-
25	-	12.2	16.0	13.8	-	15.9	15.2	13.2	-

Table 4–18. Dissolved-oxygen profiles for site CL2, Channel Lake, near Antioch, Illinois, April 21–November 25, 1998

[all concentrations of dissolved oxygen are in milligrams per liter; -, data unavailable]

Depth (feet)	Date								
	April 21, 1998	May 15, 1998	June 15, 1998	June 17, 1998	July 13, 1998	July 15, 1998	Aug. 11, 1998	Oct. 26, 1998	Nov. 25, 1998
0	10.7	10.2	16.9	12.6	9.5	4.0	9.9	13.7	12.4
1	10.4	10.1	11.9	12.6	9.4	4.7	9.9	13.8	12.4
3	10.0	10.1	12.2	12.5	9.4	5.9	9.9	13.4	12.5
5	10.1	9.9	12.3	11.9	9.8	5.7	9.9	11.2	12.4
7	10.1	10.4	8.0	9.6	9.6	4.9	9.8	9.8	12.3
9	10.1	10.0	5.1	9.1	8.7	3.5	9.7	9.5	12.0
11	9.8	9.0	3.3	8.1	2.4	2.3	9.7	9.3	11.8
13	9.8	8.6	3.2	5.9	.2	1.7	9.6	9.1	11.8
15	10.0	8.0	3.3	5.3	.1	1.1	7.5	9.0	11.7
17	10.0	7.4	2.6	4.8	.1	1.0	.3	8.9	11.7
19	9.9	5.8	2.6	3.5	.1	.9	.2	8.9	11.7
21	9.9	5.1	2.4	2.8	-	.8	.1	8.9	-
23	-	4.5	2.4	.1	-	.7	.1	8.8	-
25	-	4.0	2.6	.1	-	.7	.1	8.9	-

Table 4–19. Temperature profiles for site CL3, Channel Lake, near Antioch, Illinois, April 21–November 25, 1998

[all temperatures are in degrees Celsius; -, data unavailable]

Depth (feet)	Date								
	April 21, 1998	May 15, 1998	June 15, 1998	June 17, 1998	July 13, 1998	July 15, 1998	Aug. 11, 1998	Oct. 26, 1998	Nov. 25, 1998
0	12.2	21.8	24.6	24.6	27.4	26.9	26.8	14.1	6.3
1	12.2	21.7	20.9	24.5	27.3	26.9	26.8	14.1	6.3
3	12.2	21.7	20.9	23.4	26.5	26.9	26.8	14.0	6.3
5	12.2	20.0	20.8	21.7	26.1	26.8	26.8	13.6	5.9
7	11.8	19.1	20.8	21.4	25.8	26.3	26.8	13.3	5.9
9	11.5	18.2	20.7	21.3	25.6	26.0	26.8	13.2	5.8
11	-	17.7	20.7	21.0	25.3	25.2	26.8	13.2	5.8
13	-	17.5	20.7	19.8	24.7	24.2	26.8	13.2	5.8
15	-	17.0	21.7	19.3	24.0	23.4	26.8	13.2	5.8
17	-	16.3	20.6	18.5	23.3	22.0	26.7	13.2	5.8
19	-	-	20.6	18.4	20.2	20.2	22.4	13.2	5.8
21	-	-	-	-	-	17.0	18.1	-	-

Table 4–20. Dissolved-oxygen profiles for site CL3, Channel Lake, near Antioch, Illinois, April 21–November 25, 1998

[all concentrations of dissolved oxygen are in milligrams per liter; -, data unavailable]

Depth (feet)	Date								
	April 21, 1998	May 15, 1998	June 15, 1998	June 17, 1998	July 13, 1998	July 15, 1998	Aug. 11, 1998	Oct. 26, 1998	Nov. 25, 1998
0	10.8	11.1	1.9	12.2	9.6	8.3	9.9	12.3	12.3
1	10.7	11.0	3.9	12.2	9.8	6.6	9.7	12.2	12.4
3	10.6	10.9	8.8	13.1	9.4	5.4	9.7	12.2	12.5
5	10.6	10.9	13.6	10.2	9.1	4.5	9.7	11.3	12.1
7	10.4	12.3	16.4	9.3	8.4	3.9	9.6	10.4	11.9
9	10.3	12.0	13.3	9.0	5.5	2.5	9.6	10.4	11.6
11	-	10.1	9.9	8.2	1.7	1.7	9.6	10.4	11.5
13	-	10.1	6.9	6.2	.2	1.2	9.5	9.8	11.5
15	-	9.9	6.7	5.5	.2	1.0	9.4	9.7	11.5
17	-	7.8	9.4	4.3	.1	.9	9.2	9.7	11.0
19	-	-	9.0	4.1	.1	.8	.3	9.7	11.0
21	-	-	-	-	-	.8	.1	-	-

Table 4–21. Temperature profiles for site LC1, Lake Catherine, near Antioch, Illinois, April 21–November 25, 1998

[all temperatures are in degrees Celsius; -, data unavailable]

	Date								
Depth (feet)	**April 21, 1998**	**May 15, 1998**	**June 15, 1998**	**June 17, 1998**	**July 13, 1998**	**July 15, 1998**	**Aug. 11, 1998**	**Oct. 26, 1998**	**Nov. 25, 1998**
0	12.0	20.9	23.1	23.3	26.4	27.6	26.7	14.5	7.2
1	12.0	20.8	21.2	23.3	26.6	27.6	26.5	14.4	7.0
3	12.0	20.8	21.0	23.0	26.5	27.6	26.5	14.4	6.7
5	12.0	20.8	20.9	22.9	26.4	27.6	26.4	13.8	6.3
7	11.9	20.8	20.7	21.2	26.4	27.6	26.4	13.7	6.3
9	11.9	20.7	20.5	21.0	26.1	27.5	26.4	13.7	6.3
11	11.6	19.4	20.5	20.9	25.7	27.4	26.0	13.7	6.2
13	11.1	18.5	20.3	20.7	25.6	27.0	26.0	13.7	6.2
15	10.9	17.4	20.2	20.4	25.3	26.4	25.8	13.7	6.2
17	10.8	16.9	20.1	20.1	25.0	26.0	25.6	13.6	6.2
19	10.7	16.6	19.8	19.6	24.9	25.9	25.5	13.6	6.2
21	10.6	16.4	19.4	19.1	24.5	25.4	25.4	13.5	6.2
23	10.6	15.7	19.1	18.4	23.5	24.6	24.6	13.5	6.2
25	10.3	15.3	19.0	17.6	21.2	23.0	22.8	13.5	6.2
27	9.9	-	-	15.8	17.2	-	20.4	13.5	6.2
29	9.7	-	-	14.1	15.3	-	16.9	13.5	6.2
31	9.5	-	-	12.1	14.1	-	15.5	13.5	6.1
33	-	-	-	11.0	13.5	-	14.4	-	6.1
35	-	-	-	10.8	13.0	-	-	-	-

Table 4–22. Dissolved-oxygen profiles for site LC1, Lake Catherine, near Antioch, Illinois, April 21–November 25, 1998

[all concentrations of dissolved oxygen are in milligrams per liter; -, data unavailable]

	Date								
Depth (feet)	**April 21, 1998**	**May 15, 1998**	**June 15, 1998**	**June 17, 1998**	**July 13, 1998**	**July 15, 1998**	**Aug. 11, 1998**	**Oct. 26, 1998**	**Nov. 25, 1998**
0	11.8	9.4	19.5	11.3	10.4	7.2	9.5	12.4	11.1
1	11.7	9.8	12.3	11.3	9.5	8.0	9.3	12.3	11.3
3	11.6	9.9	9.0	11.3	10.1	11.9	9.2	12.3	11.1
5	11.2	10.0	10.1	10.9	10.1	19.6	9.0	10.4	11.1
7	11.4	9.9	8.5	9.3	10.1	16.3	8.8	10.0	11.0
9	11.1	9.9	3.6	8.6	9.5	10.7	7.5	9.6	10.9
11	11.0	10.1	2.7	8.4	5.9	9.4	4.8	9.5	10.9
13	10.6	9.9	2.6	8.6	5.1	8.6	4.0	9.4	10.8
15	10.1	9.8	2.6	8.0	2.7	8.2	3.5	8.9	10.8
17	10.2	9.6	2.1	7.6	.3	9.2	2.9	8.6	10.8
19	10.0	9.3	1.9	7.0	.2	9.2	2.1	8.5	10.8
21	9.7	9.1	1.9	6.5	.1	9.2	.8	8.5	10.7
23	9.3	8.8	1.9	5.8	.1	8.4	.1	8.6	10.7
25	9.0	8.5	1.7	3.1	.1	6.5	.1	8.5	10.7
27	8.0		-	.2	.1	-	.1	8.5	10.6
29	6.7	-	-	.1	.1	-	.1	8.4	10.6
31	4.6	-	-	.1	.1	-	.1	8.3	10.6
33	-	-	-	.1	.1	-	.1	-	10.6
35	-	-	-	.1	.1	-	-	-	-

Table 4–23. Temperature profiles for site LC2, Lake Catherine, near Antioch, Illinois, April 21–November 25, 1998

[all temperatures are in degrees Celsius; -, data unavailable]

Depth (feet)	April 21, 1998	May 15, 1998	June 15, 1998	June 17, 1998	July 13, 1998	July 15, 1998	Aug. 11, 1998	Oct. 26, 1998	Nov. 25, 1998
0	11.7	19.3	21.3	24.2	23.0	27.2	26.4	14.5	6.8
1	11.7	19.2	21.0	24.1	26.8	27.2	26.5	14.5	6.8
3	11.6	19.1	20.8	23.7	26.8	27.2	26.5	14.4	6.6
5	11.6	18.1	20.6	22.2	26.4	27.1	26.4	13.9	6.6
7	11.6	18.2	20.5	21.7	26.0	26.7	26.4	13.8	6.5
9	11.6	17.6	20.5	21.2	25.8	26.3	26.4	13.7	6.5
11	11.5	17.3	20.4	20.9	25.7	26.1	26.4	13.7	6.3
13	11.4	17.1	20.4	20.7	25.5	25.9	26.3	13.7	6.3
15	11.1	16.8	20.4	20.5	25.4	25.7	26.0	13.7	6.2
17	10.8	16.3	20.4	20.1	25.1	25.6	25.9	13.7	6.2
19	10.7	16.0	20.5	19.7	24.9	25.3	25.5	13.7	6.2
21	10.5	15.8	20.4	19.4	24.3	25.0	25.3	13.6	6.2
23	10.3	15.7	20.2	18.6	23.1	24.6	24.8	13.6	6.2
25	10.1	15.9	19.8	17.5	19.6	23.1	23.0	13.5	6.2
27	9.8	-	-	15.8	18.4	-	20.0	13.5	6.2
29	9.7	-	-	14.2	-	-	17.4	13.5	6.2
31	9.6	-	-	12.1	-	-	15.5	13.5	6.2
33	9.6	-	-	11.1	-	-	14.2	13.5	6.2
34	9.4	-	-	-	-	-	13.1	13.5	-
36	-	-	-	-	-	-	12.8	13.5	-

Table 4–24. Dissolved-oxygen profiles for site LC2, Lake Catherine, near Antioch, Illinois, April 21–November 25, 1998

[all concentrations of dissolved oxygen are in milligrams per liter; -, data unavailable]

Depth (feet)	April 21, 1998	May 15, 1998	June 15, 1998	June 17, 1998	July 13, 1998	July 15, 1998	Aug. 11, 1998	Oct. 26, 1998	Nov. 25, 1998
0	11.2	9.0	19.8	10.9	10.0	12.5	8.7	12.9	10.8
1	11.1	9.8	13.5	10.9	9.9	12.5	8.7	12.8	10.8
3	11.0	9.8	11.8	11.2	9.9	2.8	8.6	12.8	10.9
5	10.9	9.7	8.2	10.6	9.3	2.9	8.6	11.5	10.9
7	10.9	9.8	5.0	9.6	9.2	2.0	8.5	10.3	10.9
9	10.9	9.7	3.4	8.9	7.1	1.4	8.2	10.1	10.8
11	10.8	9.6	2.6	8.5	7.1	1.1	8.0	9.7	10.7
13	10.5	9.5	1.9	8.2	5.6	1.0	7.6	9.6	10.6
15	10.4	9.4	1.8	7.9	4.9	.8	4.5	9.5	10.6
17	10.0	9.0	3.8	7.5	1.1	.8	3.9	9.5	10.7
19	9.5	8.7	2.5	7.2	.1	.8	2.2	9.5	10.8
21	9.3	8.4	5	6.6	.1	.8	.2	8.9	10.8
23	9.2	8.3	2.2	5.7	.1	.8	.1	8.6	10.7
25	8.7	8.5	2.3	2.7	.1	.7	.1	8.5	10.8
27	8.3	-	-	.2	.1	-	.1	8.4	10.8
29	7.3	-	-	.1	-	-	.1	8.4	10.8
31	7.1	-	-	.1	-	-	.1	8.4	10.7
33	6.8	-	-	.1	-	-	.1	8.3	10.7
35	6.1	-	-	-	-	-	.1	8.1	-
37	-	-	-	-	-	-	.1	7.7	-

Table 4–25. Temperature profiles for site LC3, Lake Catherine, near Antioch, Illinois, April 21–November 25, 1998

[all temperatures are in degrees Celsius; -, data unavailable]

Depth (feet)	Date								
	April 21, 1998	May 15, 1998	June 15, 1998	June 17, 1998	July 13, 1998	July 15, 1998	Aug. 11, 1998	Oct. 26, 1998	Nov. 25, 1998
0	11.1	16.5	21.1	23.7	26.7	26.4	26.7	14.5	6.8
1	10.9	16.0	20.9	23.8	26.8	26.3	26.5	14.6	6.8
3	11.1	16.1	21.0	23.3	26.6	25.9	26.5	13.9	6.7
5	11.2	17.2	20.9	22.2	26.3	25.9	26.4	13.7	6.4
7	11.4	18.0	20.8	21.6	26.1	26.0	26.4	13.7	6.3
9	11.4	17.3	20.8	20.9	25.9	25.9	26.4	13.7	6.3
11	11.5	17.0	20.7	20.8	25.6	25.8	26.0	13.6	6.3
13	11.5	16.8	20.7	20.5	25.3	25.7	26.0	13.6	6.3
15	11.5	16.5	20.7	20.4	25.2	25.5	25.8	13.6	6.3
17	10.9	16.2	20.6	20.4	25.0	25.5	25.6	13.6	6.3
19	10.5	15.9	20.5	19.3	24.8	25.3	25.5	13.6	6.3
21	10.4	15.6	20.2	19.0	24.7	24.8	25.4	13.5	6.3
23	10.3	15.3	20.0	18.5	23.6	24.4	24.6	13.5	-
25	-	14.1	-	16.6	20.3	-	22.8	13.5	-
27	-	-	-	16.0	16.5	-	20.4	-	-
29	-	-	-	-	-	-	16.9	-	-
31	-	-	-	-	-	-	15.5	-	
33	-	-	-	-	-	-	14.4	-	-

Table 4–26. Dissolved-oxygen profiles for site LC3, Lake Catherine, near Antioch, Illinois, April 21–November 25, 1998

[all concentrations of dissolved oxygen are in milligrams per liter; -, data unavailable]

Depth (feet)	Date								
	April 21, 1998	May 15, 1998	June 15, 1998	June 17, 1998	July 13, 1998	July 15, 1998	Aug. 11, 1998	Oct. 26, 1998	Nov. 25, 1998
0	10.3	9.3	19.3	10.6	9.3	3.0	9.5	12.4	11.0
1	10.2	8.8	13.3	10.5	9.5	2.5	9.3	12.4	11.0
3	10.2	8.6	9.3	10.3	9.4	2.4	9.2	10.7	11.0
5	10.3	9.2	9.5	9.3	8.7	2.1	9.0	10.1	11.0
7	10.4	9.5	8.0	9.2	8.9	1.5	8.8	9.9	10.9
9	10.4	9.4	6.5	8.4	8.5	1.0	7.5	9.2	10.9
11	10.6	9.2	5.4	8.3	6.7	.8	4.8	9.1	10.8
13	10.6	9.1	4.1	8.0	4.1	.8	4.0	9.0	10.7
15	10.3	9.0	8.5	7.8	3.7	.7	3.5	9.0	10.7
17	9.9	8.8	4.2	7.8	.4	.7	2.9	9.0	10.7
19	9.4	8.7	3.3	6.7	.3	.7	2.1	8.9	10.6
21	9.1	8.5	3.0	6.1	.1	.7	.8	8.6	10.7
23	9.0	8.2	3.0	5.3	.1	.7	.1	8.4	-
25	-	6.5	-	.7	.1	-	.1	7.9	-
27	-	-	-	.2	.1	-	.1	-	-
29	-	-	-	-	-	-	.1	-	-
31	-	-	-	-	-	-	.1	-	-
33	-	-	-	-	-	-	.1	-	-

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