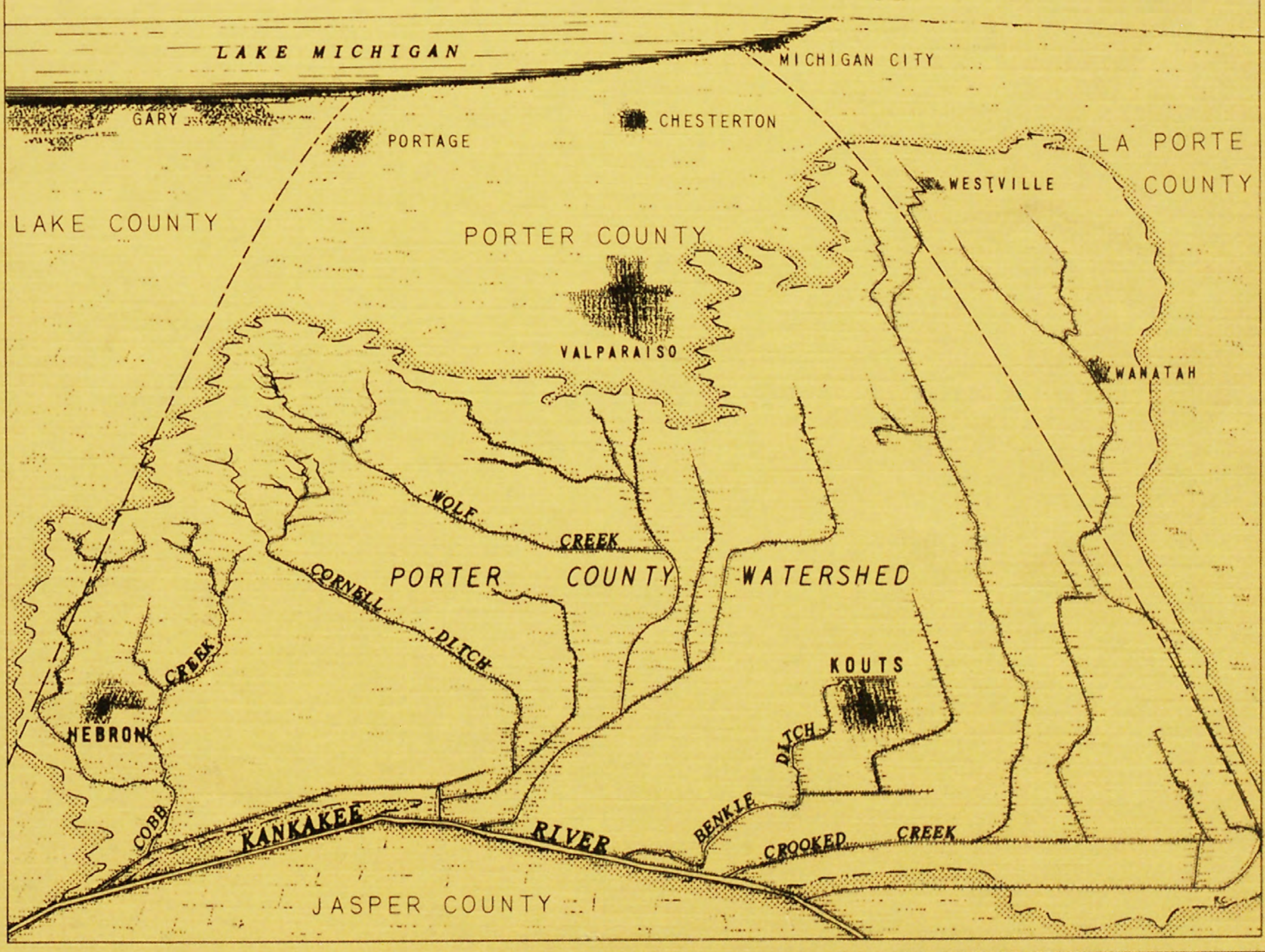
WATER-QUALITY ASSESSMENT OF THE PORTER COUNTY WATERSHED, KANKAKEE RIVER BASIN, PORTER COUNTY, INDIANA

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

OPEN-FILE REPORT 80-331

PREPARED IN COOPERATION WITH THE
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE



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Indianapolis, Indiana
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METRIC CONVERSION FACTORS

The inch-pound units used in this report can be converted to the metric system of units as follows:

Multiply inch-pound unit	By	To obtain metric unit
inch (in.)	25.40	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square foot (ft^2)	0.0929	square meter (m^2)
square mile (mi^2)	2.590	square kilometer (km^2)
cubic foot per second (ft^3/s)	0.0283	cubic meter per second (m^3/s)
cubic foot per second per square mile [$(ft^3/s)/mi^2$]	0.0109	cubic meter per second per square kilometer [$(m^3/s)/km^2$]
acre	0.4047	hectare (ha)
acre-foot	1,233	cubic meter (m^3)

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ABSTRACT

Water type in the 241-square mile watershed is primarily calcium bicarbonate, except in Crooked Creek and Greiger ditch, where the water type is a combination of calcium bicarbonate and calcium sulfate, and in Crumpacker Arm, where in December 1977 at one site water type was sodium chloride. Concentrations of dissolved chemical constituents in surface water and contents of chlorinated hydrocarbons in streambed samples in the watershed were generally less than water-quality alert limits set by the U.S. Environmental Protection Agency, except in Crooked Creek. During sampling, this stream was affected by sewage, chlorinated hydrocarbons, and two chemical spills.

Ranges of on-site field measurements were: specific conductance, from 102 to 1,060 micromhos per centimeter at 25° Celsius; water temperature, from 7.0° to 31.8° Celsius; pH, from 6.8 to 8.9; dissolved oxygen, from 2.5 to 14.9 milligrams per liter and from 27 to 148 percent saturation; and instantaneous discharge from 0 to 101 cubic feet per second. Concentrations of most dissolved-inorganic constituents (heavy metals and major ions) and dissolved-solids did not vary significantly from one sampling period to the next at each site. The range of concentrations that varied significantly were (in milligrams per liter): iron, from 0.01 to 2.0; manganese, from 0.03 to 0.69; organic carbon, from 2.4 to 27.0; ammonia, from 0 to 6.1; nitrate plus nitrite, from 0.05 to 2.7; organic nitrogen, from 0 to 1.7; Kjeldahl nitrogen, from 0.13 to 6.7; and phosphorus, from 0.00 to 3.1. Concentrations of dissolved manganese, organic carbon, dissolved nitrate plus nitrate, and suspended sediment varied seasonally at most sites.

Populations and identification of bacteria, phytoplankton, periphyton, and benthic invertebrates indicate a well-balanced environment at most sites, except in Crooked Creek.

INTRODUCTION

Environmental Setting and Conditions

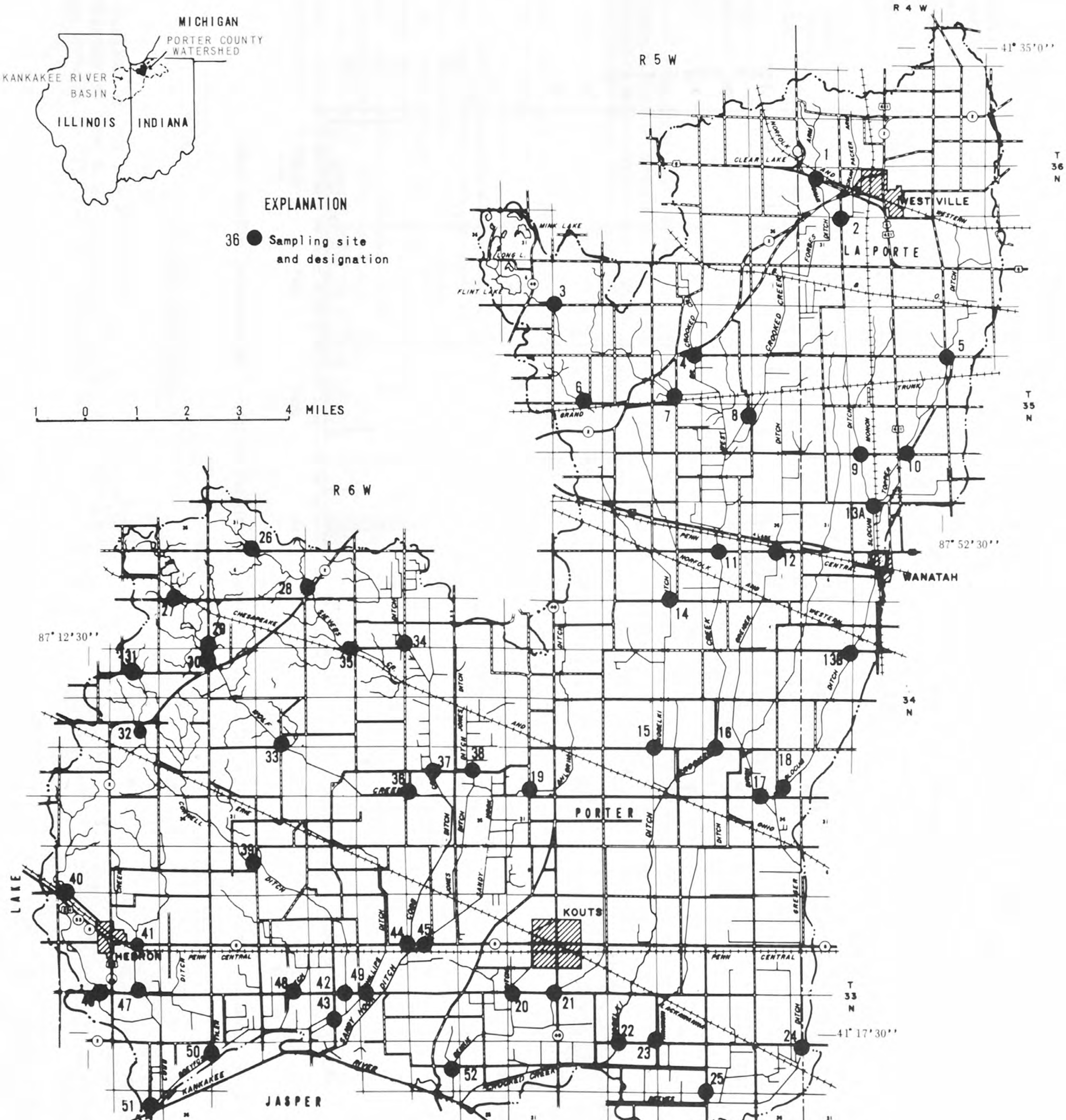
The Porter County watershed of the Kankakee River basin drains 241 mi^2 (154,240 acres) of northwestern Indiana (Hoggatt, 1975, p. 134, 136, and 172). Of these, 147,140 acres are in southern Porter County, 5,000 are in southeastern LaPorte County, and 2,100 are in southwestern Lake County (fig. 1). Land use in the watershed is 78 percent cropland, 9 percent pasture and grassland, 5 percent woodland, 5 percent urban and farmsteads, 1 percent wildlife and recreation, and 2 percent miscellaneous. Populations of small towns in the primarily agricultural area are Hebron, 1,624; Kouts, 1,388; Wanatah, 773; and Westville, 2,614 (Robert Rasely, Soil Conservation Service, written commun., October 19, 1977). A sewage-treatment plant in the southwestern section of Westville discharges effluent near Crumpacker Arm, a tributary of Crooked Creek.

Names and drainage areas of the six major tributaries to the Kankakee River in the watershed are: Breyfogel ditch, 22.9 mi^2 (square miles); Phillips ditch, 19.6 mi^2; Sandy Hook ditch, 52.5 mi^2; Benkie ditch, 12.3 mi^2; Reeves ditch, 54.4 mi^2; and Crooked Creek, 79.4 mi^2 (Hoggatt, 1975, p. 134, 136, and 172). All streams are perennial, except for their extreme upper reaches, and each stream has been partly or wholly channelized.

Average annual precipitation, from 1961 to 1977, 39.9 in. (inches), was evenly distributed throughout the year (fig. 2). The average runoff from 1968 to 1977 was 14.4 in. (U.S. Geological Survey, 1977, p. 286).

The two physiographic units in the Porter County watershed are the Valparaiso moraine and the Kankakee outwash and lacustrine plain (Schneider, 1966, p. 51-52). These units are composed of unconsolidated Pleistocene deposits that range in thickness from 50 to 200 ft (feet). The Valparaiso unit is a compound moraine that grades between rolling hills and gently undulating till plains. Its average elevation is between 700 and 800 ft above sea level. Many of the high knobs exceed 850 ft. The Kankakee outwash and lacustrine plain unit is physiographically low, poorly drained, and underlain mostly by sand.

Soils are of recent origin and vary widely in characteristics and potential productivity, owing to differences in mineralogical composition. Soil types in the watershed are Plainfield and Oshtemo sands; Maumee and Gilford sandy loams; Tracy, Door, and Fox loams; and the Chalmers, Elliott, Parr, and Sidell types (Ulrich, 1966, p. 85-87). The Fox and Oshtemo soils developed on calcareous sand and gravel and the Tracy and Door, on gravel, sand, and acidic shale. The Maumee and Gilford, black, loamy soils of former marshland areas, are the most productive. The Plainfield soil is a loose sandy soil. The Sidell, Parr, Elliott, and Chalmers soils, in the northwestern part of the study area (Ulrich, 1966, p. 69), are dark, organic, fertile, and very productive soils formed in limy glacial deposits.



Base from U.S. Department of Agriculture, Soil Conservation Service. Porter County Kankakee River Watershed. Kankakee River Basin, Jasper, Lake, La Porte, and Porter Counties, Indiana. Map 5, R-29, 690, 12-1-71, Revised 7-27-72

Figure 1.-- Locations of data-collection sites in the Porter County, Ind., watershed of the Kankakee River basin.

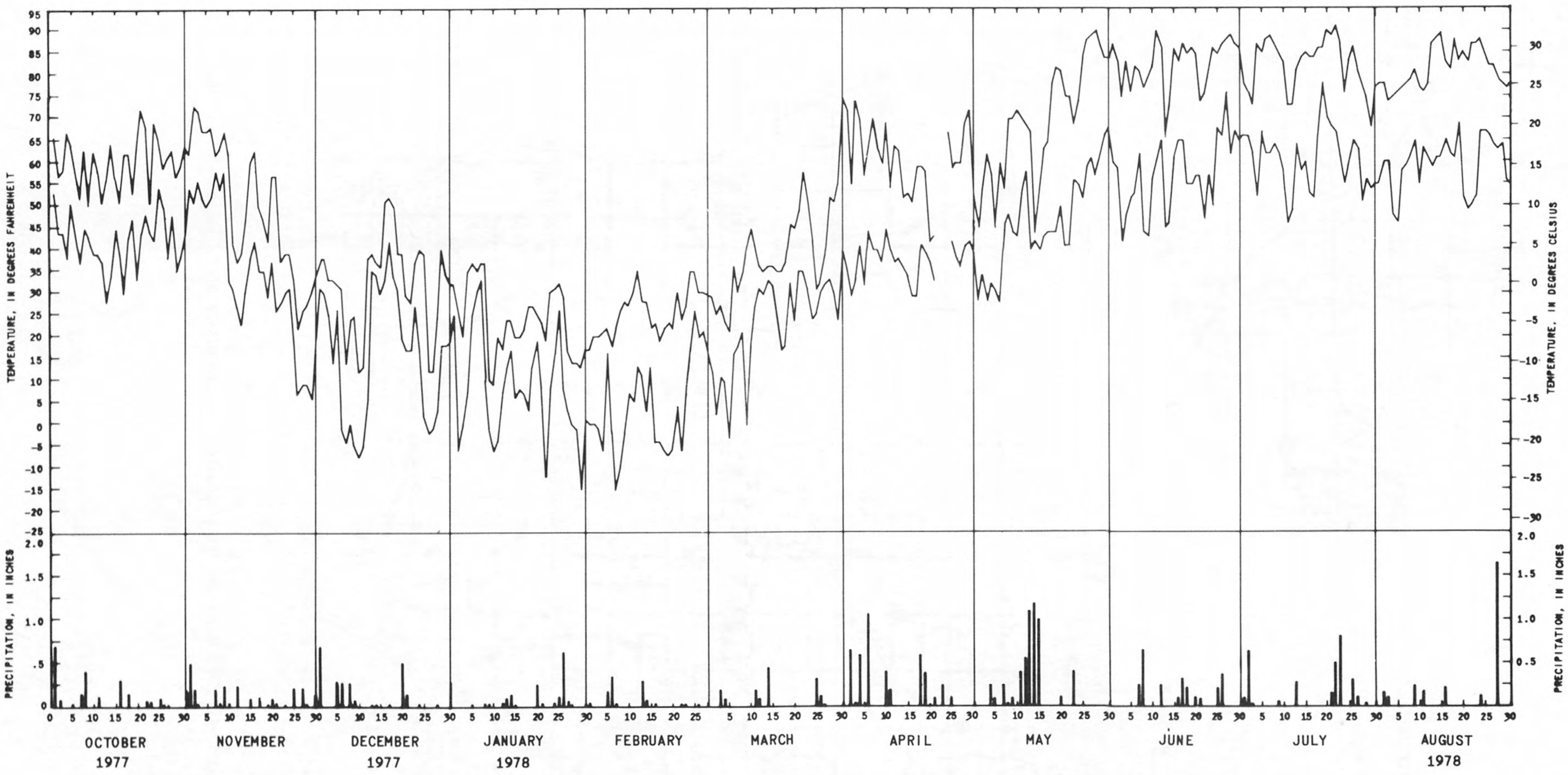


Figure 2.-- Precipitation and maximum and minimum air temperatures at Valparaiso, Ind., (data from National Oceanic and Atmospheric Administration, 1977 and 1978).

Problems

The Kankakee River and its major Porter County tributaries flood almost annually and on the average about three times per year along the Kankakee River (Robert Rasely, U.S. Soil Conservation Service, written commun., October 1977). Farming efficiency is reduced by the flooding and inadequate soil drainage. The severity of the flooding ranges from water just overflowing the river banks to parts of the watershed being completely under water. Because about 80 percent of the approximately 15,400 acres in the 100-year flood plain of the major tributaries is cropland, spring flooding delays planting and reduces the quantity and quality of crops, and summer and autumn flooding may damage or destroy crops. Flooding of tributaries is less frequent than flooding of the main stem, but all major tributaries are dependent on the river as an outlet. Inadequate soil drainage results from restricted streamflow. Approximately 40,000 acres of cropland within the watershed is inadequately drained (Robert Rasely, Soil Conservation Service, written commun., October 1977).

Pesticides and other chlorinated hydrocarbons adsorbed on streambed materials and constituents dissolved in the water may be a problem. These organic and inorganic constituents may come from both point and nonpoint sources; for example, runoff from cultivated land, feedlots, discharges from wastewater treatment facilities, individual homesteads, and industry.

Additional problems in the study area included chemical spills in the Crooked Creek drainage basin (fig. 1), upstream from site 2 just before sample collection in June and August 1978. On June 28, 1978, 8,000 gallons of paint waste was spilled into the stream; water samples were collected several hours later before the cleanup crew arrived (U.S. Environmental Protection Agency, Chicago, Ill., Ralph Coons, oral commun., September 1978). In a second spill, on August 28, 1978, 35,000 gallons of waste crankcase oil entered the stream upstream from site 2 (U.S. Environmental Protection Agency, Chicago, Ill., Ralph Coons, oral commun., September 1978). Water samples were collected 2 days later on August 30, 1978. At this time, a cleanup crew was still working to remove the oil from the stream at site 2 and various other sites downstream. The long-term effects of these chemical spills on the environment would be difficult to predict.

Purpose and Scope

Water quality of the Porter County watershed in the Kankakee River basin was investigated by the U.S. Geological Survey in cooperation with the Soil Conservation Service to (1) define variations in concentrations of dissolved inorganic constituents (heavy metals, major ions, and nutrients[1]), suspended sediment, organic carbon, chlorinated hydrocarbons, fecal coliforms, and fecal streptococci, as well as variations in communities of phytoplankton, periphyton, and benthic invertebrates; (2) identify areas and possible sources of water-quality problems; and (3) provide the Soil Conservation Service with baseline water-quality data necessary for satisfying their environmental evaluation needs.

On-site field measurements of pH, specific conductance, water temperature, and dissolved-oxygen concentration were obtained in a basinwide reconnaissance of 51 sites on November 1 and 2, 1977 (table 1 and fig. 1). In addition, land use and other notable conditions were observed. On the basis of reconnaissance data, 21 of the 51 sites were selected for additional sampling on November 30 and December 1 and 2, 1977. In addition to on-site field measurements, including instantaneous discharge, water samples were collected for laboratory determination of dissolved inorganic constituents (heavy metals, major ions, and nutrients), organic carbon, and suspended sediment. Starting in April 1978, streambed samples were collected for determining chlorinated-hydrocarbon concentrations. Water samples were also collected for field determination of fecal coliform and fecal streptococci.

From the 21 sites sampled for water-quality determinations in November and December 1977 (tables 2-11), 10 sites were chosen for three additional sampling runs (April 12-13, 1978; June 28-29, 1978; and August 29-31, 1978). Water samples were also collected at selected sites for phytoplankton cell counts and generic identification in April, July, and August 1978. Artificial substrate samplers for the collecting of benthic invertebrates and mylar strips for the collecting of periphyton were placed in selected streams on June 29, 1978, and were collected on July 20, 1978.

On July 14, 1979, two core samples were collected at site 44 at a depth of 2 ft into (1) the stream bank at water's edge and (2) the middle of the streambed. These samples were analyzed for chlorinated hydrocarbons.

Methods

During the basinwide reconnaissance and samplings, pH, specific conductance, dissolved oxygen, and water temperature were measured in the stream by a multivariable water-quality instrument calibrated for each variable at the beginning and end of each day. Instantaneous stream discharge was measured by a rated flow meter. These data are given in tables 1 and 2. (All water-quality samples were analyzed by the U.S. Geological Survey.)

Water samples for the determination of dissolved-inorganic constituents (heavy metals, major ions, and nutrients) and organic carbon for sampling sites (table 3 and fig. 1) were collected and analyzed by methods of Brown, Skougstad, and Fishman (1970). Streambed samples for determination of chlorinated hydrocarbons were also collected at the streambed surface and depth

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[1]Compounds containing nitrogen and phosphorus.

of 2 ft into the bank and into the middle of the streambed (table 4). Methods by Goerlitz and Brown (1972) were used for collection and analysis of streambed samples.

Methods used in collection and analysis of suspended sediment were those of Guy (1970) and Guy and Norman (1970). A Geological Survey DH-48 suspended sediment sampler was used to collect width and depth-integrated samples.

Water samples were collected at selected sites on four sampling runs (table 6) for counting fecal coliform and fecal streptococcal bacteria. Samples were collected in sterilized glass bottles and were chilled and plated within 3 hours after collection. They were then analyzed after full incubation (24 hours at 44°C for fecal coliform and 48 hours at 35°C for fecal streptococcus). Methods of collection and analysis of the bacterial samples are described by Slack and others (1973).

Mylar strips and jumbo artificial multiplates were used for the collection of periphyton and benthic invertebrates, respectively. Phytoplankton samples were collected in bottles and preserved. These collection methods were chosen so comparison of data could be made between sites. Methods of collection and analysis are described by Slack and others (1973). Cell counts, genera identification, and diversity indices (a measure of community structure that permits comparison of data between sampling sites) were reported for each sampled site.

RESULTS

Field Measurements

Water temperature ranged from 7.0°C during the sampling run of November 30-December 2, 1977, to 26.6°C during the sampling run of June 28-29, 1978 (table 2). Maximum and minimum air temperatures and precipitation data recorded at the National Oceanic and Atmospheric Station at Valparaiso, Ind., are plotted for October 1977 to September 1978 in figure 2 (National Oceanic and Atmospheric Administration, 1977 and 1978).

The maximum variation in pH at a given site from one sampling run to the next was 1.3 at site 51. The pH for all the sites ranged from 6.8 to 8.9, near the range sited for natural waters by Hem (1970, p. 93).

Dissolved-oxygen concentration ranged from 2.5 to 14.9 mg/L (milligrams per liter), or from 27 to 148 percent of saturation. Dissolved-oxygen concentration ranged from 2.7 to 5.4 mg/L at site 2 (downstream site from Westville and a sewage-treatment plant) but steadily increased at downstream sites 8, 16, and 22 (figs. 3 and 4). The only other low dissolved-oxygen concentration (2.5 mg/L) was measured at site 28 on June 29, 1978. The cause of this low concentration may have been due to stagnant or low-flow conditions.

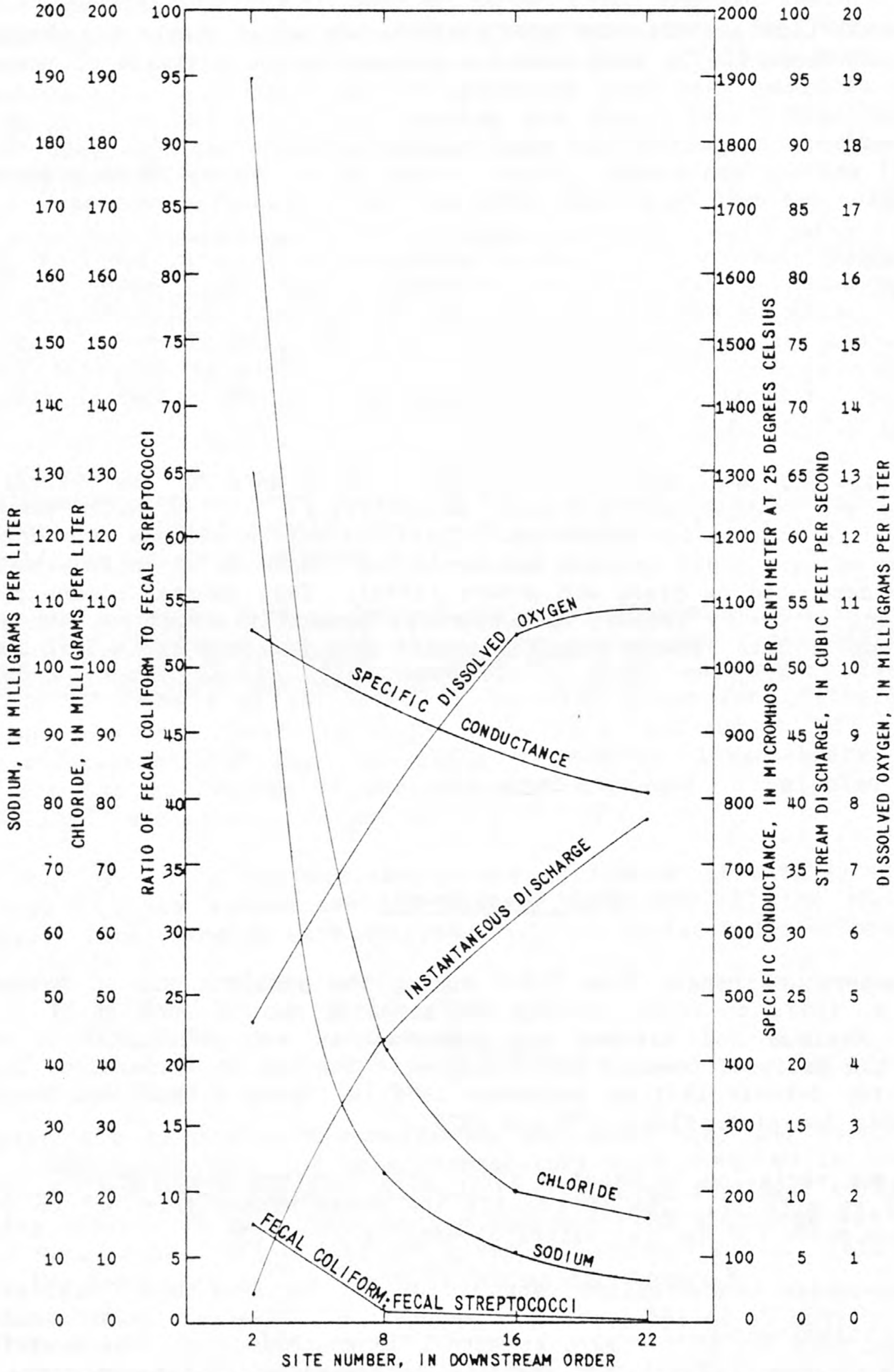

Figure 3.-- Effects of sewage-plant effluent on water quality at sampling sites downstream from Westville, Ind., in the Porter County watershed of the Kankakee River basin, November 30, 1977.

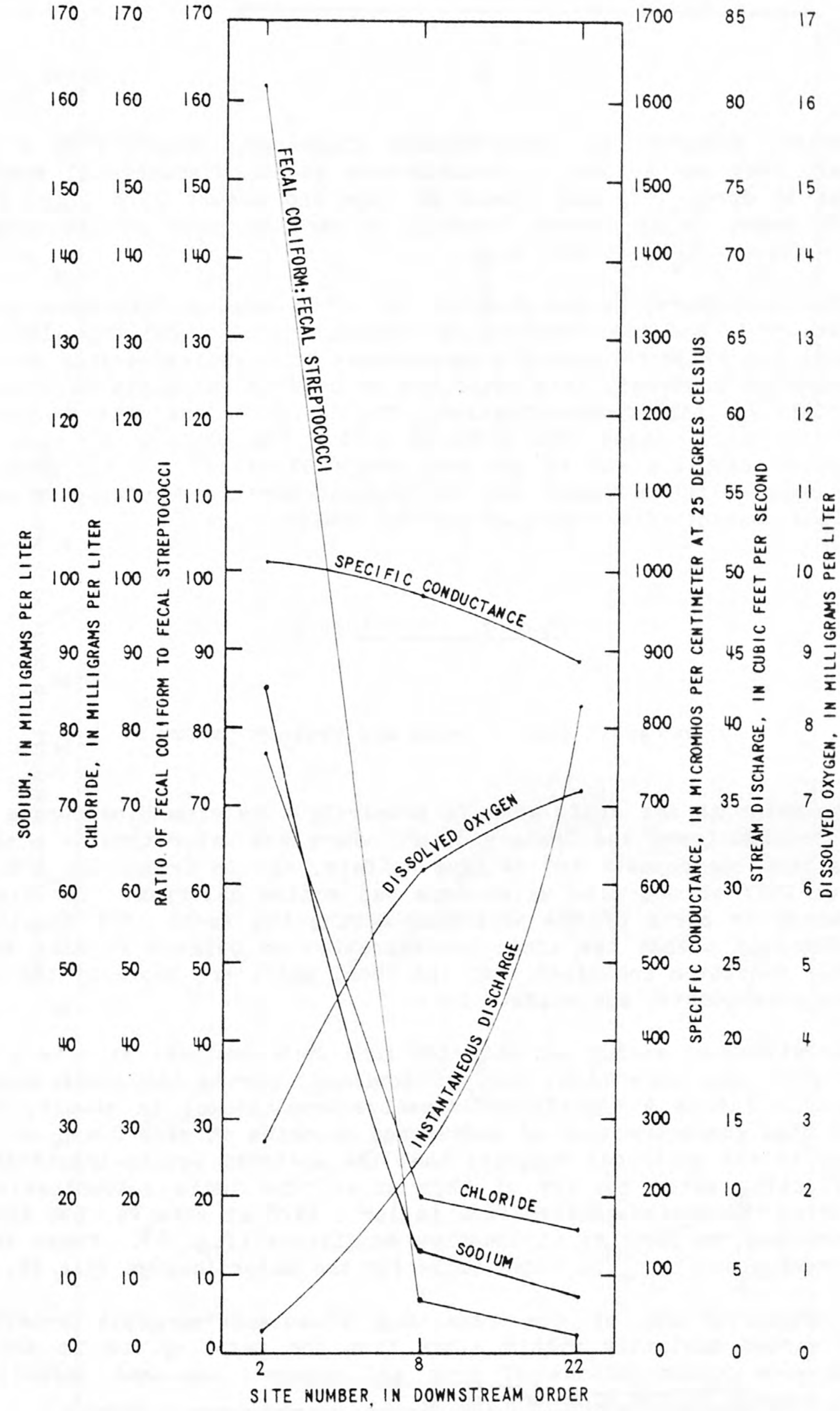

Figure 4.-- Effects of sewage-plant effluent on water quality at sampling sites downstream from Westville, Ind., in the Porter County watershed of the Kankakee River basin, June 28, 1978.

Streamflow, measured as instantaneous discharge, ranged from 0 to 101 ft^3/s (cubic feet per second). Instantaneous stream discharge at most sites was highest in April 1978 and lowest in June and August 1978 (fig. 5). In April 1978, heavy rains caused flooding in various parts of the watershed. Site 51 was inaccessible at this time.

Specific conductance ranged from 261 to 1,060 umho/cm (micromhos per centimeter) at 25°C, and dissolved-solids concentration ranged from 147 to 719 mg/L. Where the ratio of specific conductance to dissolved-solids concentration is known for a stream, that ratio can be used to calculate an approximate value of dissolved-solids concentration. The ratio for the watershed averaged 0.63, but the ratio ranged from 0.46 to 0.74. The maximum variance of the ratio from one sampling run to the next was 0.02 within sites. Site 2, affected by sewage-plant effluent, had the highest specific conductance and dissolved-solids concentration; site 28 had the lowest values.

Chemical Constituents

Inorganic constituents and organic carbon

Surface water in the study area is primarily a calcium bicarbonate water, except in Crooked Creek and Greiger ditch, where the water type is a combination of calcium bicarbonate and calcium sulfate, and in Crumpacker Arm, where in December 1977 at one site water type was sodium chloride. The high flow and floodwater in parts of the watershed during the April 1978 sampling did not significantly change the ionic concentration or balance at most sampling sites. This condition indicates that the local soils are probably the sources of calcium, bicarbonate, and sulfate ions.

Concentrations of sodium and chloride ions were dominant at site 2 on December 2, 1977, and were high, but not dominant, during the other samplings. As sodium chloride is a significant dissolved-constituent in sewage, the detection of high concentrations of sodium and chloride at site 2 and not at the other sites in the watershed suggests that the upstream sewage-treatment plant may be affecting water quality at this site. The ionic concentrations decreased during the period of high flow in April 1978 at site 28, but the ionic balance remained the same as at low-flow conditions (fig. 6). These data indicate sources other than the local soils for the major ions at site 28.

Most concentrations of the remaining dissolved-inorganic constituents (table 3) varied minimally within sites from one sampling run to the next. Exceptions were concentrations of iron and apparent seasonal variations of manganese, organic carbon, and nutrients.

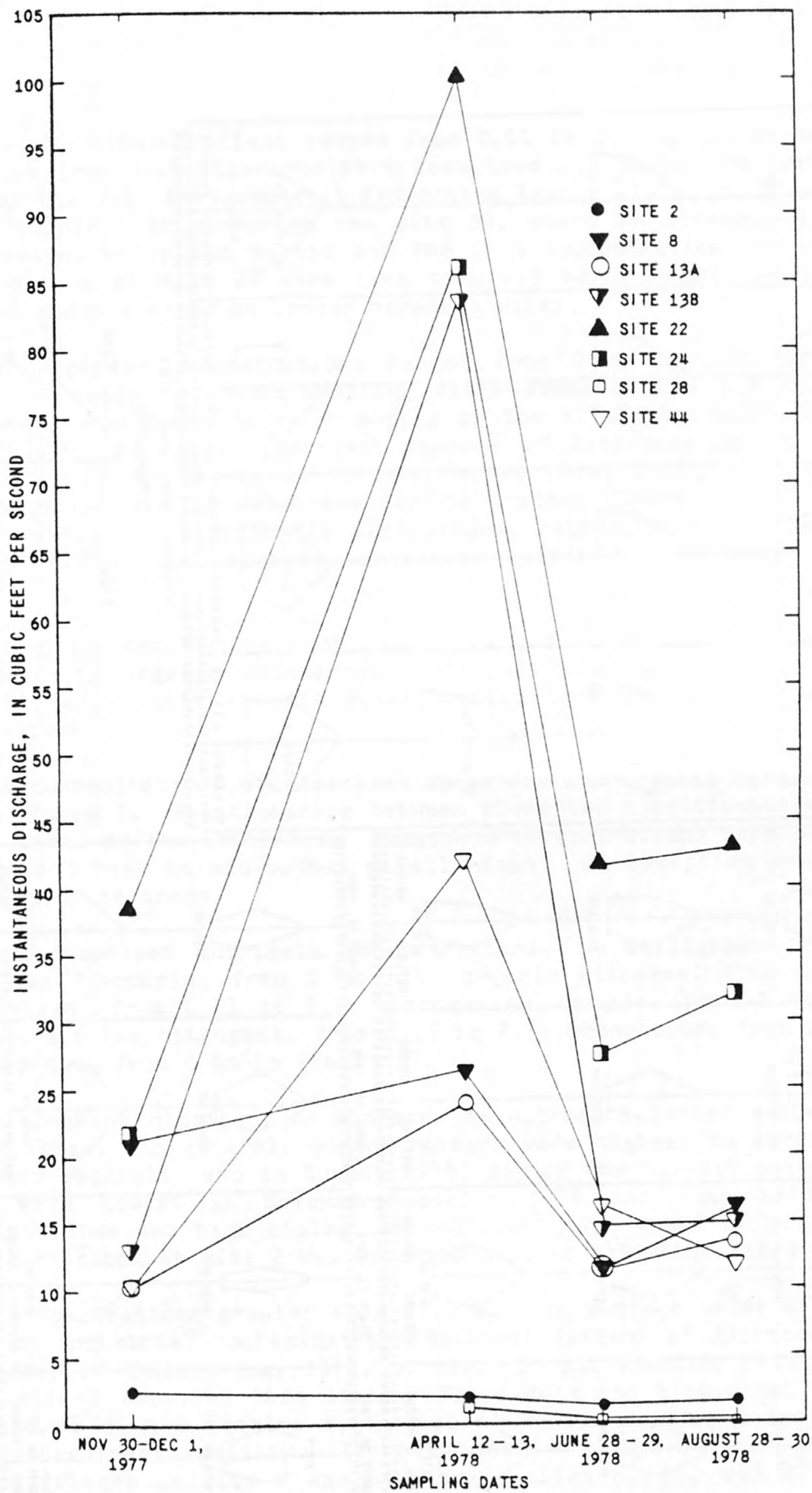

Figure 5.-- Seasonal fluctuation of instantaneous discharge at sampling sites in the Porter County, Ind., watershed of the Kankakee River basin.

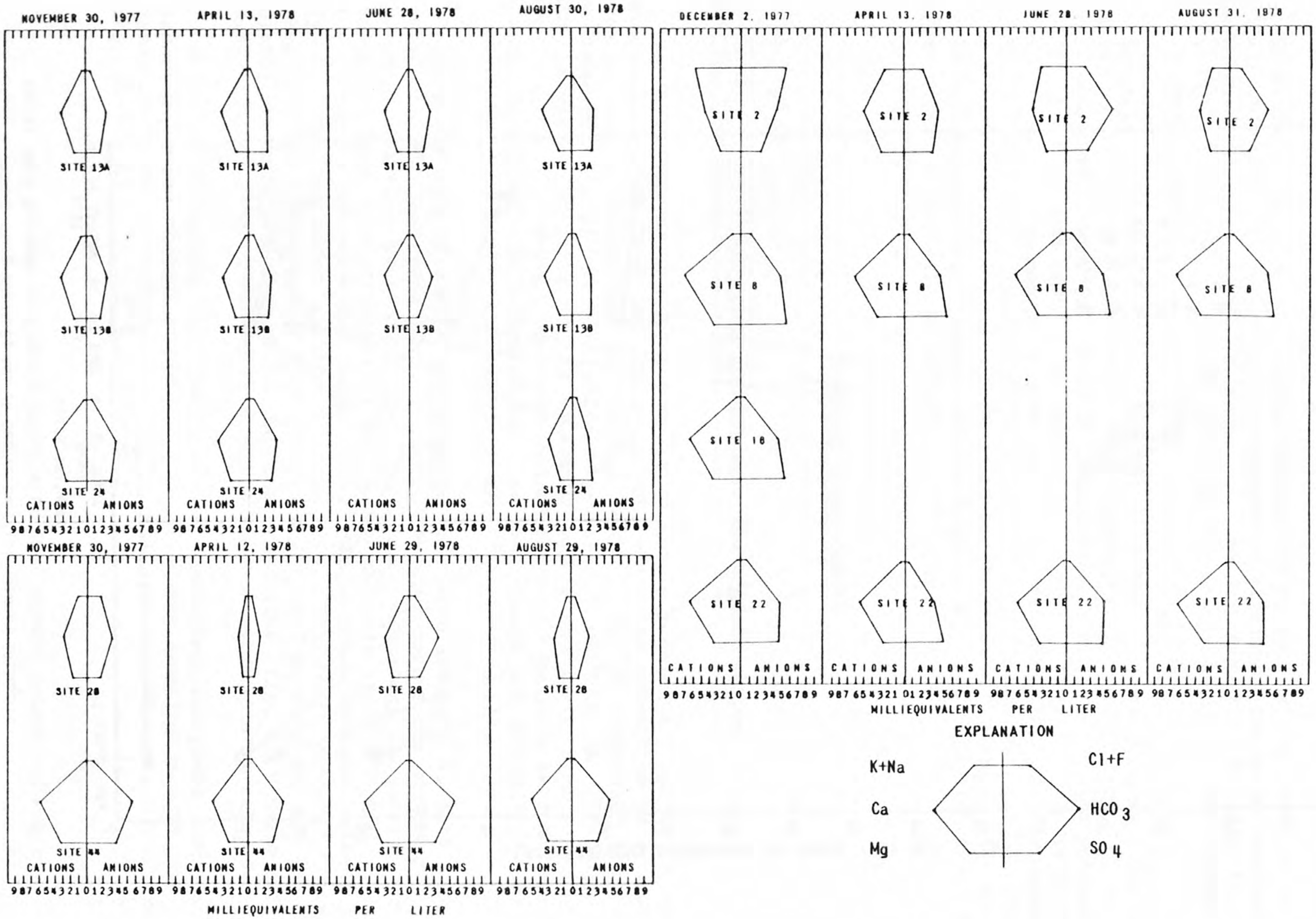

Figure 6.-- Stiff (1951) diagrams of water samples collected in the Porter County, Ind., watershed of the Kankakee River basin.

Dissolved-iron concentrations ranged from 0.01 to 2.0 mg/L. At most sampling sites the iron concentrations were less than 0.3 mg/L, the upper limit recommended by the U.S. Environmental Protection Agency (1976, p. 152) for domestic water supply. An exception was site 28, where on November 30, 1977, the water appeared milky and turbid and the iron concentration was 2.0 mg/L. Iron concentrations at site 28 were less than 0.3 mg/L during the remaining sampling runs, and the water no longer appeared milky.

Dissolved-manganese concentrations ranged from 0.01 to 0.69 mg/L. The manganese concentration at most sampling sites exceeded the 0.5 mg/L upper limit recommended for domestic water supply by the U.S. Environmental Protection Agency (1976, p. 178). Important sources of manganese include freshly fallen leaves and other plants in forested areas (Hem, 1964, p. B2-B3) from which a high percentage of manganese can be leached (Oborn, 1964, p. C12). Although the watershed is primarily agricultural rather than forested, trees lining the banks of most streams contribute leaves to the streams during autumn.

Dissolved organic-carbon concentration ranged from 2.4 to 20 mg/L. Naturally occurring organic substances, especially fulvic acid (Zajicek and Pojasek, 1976), are factors in the solubilization and transport of manganese in aquatic systems.

Trends in concentrations of dissolved manganese and organic carbon are illustrated in figure 7. Relationships between these two constituents were evident at most sites in the watershed. Manganese concentrations were highest in late autumn and lowest in mid-summer at all sites. An exception was site 2, which had an opposite trend.

Ranges of dissolved nutrients concentrations, in milligrams per liter, were as follows: ammonia, from 0 to 6.1; organic nitrogen, from 0 to 1.7; Kjeldahl nitrogen, from 0.13 to 6.7; nitrogen as ammonia, from 0 to 22; nitrite plus nitrate (as nitrogen), from 0.05 to 2.7; phosphorus, from 0 to 3.1; and orthophosphate, from 0 to 15 (table 3).

Concentrations of nitrite plus nitrate (as nitrogen) varied seasonally at all sampling sites. In general, concentrations were highest in April 1978, a period of heavy rainfall, and in August 1978, during the harvest season. Concentrations were lowest in November-December 1977 and June 1978, during periods of low flows and high biological activity. The trend of nitrite plus nitrate concentrations at site 2 was opposite that at all other sites (fig. 8).

Ammonia concentrations greater than 0.10 mg/L in surface water often indicate sewage or industrial contamination (National Academy of Sciences and the National Academy of Engineering, 1972, p. 55). On all sampling dates, concentrations at site 2 exceeded this limit. These data and biological and field data collected at site 2 (tables 1, 2, and 6) indicate effects from the upstream sewage-treatment facility. Figures 3 and 4 illustrate the effects of sewage-plant effluent on site 2 and downstream sites 8, 16, and 22 (Crooked Creek drainage basin), and all data suggest that the downstream sites recover from the sewage-plant effluent.

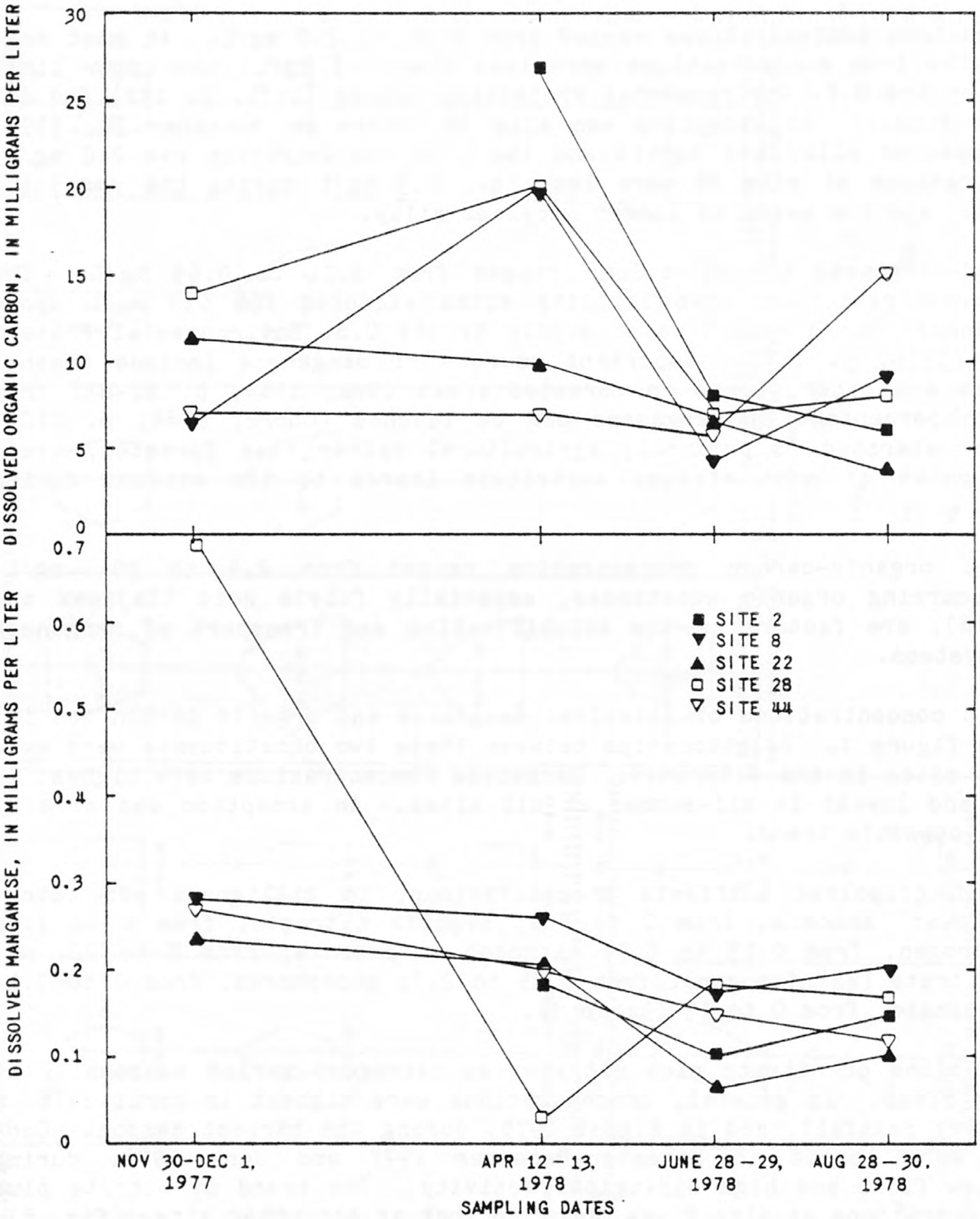

Figure 7.-- Trends of dissolved-manganese and dissolved-organic-carbon concentrations in the Porter County, Ind., watershed of the Kankakee River basin.

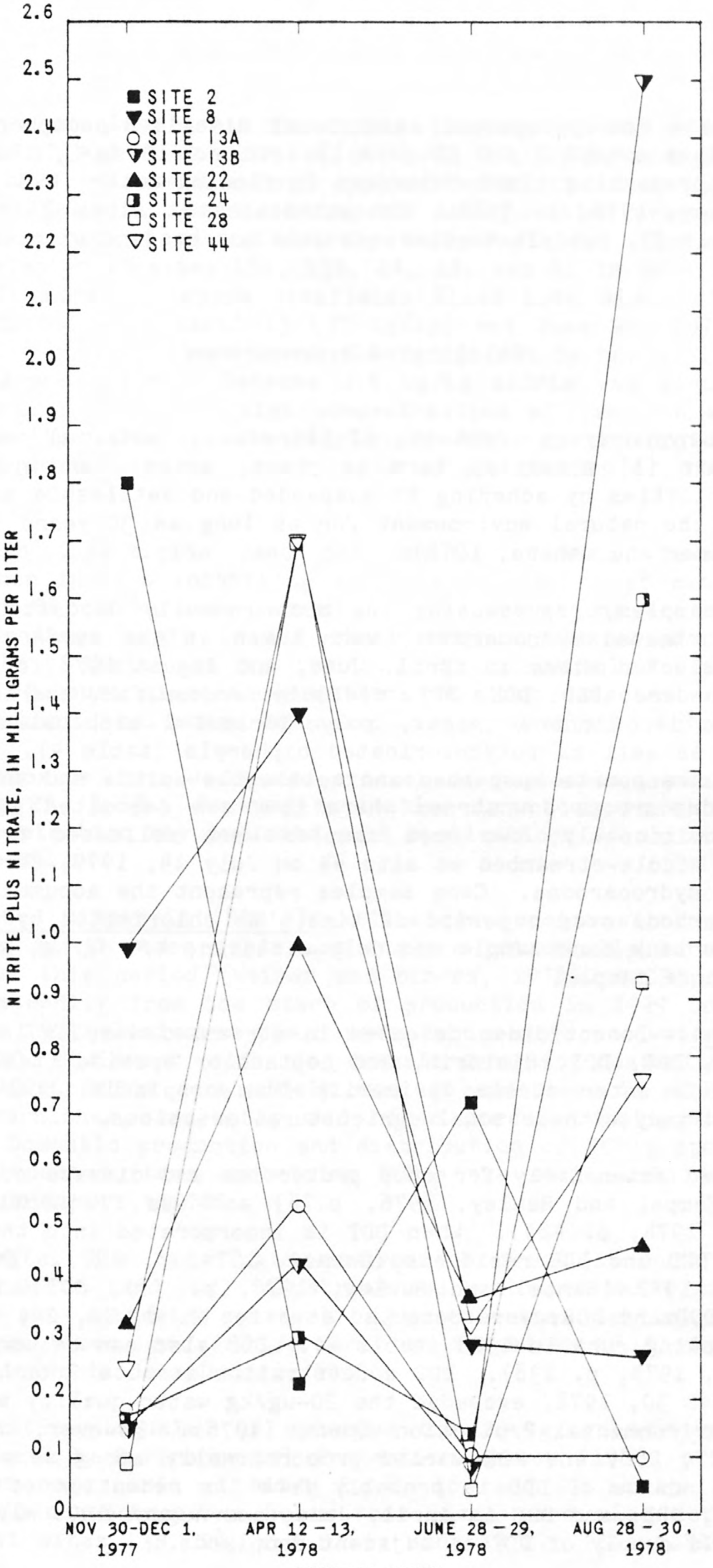

Figure 8.-- Seasonal distribution of dissolved nitrite plus nitrate concentrations (as nitrogen) in the Porter County, Ind., watershed of the Kankakee River basin.

Orthophosphate (as phosphorus) and total dissolved-phosphorus concentrations at all sites except 2 and 51 were less than 0.10 mg/L, the minimum concentration for preventing plant nuisances in flowing water (U.S. Environmental Protection Agency, 1976, p. 356). Concentrations at sites 2 and 51 exceeded this limit (table 3), but plant nuisances were not evident at either site.

Chlorinated hydrocarbons

Chlorinated-hydrocarbon content of streambed material was determined because of their (1) potential harm to plant, animal, and human life; (2) transport capabilities by adhering to suspended and settleable solids, and (3) persistance in the natural environment for as long as 30 years (Guenzi, 1974, p. 342; and Weimer and others, 1978).

Streambed samples, representing the most recently deposited sediment and associated chlorinated hydrocarbons, were taken at the surface layer of the streambed at selected sites in April, June, and August 1978 for determination of aldrin, chlordane, DDD, DDE, DDT, dieldrin, endosulfan, endrin, heptachlor, heptachlor epoxide, lindane, mirex, polychlorinated naphthalene , perthane, and toxaphene, as well as polychlorinated biphenyls (table 4). High flow, as in April 1978, transports suspended and settleable solids and their associated chlorinated hydrocarbons downstream where they are deposited as flow returns to normal. Additionally, two core samples were collected from the bank's water edge and middle-streambed at site 44 on July 14, 1979, for determination of chlorinated hydrocarbons. Core samples represent the accumulation of chlorinated hydrocarbons over a period of time. No chlorinated hydrocarbons were detected in the bank core sample and only dieldrin, 4.6 ug/kg, was detected in the streambed core sample.

Insecticides.--Insecticides detected in streambed samples included aldrin, chlordane, DDD, DDE, DDT, dieldrin, and heptachlor epoxide (table 4). Insecticides generally enter streams primarily from croplands; therefore, concentrations should vary with seasonal agricultural practices.

DDT was used extensively for crop protection and disease control programs before 1972 (Hampel and Hawley, 1976, p.76) and was frequently detected in soils (Guenzi, 1974, p. 484). When DDT is incorporated into the soil, it can be reduced to DDD and DDE residuals (Guenzi, 1974, p. 137). Even though DDT was banned in 1972 (Hampel and Hawley, 1976, p. 76), DDT and its reduced counterparts, DDD and DDE, were detected at sites 2, 8, 22, 24, 46, 51, and 44 on various sampling runs in 1978 (table 4). DDD also can be used as an insecticide (Guenzi, 1974, p. 138). DDD concentration at site 2 on June 28 and at site 8 on August 30, 1978, exceeded the 20-ug/kg water-quality alert limit set by the U.S. Environmental Protection Agency (1976). However, because concentrations of DDT, DDD, and DDE varied proportionally among sampling sites and samplings, the source of DDD is probably from the reduction of DDT. The detection of DDT, DDD, and DDE in April, June, and August 1978 may have been due to use of an old supply of DDT on adjacent croplands.

Aldrin is an unstable organic insecticide that is quickly reduced to dieldrin. Detection of aldrin at site 46 on April 12, 1978, and at site 44 on June 29, 1978, may indicate a recent application of the insecticide to adjacent croplands. Dieldrin, besides being the decomposition product of aldrin, is also an insecticide used extensively on cornfields. Concentrations of dieldrin were detected at sites 13A, 13B, 24, 28, and 51 in June 1978 (table 4 and fig. 1). At site 44, where cornfields lined both sides of the stream, dieldrin concentrations on April 13 (35 μg/kg) and June 29, 1978 (74 μg/kg) exceeded the water-quality alert limit (20 μg/kg) set by the U.S. Environmental Protection Agency (1976). Because 0.6 μg/kg aldrin was also detected at site 44 on June 29, 1978, the high concentrations of dieldrin were probably due to either applications of both aldrin and dieldrin or application of aldrin and partial reduction to dieldrin and no application of dieldrin at all on adjacent cornfields at site 44.

Chlordane, an insecticide used for control of ants, termites, grasshoppers, and other insects inhabiting soils, was detected at sites 2, 8, 22, 28, 44, 46, and 51 in various samplings. Concentrations at site 8 in the Crooked Creek drainage basin in all three samplings exceeded the 20 μg/kg water-quality alert limit set by the U.S. Environmental Protection Agency (1976, p. 240). Because high concentrations were not detected at other sites in this drainage basin, chlordane application was probably localized at site 8.

Heptachlor epoxide, the weathered product of heptachlor, was detected at site 44 on June 29, 1978. Because heptachlor is a commercial component of chlordane, this detection may indicate past applications of chlordane on cornfields near site 44.

Polychlorinated biphenyls (PCB's).--PCB's can persist within the environment for as long as 30 years after use and are potentially harmful to human beings throughout this period (Weimer and others, 1978). PCB production and uses increased steadily from the start of production in 1929 until restrictions imposed in 1971 eliminated their uses in domestic production in all but closed electrical equipment such as transformers and capacitors (Durfee, 1975). Before 1971, PCB's were widely used as additives in adhesives, plastics, paints, varnishes, sealants, and other surface coatings (Weimer and others, 1978). Domestic production and distribution of PCB's stopped in late 1977; however, imported items containing PCB's are still sold in the United States (Weimer and others, 1978).

PCB's can enter the hydrologic environment from (1) runoff of sewage sludges disposed of on land, (2) industrial and municipal waste discharge (including treated and untreated wastes), (3) accidental spills, (4) improper waste-disposal practices, and (5) formerly as ingredients of insecticides or as carriers for insecticides (Dennis, 1975).

PCB concentrations equaled or exceeded the 20-μg/kg water-quality alert limit set by the U.S. Environmental Protection Agency (1976, p. 364) in the Crooked Creek drainage basin at sites 2, 8, 16, and 22 in April, June, and August 1978. PCB concentrations below this limit were also detected within the study area at sites 13B, 28, and 51 in June 1978. (See table 4 and fig. 1.)

PCB concentrations decreased progressively in the Crooked Creek drainage basin from site 2 to site 22 in April and June 1978 (table 4), but PCB concentration was higher at site 8 (160 ug/kg) than at upstream site 2 (66 ug/kg) on August 30, 1978.

Because the Crooked Creek drainage basin has so many water-quality problems and because of past PCB uses in a variety of long-lived equipment and PCB's persistent nature, once it is introduced into the environment, determination of when and from what source PCB's were introduced into the streams would be difficult.

PCB concentrations at sites 13B and 28 in June 1978 were 11 and 10 ug/kg, respectively. No PCB's were detected in a resampling of site 13B on August 30, 1978. Sites upstream and downstream from sites 13B, 28, and 51 were sampled at least once for PCB's, but none was detected. These samplings indicate that PCB's detected were fairly isolated in some parts of the watershed.

Even though PCB's are no longer produced in the United States, they will continue to be a problem because (1) they have been used in a variety of industrial products and can persist for as long as 30 years, (2) PCB molecules do not readily decompose, (3) they are not quickly absorbed and washed out to sea because they do not dissolve readily in water, (4) PCB's are not easily destroyed because they are resistant to heat, (5) PCB's accumulate in the fatty tissues of animals, (6) fish are very slow in eliminating PCB's from their system, and (7) PCB's are capable of being incorporated into the biological food chain (Weimer and others, 1978).

Suspended Sediment

Sediment is widely recognized as a contaminant of surface water. This natural product of erosion agrades streams and reservoirs and obstructs flows through bridges and culverts. Sediment is also a transport mechanism, by adsorption, for toxic metals, radionuclides, nutrients, pesticides, and toxic organic compounds.

Suspended-sediment samples were collected at seven sites during each of the four sampling runs (table 5 and fig. 9). Measured suspended-sediment concentration ranged from 8 mg/L (site 13A, June 1978) to 75 mg/L (site 44, August 30, 1978)[1].

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[1]Conversion of milligrams per liter to tons per day

$$Q_s = QwC_sk$$

where

Q_s = tons per day

Qw = water discharge, in cubic feet per second,

C_s = discharge weighted mean concentration, in milligrams per liter,

and

$k = 0.0027$.

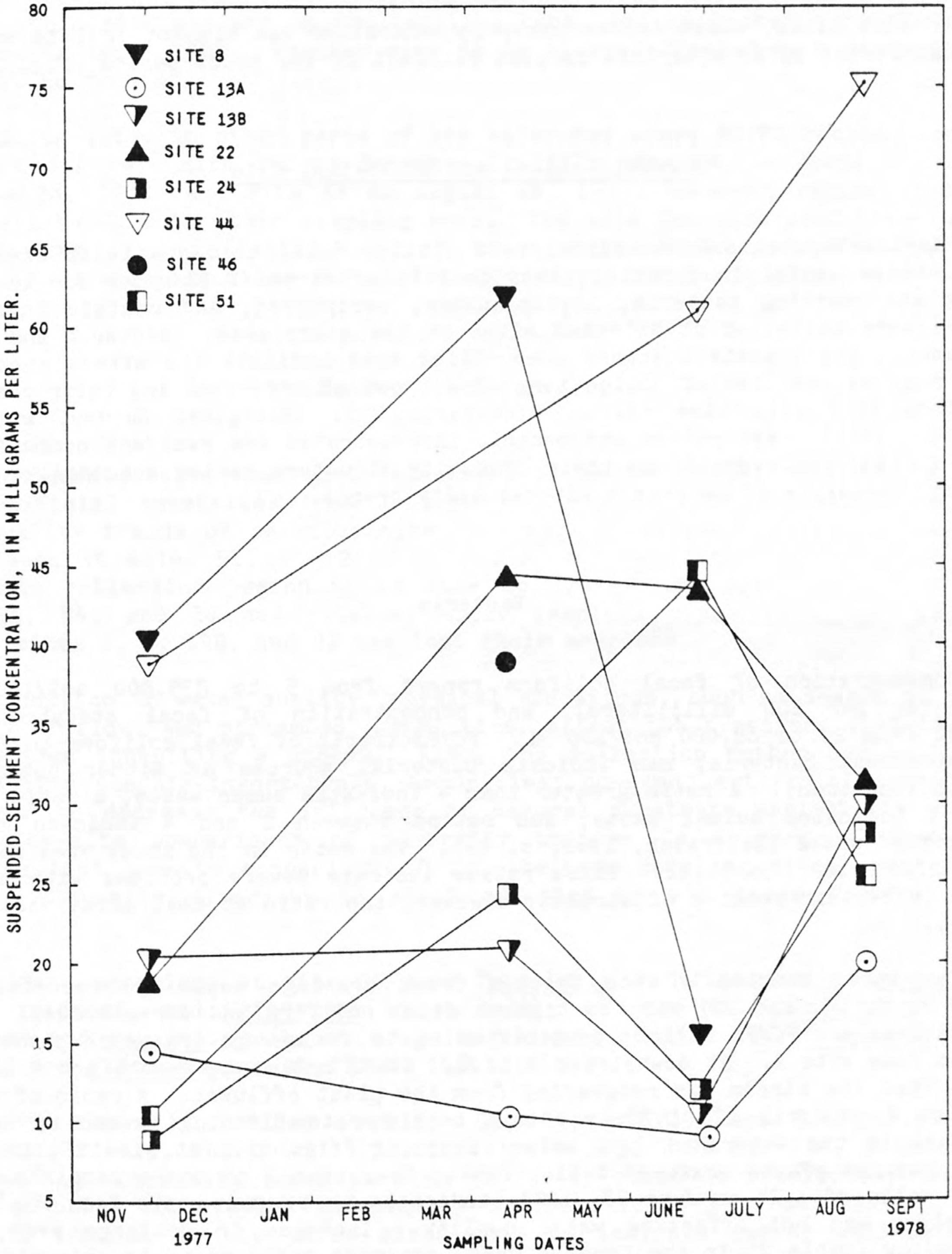

Figure 9.-- Suspended sediment concentrations in the Porter County, Ind., watershed of the Kankakee River basin.

At most sites, suspended-sediment concentration was highest in late summer (August 29-31, 1978) after the largest rainfall of the study period (fig. 2).

Microbiological and Biological Data

Microbiological and biological data (tables 6-11) collected with chemical data can be useful in defining water quality of streams. Samples for identifying and counting bacteria, phytoplankton, periphyton, and benthic invertebrates were collected at selected sites in the study area. Bacteria and phytoplankton are transient stream communities that indicate the stream's condition only at the time of collection. The types of organisms and their concentrations vary with time (R. J. Pickering, U.S. Geological Survey, written commun., 1974). Periphyton and benthic invertebrates are resident communities of a stream, and even though their community structure varies seasonally, they can be indicative of long-term water-quality trends.

Bacteria

Concentration of fecal coliform ranged from 5 to 335,000 col/100 mL (colonies per 100 milliliters), and concentration of fecal streptococcus ranged from 20 to 88,000 col/100 mL. FC/FS (ratio of fecal coliform to fecal streptococcal bacteria) can indicate bacterial sources as either human or animal (nonhuman). A ratio greater than 4 indicates human waste, a ratio less than 1 indicates animal waste, and ratios between 1 and 4 indicate mixed sources of waste (Geldreich, 1966, p. 46). The ratio in the study area ranged from 2.2×10^{-4} to 81.71. These ratios indicate severe problems with human waste in certain reaches of streams; however, the ratio at most sites was less than 1.

The upper reaches of the Crooked Creek drainage basin (represented by sites 2, 8, 16, and 22) had the highest fecal coliform and streptococcal concentrations and FC/FS ratios, probably owing to the sewage-treatment plant upstream from site 2. At downstream site 8, FC/FS ratios between 1 and 4 indicated that the stream was recovering from the plant effluent. A ratio of 5.75 at site 8 on April 12, 1978, may have been due to flushing caused by heavy rainfall in the watershed just before sampling (fig. 3). At site 22, in the lower reaches of the drainage basin, ratios less than 1 on three sampling runs and a ratio of 1.24 on June 28, 1978, indicated that human waste from the sewage plant was not affecting water quality. Increase in drainage area and streamflow (table 2) in the Crooked Creek drainage basin probably accounts for the quick recovery of the stream.

Site 2 had a FC/FS ratio of 81.71 on June 28, 1978. An upstream chemical spill of 8,000 gallons of oil-based paint waste (Ralph Coons, U.S. Environmental Protection Agency, Chicago, Ill., oral commun., September 1978) before sampling may have killed some fecal streptococci and caused an unusually high FC/FS ratio.

Site 46 was the only other sampling site where the FC/FS ratio was greater than 4. This site was dry on two sampling runs, and no bacteria samples were collected in April 1978. Whether site 46 is always affected by human waste is difficult to predict.

Sampling sites in other parts of the watershed where FC/FS ratios were between 1 and 4 were site 15, on December 1, 1977; site 24, on April 12, 1978, and June 28, 1978; and site 44 on August 28, 1978; however, ratios at these sites were below 1 on other sampling runs. The data indicate that these sites may occasionally be affected by both human and animal waste but that, in general, most sampling sites were not chronically affected by human waste.

Benthic Invertebrates

A semiquantitative numerical assessment of benthic invertebrates was done with artificial substrates from June 28 to July 20, 1978, to assess general water-quality trends of selected sites. Jumbo artificial multiplate samplers were placed at sites 51, 44, 2, 8, 22, 13B, and 24 (fig. 1) for benthic invertebrate collection beginning on June 28, 1978. By July 20, 1978, only sites 51, 44, and 24 had retained their samplers over the 23-day period, whereas sites 2, 8, 13B, and 22 had lost their samplers.

In addition to water quality, physical conditions, such as season of year, velocity of flow, and streambed composition, affect the types and distribution of organisms inhabiting a stream. Also, the collection method can be biased for specific benthic-invertebrate communities; however, artificial substrates were used to decrease the influence of natural substrate variability and to make inter-site comparisons of diversity indices (a measure of community structure that permits comparison of data between sampling sites) more meaningful. Community diversity is still affected by all these factors to a degree.

Dominant organisms at site 51 were *Tubellaria* sp (flatworms), *Conchapelopia* sp (midges), and *Cricotopus* sp (midges); at site 44, *Cheumatopsyche* sp (beetles) and *Asellus* sp (aquatic sow bugs); and at site 24, *Phaenopsectra* sp (midges) and *Stenonema* sp (mayflies) (table 7).

Genera diversity indices at sites 51, 44, and 24 were 3.48, 2.65, and 2.24, respectively, and total counts were 183, 192, and 164, respectively. The high diversity index at site 51, 3.48, could be attributable to the influx of other tributaries immediately upstream (fig. 1) from site 51. The diversity indices at the three sites seem to indicate fairly well-balanced systems.

Phytoplankton

Water samples were collected for cell counts and genus identification of phytoplankton at selected sites in April, July, and August 1978. (See tables 8, 9, and 10.) These samples are representative of transient communities in a stream and may not necessarily be indicative of the water-quality at the collection site but rather of some undetermined process upstream. Whether a riverine phytoplankton community exists or phytoplankton in flowing water are the result of constant or frequent drainage from lentic water and dislodged periphyton is debatable according to Hynes (1970, p. 94-111). In either case, the interpretation of phytoplankton data is difficult because the data may reflect some process upstream from the sampling site that may or may not be related to stream quality.

Algal populations ranged from 15 to 3,500 cells/mL. (See tables 8, 9, and 10.) Generally, cell populations were highest in summer (July 20, 1978) and lowest in spring (April 1978). Increased streamflow (fig. 5) and high water due to heavy rainfall and flooding in various parts of the watershed in April 1978 probably diluted the streams. Cell populations in the watershed were highest at site 51 in July and August 1978 and were lowest at sites 8 and 22 (Crooked Creek) in April and July 1978 (tables 8, 9, and 10). Generally, diatoms dominated the samples, but an increase in populations of green and blue-green algae and euglenoids were evident in the warm months of July and August 1978 (tables 9 and 10).

Genera diversity indices ranged from 0 to 3.5 (tables 8, 9, and 10) and did not seem to follow any trend. Lowest diversity indices were in the Crooked Creek drainage basin at site 8 (0.7) on April 13, 1978, and at site 22 (0.0) on August 30, 1978. The low values may have resulted from sewage-plant effluent (figs. 3 and 4) and chemical spills upstream from site 2 rather than conditions at the collection site. Diversity indices of the remaining sampling sites were exceeded 1.0 in April, July, and August 1978 and indicate improved conditions.

A pollution-tolerance index for phytoplankton communities at each site was calculated by summing the pollution factors for each genera whose population was greater than 50 cells/mL (Palmer, 1969). An index of 20 or more indicates high organic enrichment; 15 to 19, moderate organic enrichment; and lower figures, lack of enrichment, a nonrepresentative sample, or that some factor is interfering with algal persistence. (See Palmer, 1969.) Pollution-tolerance indices at most sites indicated no organic enrichment (tables 8, 9, and 10); but an index of 16 at site 44 on April 13, 1978, indicated moderate organic enrichment, and an index of 22 at site 51 on August 29, 1978, indicated high organic enrichment. The high cell population that gave site 51 a high pollution-tolerance index was probably due to mixing of algae from other streams (fig. 1). Site 44 was probably affected by factors such as low flow, tree-leaf loading, or some undetermined upstream process rather than direct organic loading by man.

Periphyton

Periphyton are resident stream communities of microscopic aquatic plants and animals that grow on a fixed submerged substrate and, therefore, may be a better long-term, water-quality indicator of stream conditions than phytoplankton. Mylar strips were placed at sites 13B and 24 on June 28, 1978, and were collected on July 20, 1978.

The results of the mylar-strip tests, an identification of the algal part of periphyton, are presented in table 11. The centric diatom, Melosira sp, and pennate diatom, Cocconeis sp, dominated at both sites 13B and 24. Various other diatoms and naviculoids were also present in each sample, but there was more variety at site 13B than at site 24. The greater number of genera at site 13B indicates a greater diversity than at site 24 and relates to site 24 having the lowest diversity index for benthic invertebrates.

Both Melosira sp and Cocconeis sp are widely distributed diatoms. Melosira sp is the most common centric diatom and is the most ubiquitous of the algal genera.

SUMMARY

Water-quality data were collected to define the general chemical and biological surface-water quality in the Porter County watershed of the Kankakee River basin, to provide baseline water-quality data for use in an environmental evaluation by the U.S. Soil Conservation Service, and to identify areas and water-quality problems.

The surface-water type in the watershed is primarily calcium bicarbonate, except in Crooked Creek and Grieger ditch, where the water type is a combination of calcium bicarbonate and calcium sulfate, and in Crumpacker Arm, where in December 1977 at one site water type was sodium chloride. The source of the ions in these compounds is probably the soil because heavy rainfall and floods in various parts of the watershed in April 1978 did not seem to affect the ion concentration or the ion balance at most sites and phytoplankton cell counts indicated dilution effects at most sites during April 1979.

Concentrations of most of the remaining dissolved-inorganic constituents varied minimally from one sampling run to the next within sites. Constituents whose concentrations varied either seasonally or exceeded water-quality alert limits are: iron (0.01 to 2.0 mg/L), manganese (0.01 to 0.69 mg/L), organic carbon (2.4 to 27 mg/L), and nutrients.

Dissolved-inorganic constituents whose concentrations exceeded water-quality limits recommended for domestic water supply by the U.S. Environmental Protection Agency were iron, manganese at most sites in the watershed, and ammonia. Phosphorus concentrations at two sites were greater than 0.10 mg/L.

Maximum chlorinated-hydrocarbon concentrations detected in the watershed in milligrams per kilogram were: aldrin, 0.9; chlordane, 36; DDD, 22; DDE, 7.5; DDT, 16; dieldrin, 74; heptachlor epoxide, 0.5; and PCB's, 160. Insecticides and PCB concentrations were highest in the Crooked Creek drainage basin. Chlordane, DDD, and dieldrin concentrations exceeded the 20-μg/kg water-quality alert limit of the U.S. Environmental Protection Agency. No chlorinated hydrocarbons were detected in the core sample collected at a depth of 2 ft into the bank at site 44 on July 14, 1979; however, a concentration of 4.6 μg/kg of dieldrin was detected in the core sample taken from a 2-ft depth at the middle of the streambed.

Concentration of suspended sediment ranged from 8 to 75 mg/L. Suspended sediment concentrations were highest in April 1978, during heavy rainfall and flooding in various parts of the watershed, and in August 1978, during harvest.

Ratios of fecal coliform to fecal streptococcus indicate that most sites were not affected by human waste. Exceptions were four sites in the Crooked Creek drainage basin and one at Cobbs ditch southeast of Hebron. Although some sites were affected occasionally by both human and animal waste, most sites were affected by only animal waste.

Phytoplankton diversity indices ranged from 0 to 3.5 and did not follow any trend. The lowest diversity indices in the study area, at two sites in the Crooked Creek drainage basin, indicate that organic wastes are affecting the stream.

A pollution-tolerance index calculated for phytoplankton communities indicates lack of organic enrichment at most sites. Moderate and high organic enrichment are indicated at sites 44 and 51. These conditions were probably caused by low flow, mixing of algae from other waters, tree-leaf load, or some other undetermined factor.

Long-term water-quality indicators, periphyton and benthic invertebrates, were collected at four sites during the summer months. Diatom genera, Melosira sp, and Cocconeis sp, were the dominant periphyton at two of the sites. Genera diversity indices for benthic invertebrates at three of the sites ranged from 2.24, to 3.48. These indices indicate well-balanced community structures at all three sites.

The bacterial, biological, and chemical data indicate that the water quality of most of the watershed is generally good. However, the Crooked Creek drainage basin is affected by chronic water-quality problems that include (1) effects of sewage-plant effluent in its upper reaches; (2) generally the highest insecticide concentrations including chlordane concentration at one site and PCB concentrations at three sites exceeding the 20 μg/kg water-quality alert limit of the U.S. Environmental Protection Agency; (3) high sodium and chloride concentrations on three sampling runs and a sodium chloride water type on December 2, 1977; (4) highest nutrient and dissolved-organic-carbon concentrations; (5) low dissolved-oxygen concentrations; (6) high fecal coliform and fecal streptococcus concentrations; (7) FC/FS ratios greater than 4 (indicating human-waste contamination); and (8) two chemical spills before the June and August 1978 sampling runs. Even though the upper reaches of the

Crooked Creek drainage basin are affected by sewage-plant effluent, data indicate that downstream sites recover.

Exceedingly high PCB concentrations in streambed samples throughout the Crooked Creek drainage basin and the two chemical spills would be detrimental to fish and other aquatic life. Because Crooked Creek is fished extensively (State of Indiana and others, 1976), the PCB's and other chlorinated hydrocarbons could also indirectly affect man. PCB's accumulate in fatty tissues in fish and other animals, and fish only slowly eliminate PCB's from their system. Because PCB's are capable of invading the biological food chain, they can affect both human and other animal health.

Also, the high chlordane concentration at site 8 and the generally high insecticide concentrations in the Crooked Creek drainage basin could be harmful to both animal and human life because insecticides, like PCB's, can persist in the environment for as long as 30 years.

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Table 1.--Field measurements of water quality in the Porter County watershed of the Kankakee River basin during 1977 reconnaissance

[Measurements by U.S. Geological Survey; e.s.t., eastern standard time; °C, degree Celsius; µmho/cm, micromho per centimeter, mg/L, milligram per liter]

Site[1] (See fig. 1.)	Date of sampling measurement	Time (e.s.t.)	Water temp. (°C)	Specific conductance (µmho/cm at 25°C)	Dissolved oxygen (mg/L)	pH
2	11-2-77	----	19.8	996	2.8	7.4
4	11-1-77	----	18.5	903	10.1	7.7
5	11-1-77	----	18.5	517	4.3	7.9
7	11-1-77	----	19.3	554	10.1	7.8
8	11-1-77	----	18.4	907	8.9	7.8
10	11-1-77	----	18.5	450	8.1	8.2
11	11-2-77	0840	17.3	943	6.4	7.8
12	11-2-77	0815	17.3	743	7.5	7.8
13	11-1-77	----	18.8	444	7.9	8.2
14	11-1-77	0905	16.9	458	6.1	7.9
15	11-1-77	0915	17.1	522	7.4	8.1
16	11-1-77	0920	17.4	907	7.4	8.0
17	11-1-77	0945	17.8	731	7.4	8.1
18	11-1-77	0935	17.6	468	6.4	8.3
19	11-2-77	0950	17.4	516	6.1	8.1
20	11-2-77	[2]1535	21.7	723	5.9	7.9
21	11-2-77	1525	21.3	580	5.5	7.9
22	11-2-77	1545	20.0	833	7.9	8.1
23	11-2-77	1550	20.8	568	6.1	7.9
24	11-2-77	1610	20.4	598	8.0	8.0
25	11-2-77	1600	20.5	596	7.1	8.0
28	11-2-77	1055	18.8	257	2.2	7.6
30	11-2-77	1145	17.6	456	7.5	8.2
32	11-2-77	1205	19.8	525	7.5	7.7
33	11-2-77	1220	19.4	618	7.4	7.8
34	11-1-77	1035	18.1	979	6.3	7.8
35	11-2-77	1030	17.9	654	7.3	8.1
36	11-2-77	1020	17.7	708	5.8	8.0
37	11-1-77	1010	17.7	845	7.0	8.0
38	11-2-77	1005	18.1	915	6.4	7.8

Table 1.--Field measurements of water quality in the Porter County watershed of the Kankakee River basin during 1977 reconnaissance--Continued

Site[1] (See fig. 1.)	Date of sampling measurement	Time (e.s.t.)	Water temp. (°C)	Specific conductance (µmho/cm at 25°C)	Dissolved oxygen (mg/L)	pH
39	11-1-77	1235	18.9	658	7.8	7.6
40	-------	1315	19.2	607	7.1	7.7
41	11-1-77	1245	20.6	633	3.0	7.8
42	11-2-77	1440	19.5	657	6.9	7.9
43	11-2-77	1430	19.6	653	7.4	8.0
44	11-2-77	1500	20.8	773	3.3	8.2
45	11-2-77	1510	21.6	771	3.0	8.1
46	11-2-77	1335	19.4	532	3.5	7.8
47	11-2-77	1345	20.7	820	5.9	7.7
48	11-2-77	1425	21.4	825	7.8	8.0
49	11-2-77	1445	19.9	707	5.3	7.9
50	11-2-77	1415	19.2	736	4.5	7.8
51	11-2-77	1400	20.1	669	5.1	7.8

[1]Sites 1, 3, 6, 9, 26, 27, 29, and 31 were dry on November 1-2, 1977, the sampling dates.

[2]For example, 1535 is the same time as 3:35 p.m.

Table 2.--Drainage area and seasonal field measurements of water quality in the Porter County watershed of the Kankakee River basin, 1977-78

[Measurements by U.S. Geological Survey; mi^2, square mile; ft^3/s, cubic foot per second; °C, degree Celsius; μmho/cm, micromho per centimeter; mg/L, milligram per liter]

Date of sampling	11-30-77						4-12-78			
Site (See fig. 1.)	28	30	36	39	44	45	28	30	44	45
Eastern standard time	1000	1025	1435	1155	1345	1410	1245	1755	[1]1600	1710
Drainage area (mi^2)	3.5	------	------	------	31.7	17.9	3.5	------	31.7	17.9
Discharge (ft^3/s)	0	[2]1	[2]6	[2]2	11	------	1.7	------	42	------
Water temperature (°C)	8.0	7.6	9.4	8.3	8.7	7.5	11.5	13.2	11.8	13.9
pH, field	7.2	7.5	8.2	8.1	8.4	7.9	7.6	8.2	8.1	8.2
Specific conductance (μmho/cm at 25°C)	563	542	102	709	733	673	274	335	333	689
Dissolved oxygen (percent saturation)	45	41	81	------	104	97	91	95	71	------
Dissolved oxygen (mg/L)	5.3	4.8	9.1	11.1	12.0	11.5	10.2	10.3	8.0	------
Weather	Freezing rain and snow						Rain			

Table 2.--Drainage area and seasonal field measurements of water quality in the Porter County watershed of the Kankakee River basin, 1977-78--Continued

Date of sampling	6-29-78				4-12-78				
Site (See fig. 1.)	28	30	44	45	28	30	35	44	45
Eastern standard time	1050	1115	1350	1400	1100	----	----	1500	----
Drainage area (mi^2)	3.5	------	31.7	17.9	3.5	------	------	31.7	17.9
Discharge (ft^3/s)	0.04	------	15.9	------	.02	------	------	12.2	------
Water temperature (°C)	19.9	21.9	22.5	26.2	21.2	14.5	17.4	18.7	23.7
pH, field	7.6	7.8	8.3	8.3	7.6	7.4	7.7	8.0	8.2
Specific conductance (μmho/cm at 25°C)	553	583	785	708	505	581	539	731	746
Dissolved oxygen (percent saturation)	27	83	80	89	92	74	78	99	118
Dissolved oxygen (mg/L)	2.5	7.5	7.1	7.6	8.3	7.3	8.2	9.4	10.3
Weather	Hot, humid sunny				Mild, sunny				

Table 2.--Drainage area and seasonal field measurements of water quality in the Porter County watershed of the Kankakee River basin, 1977-78--Continued

Date of sampling	11-30-77		4-13-78		6-29-78		8-30-78	
Site (See fig. 1.)	43	52	43	52	43	52	43	52
Eastern standard time	1300	1450	1722	1700	1245	1420	------	----
Drainage area (mi^2)	19.0	------	19.0	------	19.0	------	19.0	-------
Discharge (ft^3/s)	------	------	------	------	------	------	------	-------
Water temperature (C°)	7.0	9.0	12.1	10.9	24.8	26.6	21.0	26.2
pH, field	8.6	8.1	8.4	8.5	8.1	8.6	8.0	8.4
Specific conductance (µmho/cm at 25°C)	666	626	467	562	668	553	544	701
Dissolved oxygen (percent saturation)	124	94	92	------	85	126	97	148
Dissolved oxygen (mg/L)	14.9	10.8	10.2	------	7.2	10.3	8.9	12.4
Weather	Freezing rain, snow		Rain		Hot, humid, sunny		Mild, sunny	

Table 2.--Drainage area and seasonal field measurements of water quality in the Porter County watershed of the Kankakee River basin, 1977-78--Continued

Date of sampling	6-28-78				8-29-78			
Site (See fig. 1.)	13A	13B	17	24	13A	13B	17	24
Eastern standard time	1300	1215	1535	1035	1005	1130	1200	1300
Drainage area (mi^2)	18.5	21.6	13	44.5	18.5	21.6	13	44.5
Discharge (ft^3/s)	11.5	14.5	------	27.6	14	15	------	32
Water temperature (°C)	21.4	19.6	24.6	23.4	17.1	18.7	21.4	21.7
pH, field	8.5	8.9	8.2	8.4	7.7	7.7	8.0	7.7
Specific conductance (µmho/cm at 25°C)	422	472	738	593	537	539	626	505
Dissolved oxygen (percent saturation)	103	101	102	97	85	92	105	92
Dissolved oxygen (mg/L)	9.4	9.5	8.8	8.5	8.4	8.8	9.6	8.3
Weather	Hot, humid, sunny				Mild, sunny			

Table 2.--Drainage area and seasonal field measurements of water quality in the Porter County watershed of the Kankakee River basin, 1977-78--Continued

Date of sampling	11-30-77			4-13-78		6-29-78		8-29-78	
Site (See fig. 1.)	41	46	51	41	46	41	51	41	51
Eastern standard time	1110	1130	1200	1740	1015	1230	1140	------	1300
Drainage area (mi^2)	------	4.4	22.3	------	4.4	------	22.3	------	22.3
Discharge (ft^3/s)	[2]2	0	7.6	------	7.2	------	6.6	------	2.7
Water temperature (°C)	8.8	7.0	7.3	12.5	11.2	32.8	25.8	21.9	21.9
pH, field	8.0	8.0	8.1	8.0	7.8	8.2	6.8	8.2	8.2
Specific conductance (µmho/cm at 25°C)	146	689	743	582	266	701	670	825	825
Dissolved oxygen (percent saturation)	97	65	88	46	73	125	112	104	104
Dissolved oxygen (mg/L)	11.8	7.8	10.6	5.0	8.3	9.5	9.4	9.4	9.4
Weather	Freezing rain, snow			Rain, flooding		Hot, humid, mild, sunny			

Table 2.--Drainage area and seasonal field measurements of water quality in the Porter County watershed of the Kankakee River basin, 1977-78--Continued

Date of sampling	12-1-77				4-13-78			
Site (See fig. 1.)	13A	13B	17	24	13A	13B	17	24
Eastern standard time	1220	1300	1410	1620	1100	1215	1310	1400
Drainage area (mi^2)	18.5	21.6	13.1	44.5	18.5	21.6	13.1	44.5
Discharge (ft^3/s)	11	13	------	21.8	23	33	------	85
Water temperature (C°)	9.6	9.6	10.3	8.3	8.2	8.8	10.3	9.5
pH, field	8.0	8.2	8.1	8.3	8.1	8.1	8.1	8.2
Specific conductance (µmho/cm at 25°C)	440	461	707	561	428	413	452	590
Dissolved oxygen (percent saturation)	83	92	83	96	69	72	80	75
Dissolved oxygen (mg/L)	9.4	10.4	9.3	11.1	8.3	8.5	9.3	8.8
Weather	Freezing rain, snow				Rain			

Table 2.--Drainage area and seasonal field measurements of water quality in the Porter County watershed of the Kankakee River basin, 1977-78--Continued

Date of sampling	12-1-77					4-13-78						
Site (See fig. 1.)	2	7	8	15	16	22	2	7	8	15	16	22
Eastern standard time	1140	1005	1040	1340	1355	1530	0845	1100	1000	1300	1250	1500
Drainage area (mi^2)	5.0	-----	22.0	12.6	50.6	69.9	5.0	-----	22.0	12.6	50.6	69.9
Discharge (ft^3/s)	2	.7	21.2	-----	-----	38.5	1.7	-----	26	-----	-----	101
Water temperature (°C)	10.6	8.6	10.3	9.2	9.9	8.8	7.7	7.7	7.6	10.3	9.6	10.3
pH, field	7.5	7.8	7.5	8.0	8.1	8.3	7.2	7.8	7.5	8.5	8.2	8.1
Specific conductance (µmho/cm at 25°C)	1,000	677	939	486	855	812	687	392	470	757	470	520
Dissolved oxygen (percent saturation)	42	90	71	91	94	95	44	65	61	85	71	75
Dissolved oxygen (mg/L)	4.6	10.4	7.9	10.5	10.5	10.9	5.3	7.9	7.5	9.9	8.3	8.7
Weather	Freezing rain, snow										Rain	

Table 2.--Drainage area and seasonal field measurements of water quality in the Porter County watershed of the Kankakee River basin, 1977-78--Continued

Date of sampling	6-28-78[3]						8-31-78[4]					
Site (See fig. 1.)	2	7	8	15	16	22	2	7	8	15	16	22
Eastern standard time	2000	1600	1915	1520	1525	1740	1430	1500	1300	1525	1515	1000
Drainage area (mi^2)	5.0	-----	22.0	12.6	50.6	69.9	5.0	-----	22.0	12.6	50.6	69.9
Discharge (ft^3/s)	1.3	-----	11.6	-----	-----	41.5	1.4	-----	16.1	-----	-----	43
Water temperature (°C)	23.0	22.4	21.9	24.6	22.9	23.0	19.9	19.8	15.7	18.1	17.2	16.8
pH, field	7.6	8.5	7.5	8.6	7.8	8.0	7.3	8.4	7.4	8.0	7.6	7.7
Specific conductance (µmho/cm at 25°C)	1,060	577	967	471	929	882	793	647	918	535	948	743
Dissolved oxygen (percent saturation)	31	122	69	128	102	82	31	105	76	96	81	79
Dissolved oxygen (mg/L)	2.7	10.6	6.2	11.0	9.0	7.2	2.9	9.8	7.7	9.3	8.0	7.8
Weather	Hot, humid, sunny						Mild, sunny					

[1]For example, 1600 is the same time as 4:00 p.m.

[2]Estimated discharge.

[3]Chemical spill on June 21, 1978.

[4]Chemical spill on August 28, 1978.

Table 3.--Laboratory analyses of water samples from the Porter County watershed of the Kankakee River basin, 1977-78

[Analyses by U.S. Geological Survey; units of measure are in milligrams per liter]

Date of sampling	11-30-77		4-12-78	6-29-78	8-30-78
Site (See fig. 1.)	46	51	46	51	51
Calcium	86	98	46	100	100
Magnesium	36	37	18	40	41
Potassium	3.5	2.5	4.2	1.8	2.7
Sodium	20	17	8.7	12	20
Bicarbonate	280	290	130	290	320
Carbonate	0	0	0	0	0
Chloride	52	30	26	21	29
Fluoride	0.2	.1	.1	.1	.2
Sulfate	78	150	49	160	170
Silica, dissolved	6.8	12	7.1	12	13
Dissolved solids (residue on evaporation at 180°C)	433	493	253	492	538
Total alkalinity (as $CaCO_3$)	230	240	110	240	260
Total hardness (as $CaCO_3$)	360	400	190	410	420
Noncarbonate hardness (as $CaCO_3$)	130	160	82	180	160
Ammonia, dissolved (as ammonia)	0.27	1.1	.10	.44	1.3
Organic nitrogen, dissolved (as N)	0.77	.31	.92	.53	.50
Kjeldahl nitrogen, dissolved (as N)	0.98	1.2	1.0	.87	1.5
Nitrite plus nitrate (as N)	2.7	.47	6.7	.41	.56
Orthophosphate, dissolved (as P)	0.00	.01	.01	.02	.06
Phosphorus, dissolved (as P)	0.03	.03	.06	.00	.08
Organic carbon, dissolved		6.6	8.2		3.8
Iron, dissolved	0.06	.05	.04	.06	.02
Manganese, dissolved	0.02	.11	.02	.15	.08

Table 3.--Laboratory analyses of water samples from the Porter County watershed of the Kankakee River basin, 1977-78--Continued

Date of sampling	12-1-77						4-13-78			6-28-78			8-31-78		
Site (See fig. 1.)	2	7	8	15	16	22	2	8	22	2	8	22	2	8	22
Calcium	87	77	140	72	130	130	95	120	110	85	130	120	74	130	130
Magnesium	30	29	41	25	41	40	33	38	35	30	44	40	26	40	38
Potassium	4.3	2.9	2.8	2.3	2.5	2.0	3.5	2.4	2.2	5.9	1.8	1.8	4.2	2.4	2.3
Sodium	130	30	23	3.4	11	7.2	45	10	7.0	85	13	7.4	43	12	7.8
Bicarbonate	270	220	270	190	280	280	260	270	230	350	280	290	290	290	270
Carbonate	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chloride	190	57	42	10	20	16	79	22	16	77	20	16	45	20	17
Fluoride	0.1	.1	0	.1	.1	0	.2	.1	.1	.2	.1	.1	.2	.1	.1
Sulfate	120	100	260	110	250	230	180	250	230	120	250	220	110	260	200
Silica, dissolved	12	10	13	9.2	12	12	15	12	11	15	13	12	13	12	13
Dissolved solids (residue on evaporation at 180°C)	719	427	661	327	605	577	586	595	530	646	612	562	463	622	544
Total alkalinity (as $CaCO_3$)	220	180	220	160	230	230	210	220	190	290	230	240	240	240	220
Total hardness as $CaCO_3$)	340	310	520	280	490	490	370	460	420	340	510	460	290	490	480
Noncarbonate hardness (as $CaCO_3$)	120	130	300	130	260	260	160	230	230	49	280	230	54	250	260
Ammonia, dissolved (as ammonia)	2.8	.32	1.2	.09	.17	.23	3.3	.79	.30	6.1	.70	.01	2.4	.28	.05
Organic nitrogen, dissolved (as N)	0.80	.19	.38	.28	.00	.17	1.2	.39	.44	1.7	.31	.42	.70	.67	.36
Kjeldahl nitrogen, dissolved (as N)	3.0	.44	1.3	.35	.13	.35	3.8	1.0	.67	6.4	.85	.43	2.6	.89	.40
Nitrite plus nitrate (as N)	1.8	2.8	.99	.27	.09	.33	.23	1.4	.99	.72	.30	.38	.05	.46	.47
Nitrogen, ammonia, dissolved (as N)	2.2	.25	.92	.07	.13	.18	2.6	.61	.23	4.7	.54	.01	1.9	.22	.04
Orthophosphate, dissolved (as P)	0.51	.00	.01	.00	.00	.00	.38	.00	.00	15	.00	.00	.47	.01	.00
Phosphorus, dissolved (as P)	0.58	.01	.01	.01	.01	.01	.81	.00	.00	3.1	.00	.01	.5	.01	.01
Organic carbon, dissolved	------	------	5.9	6.3	8.2	9.4	27	20	10	9.8	4.6	6.9	5.1	8.0	4.2
Iron, dissolved	0.41	.07	.11	.01	.01	.02	.19	.35	.01	.12	.08	.12	.09	.04	.01
Manganese, dissolved	0.16	.23	.28	.26	.26	.24	.19	.26	.21	.11	.18	.07	.16	.20	.11

Table 3.--Laboratory analyses of water samples from the Porter County watershed of the Kankakee River basin, 1977-78--Continued

Date of sampling	11-30-77					4-12-78		6-29-78		8-30-78	
Site (See fig. 1.)	28	30	43	44	45	28	44	28	44	28	44
Calcium	59	75	96	120	100	26	90	60	110	41	98
Magnesium	24	32	38	41	35	11	31	24	41	14	34
Potassium	3.7	2.4	1.9	1.8	2.0	3.8	2.5	6.7	1.6	7.3	2.4
Sodium	24	7.6	11	5.5	5.4	5.0	6.3	14	5.3	7.2	4.7
Bicarbonate	180	270	320	340	270	74	260	220	340	130	290
Carbonate	0	0	0	0	0	0	0	0	0	0	0
Chloride	57	14	21	12	15	10	16	28	11	18	10
Fluoride	0.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
Sulfate	64	73	120	160	170	40	150	55	150	45	150
Silica	8.9	12	11	12	11	6.7	9.2	5.3	11	9.3	11
Dissolved solids (residue on evaporation at 180°C)	333	351	459	522	473	147	441	303	499	211	457
Total alkalinity (as $CaCO_3$)	150	220	260	280	220	61	210	180	280	110	240
Total hardness (as $CaCO_3$)	250	320	400	470	390	110	350	250	440	160	380
Noncarbonate hardness (as $CaCO_3$)	99	98	130	190	170	50	140	68	160	53	150
Ammonia, dissolved (as ammonia)	0.49	.15	.06	.28	.19	.00	.23	.46	.01	.40	.14
Organic nitrogen, dissolved (as N)	0.38	.44	.21	.12	.19	1.2	.46	1.0	.59	.89	.68
Kjeldahl nitrogen, dissolved (as N)	0.76	.56	.26	.34	.34	1.2	.64	1.4	.60	1.2	.79
Nitrite plus nitrate (as N)	0.09	.3	.55	.26	.19	1.7	1.7	.05	.32	.93	.76
Nitrogen, ammonia, dissolved (as N)	0.38	.12	.05	.22	.15	.00	.18	.36	.01	.31	.11
Orthophosphate, dissolved (as P)	0.00	.00	.00	.00	.00	.00	.00	.04	.00	.01	.00
Phosphorus, dissolved (as P)	0.01	.01	.02	.01	.01	.10	.01	.05	.02	.02	.01
Organic carbon, dissolved	14	7.8	10	7.0	7.3	20	7.1	7.3	6.0	7.6	15
Iron, dissolved	2.0	.12	.01	.03	.03	.07	.03	.07	.03	.05	.01
Manganese, dissolved	0.69	.23	.06	.27	.31	.03	.20	.18	.15	.17	.12

Table 3.--Laboratory analyses of water samples from the Porter County watershed of the Kankakee River basin, 1977-78--Continued

Date of sampling	12-1-77				4-12-78			6-28-78			8-29-78		
Site (See fig. 1.)	13A	13B	17	24	13A	13B	24	13A	13B	24	13A	13B	24
Calcium	62	63	100	82	62	62	78	61	63	76	70	66	62
Magnesium	19	20	34	28	19	20	26	19	20	25	19	18	18
Potassium	1.8	2.1	2.0	1.7	1.4	1.6	1.7	1.2	1.6	1.6	2.7	2.7	3.8
Sodium	8.9	12	8.0	7.0	5.2	6.8	6.0	5.0	6.6	6.8	4.4	5.7	3.5
Bicarbonate	150	160	230	210	140	170	200	160	170	24	150	150	120
Carbonate	0	0	0	0	0	0	0	0	0	0	0	0	0
Chloride	16	23	16	15	9.6	14	14	8.6	12	13	9.5	11	8.5
Fluoride	0.1	.1	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1
Sulfate	93	88	200	140	110	100	130	92	89	130	120	110	120
Silica, dissolved	11	11	11	11	9.9	10	8.8	11	11	10	11	11	8.3
Dissolved solids (residue on evaporation at 180°C)	287	299	487	389	289	300	365	277	288	275	323	310	291
Total alkalinity (as $CaCO_3$)	120	130	190	170	110	140	160	130	140	20	120	120	98
Total hardness (as $CaCO_3$)	230	240	390	320	230	240	300	230	240	290	250	240	230
Noncarbonate hardness (as $CaCO_3$)	110	110	200	150	120	98	140	99	100	270	130	120	130
Ammonia, dissolved (as ammonia)	0.09	.13	.53	.10	.04	.01	.00	.01	.00	.00	.10	.10	.10
Organic nitrogen, dissolved (as N)	0.07	.17	.25	.13	.22	.26	.17	.16	.26	.25	.92	.66	.88
Kjeldahl nitrogen, dissolved (as N)	0.14	.27	.66	.21	.25	.27	.17	.17	.26	.25	1.0	.74	.96
Nitrite plus nitrate (as N)	0.18	.16	.47	.17	.54	.44	.31	.10	.08	.14	2.7	2.5	1.6
Nitrogen, ammonia, dissolved (as N)	0.07	.10	.41	.08	.03	.01	.00	.01	.00	.00	.08	.08	.08
Orthophosphate, dissolved (as P)	0.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.05	.02	.00
Phosphorus, dissolved (as P)	0.01	.01	.01	.01	.00	.00	.00	.00	.01	.01	.09	.02	.01
Organic carbon, dissolved	9.3	9.1	------	7.8	3.2	7.7	2.4	7.1	15	4.5	6.1	6.6	12
Iron, dissolved	0.04	.02	.03	.01	.24	.01	.01	.04	.06	.02	.07	.09	.05
Manganese, dissolved	0.18	.15	.26	.15	.11	.01	.11	.03	.05	.06	.13	.06	.09

Table 4.--Concentrations of chlorinated hydrocarbons in samples of streambed from the Porter County watershed of the Kankakee River basin in 1978

[Analyses by U.S. Geological Survey; concentrations in micrograms per kilogram; ND, not detected]

Date of sampling	4-13-78	6-29-78		4-12-78	6-29-78
Site (See fig. 1.)	44	28	44	48	51
Aldrin	0.9	ND	.6	.6	ND
Chlordane	ND	3	3	3	5
DDD	ND	ND	0.8	.5	2.1
DDE	ND	ND	0.3	.7	.6
DDT	ND	ND	0.8	1.3	.3
Dieldrin	35	2.9	74	10	3.0
Endosulfan	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND
Heptachlor epoxide	ND	ND	0.5	ND	ND
Lindane	ND	ND	ND	ND	ND
Mirex	ND	ND	ND	ND	ND
PCB (polychlorinated biphenyl)	ND	10	ND	ND	ND
PCN (polychlorinated naphthalene)	ND	ND	ND	ND	ND
Perthane	ND	ND	ND	ND	ND
Toxaphene	ND	ND	ND	ND	ND

Table 4.--Concentrations of chlorinated hydrocarbons in samples of streambed from the Porter County watershed of the Kankakee River basin in 1978--Continued

Date of sampling	4-13-78		6-28-78			8-30-78	
Site (See fig. 1.)	8	22	2	8	22	2	8
Aldrin	ND	ND	ND	ND	ND	ND	ND
Chlordane	36	3.0	16	24	5.0	7.0	30
DDD	7.3	1.8	27	5.9	1.7	11	22
DDE	1.5	ND	ND	2.7	.5	6.9	1.6
DDT	1.5	.8	16	.3	2.2	3.6	2.3
Dieldrin	15	4.4	6.9	16	3.8	3.9	4.4
Endosulfan	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	ND	ND	ND	ND	ND	ND	ND
Lindane	ND	ND	ND	ND	ND	ND	ND
Mirex	ND	ND	ND	ND	ND	ND	ND
PCB (polychlorinated biphenyl)	31	11	80	75	20	66	160
PCN (polychlorinated naphthalene)	ND	ND	ND	ND	ND	ND	ND
Perthane	ND	ND	ND	ND	ND	ND	ND
Toxaphene	ND	ND	ND	ND	ND	ND	ND

Table 4.--Concentrations of chlorinated hydrocarbons in samples of streambed from the Porter County watershed of the Kankakee River basin in 1978--Continued

Date of sampling	4-13-78		6-28-78			8-30-78	
Site (See fig. 1.)	13B	24	13A	13B	24	13A	13B
Aldrin	ND	ND	ND	ND	ND	ND	ND
Chlordane	ND	ND	ND	ND	ND	ND	ND
DDD	ND	0.8	ND	ND	.5	ND	.3
DDE	ND	ND	ND	7.5	ND	ND	.3
DDT	ND	0.8	ND	ND	.3	ND	ND
Dieldrin	ND	1.4	.6	.6	1.5	1.0	1.0
Endosulfan	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	ND	ND	ND	ND	ND	ND	ND
Lindane	ND	ND	ND	ND	ND	ND	ND
Mirex	ND	ND	ND	ND	ND	ND	ND
PCB (polychlorinated biphyenyl)	ND	ND	ND	11	ND	ND	ND
PCN (polychlorinated naphthalene)	ND	ND	ND	ND	ND	ND	ND
Perthane	ND	ND	ND	ND	ND	ND	ND
Toxaphene	ND	ND	ND	ND	ND	ND	ND

Note.--In analyses to determine chlorinated hydrocarbon concentrations of two core samples collected at site 44 on July 14, 1979, one at a depth of 2 ft into the bank at water's edge and the other at a depth of 2 ft into the center of the streambed, the only chlorinated hydrocarbon detected was dieldrin, 4.6 µg/kilogram, in the core from the streambed.

Table 5.--Suspended-sediment concentrations for selected sites in the Porter County watershed of the Kankakee River basin in 1977-78

[Data collected by U.S. Geological Survey and reported in milligrams per liter]

Site[1]	11-30-77	4-13-78	6-28-78	8-30-78
2	(2)	(2)	(2)	(2).
7	(2)	(2)	(2)	(2).
8	41	64	16	(2).
13A	14	11	8	20
13B	21	22	11	30
15	(2)	(2)	(2)	(2).
24	8	24	11	28
28	(2)	(2)	(2)	(2).
30	(2)	(2)	(2)	(2).
43	(2)	(2)	(2)	(2).
44	39	Contaminated	62	75
46	(2)	38	(2)	(2).
51	11	Flooded	44	26

[1]See figure 1 for site locations.

[2]No data collected.

Table 6.--Bacterial data for the Porter County watershed of the Kankakee River basin in 1977-78

[Counts by U.S. Geological Survey; mL, milliliters]

Site	Date of sampling	Total count (colonies/100 mL)		Ratio of fecal coliform to fecal streptococcal bacteria
		Fecal coliform bacteria	Fecal streptococcal bacteria	
28	12-1-77	182	6,550	0.03
	6-28-78	4,800	5,100	.94
	8-28-78	50,000	56,000	.89
30	12-1-77	30	773	.04
44	11-30-77	5	140	.04
	4-12-78	360	480	.75
	6-28-78	960	1,500	.64
	8-28-78	45,000	40,000	1.13
45	12-1-77	88	170	.52
46	11-30-77	583	85	6.86
	4-12-78	Dry	Dry	Dry
51	11-30-77	15	135	.13
	6-28-78	820	1,200	.68
	8-28-78	52,000	88,000	.59
2	12-1-77	145,000	19,330	7.50
	4-12-78	3,180	240	13.25
	6-28-78	335,000	4,100	81.71
	8-28-78	64,000	10,580	6.05
8	12-1-77	100	80	1.25
	4-12-78	115	20	5.75
	6-28-78	700	240	2.92
	8-28-78	15,000	15,040	1.00
7	12-1-77	150	1,685	.09
16	12-1-77	5	120	.04
15	12-1-77	207	165	1.30

Table 6.--Bacterial data for the Porter County watershed of the Kankakee River basin in 1977-78--Continued

Site	Date of sampling	Total count (colonies/100 mL)		Ratio of fecal coliform to fecal streptococcal bacteria
		Fecal coliform bacteria	Fecal streptococcal bacteria	
22	12-1-77	5	300	0.02
	4-12-78	117	120	.98
	6-28-78	2,300	1,850	1.24
	8-28-78	3,060	32,000	.10
13A	12-1-77	5	123	.04
	4-12-78	27	55	.49
	6-28-78	390	650	.60
	8-28-78	20	32,000	6.3×10^{-4}
13B	12-1-77	250	650	.40
	4-12-78	80	1,113	.07
	6-28-78	2,300	12,850	.18
	8-28-78	10	46,000	2.2×10^{-4}
24	12-1-77	35	180	.20
	4-12-78	60	27	2.22
	6-28-78	3,000	1,500	2.00
	8-28-78	33,000	60,000	.55

Table 7.--Benthic-invertebrate data collected during the 23-day colonization period from June 28 to July 20, 1978, in the Porter County watershed of the Kankakee River basin

[Counts by U.S. Geological Survey]

Organism	Count		
	Site 51	Site 44	Site 24
Annelida			
Hirudinea sp	1	--	--
Arthropod (Arthropods)			
Ablabesmyia sp	13	10	7
Acroneuria sp	--	--	1
Asellus sp (sow bugs)	6	41	8
Boyeria sp	--	2	--
Caenis sp	1	5	5
Cheumatopsyche sp (beetles)	--	81	3
Chironomus sp	3	1	1
Cladotanytarus sp	5	--	--
Concapelopia sp (midges)	35	--	--
Corynoneura sp	2	--	1
Cricotopus sp (midges)	21	2	--
Decapoda sp	--	1	--
Dineutus sp	1	3	3
Dubiraphia sp	1	11	--
Ephemeroptera sp	--	--	--
Epeorus sp	--	3	--
Eukiefferiella sp	--	2	3
Glyptotendipes sp	--	1	--
Hetaerina sp	--	3	--
Hydroptila sp	8	--	--
H. Azteca sp	12	--	--
Ischnura sp	3	--	--
Microtendipes sp	--	--	3
M. Glabratus sp	--	2	--
Orthocladius sp	--	1	--
Parachironomus sp	--	4	--
Paralautarborniella sp	--	1	--
Phaenopsectra sp (midges)	6	--	55

Table 7.--Benthic-invertebrate data collected during the 23-day colonization period from June 28 to July 20, 1978, in the Porter County watershed of the Kankakee River basin--Continued

Organism	Count		
	Site 51	Site 44	Site 24
Arthropod			
(Arthropods)--Continued			
Peltodytes sp	1	2	--
Polycentropus sp	2	--	--
Polypedilum sp	2	--	2
Procladius sp	4	--	1
Psectrocladius sp	5	--	--
Stenacron sp	5	--	--
Stenonema sp (mayflies)	--	11	67
Tanytarsus sp	--	--	3
Thienenanniella sp	4	--	--
Unknown species	3	5	1
Mollusca (Molluscs)			
Physa sp	7	--	--
Platyhelminthes (flatworms)			
Tubellaria sp	32	--	--
Total count	183	192	164
Genera-diversity index	3.48	2.65	2.24

Table 8.--Phytoplankton data collected in the Porter County watershed of the Kankakee River basin on April 13, 1978

[Cell counts by U.S. Geological Survey; mL, milliliter]

Organism	Cell count (cells/mL)			
	Site 44	Site 8	Site 22	Site 24
Chlorophyta (green algae)				
Ankistrodesmus sp	15	--	--	--
Chlamydomonas sp	17	--	--	6
Dictyosphaerium sp	17	--	--	--
Gomphonema sp	--	--	--	--
Nitzschia sp	--	--	--	--
Oocystis sp	--	--	--	24
Chrysophyta (yellow-brown algae and diatoms)				
(pennate diatoms)				
Eunotia sp	2	--	--	--
Fragilaria sp	4	--	--	--
Gomphonema sp	--	20	38	.6
Hannaea sp	2	--	--	--
Synedra sp	4	--	25	18
(naviculoids)				
Navicula sp	2	--	13	35
Nitzschia sp	--	80	--	6
Cyanophyta (blue-green algae)				
(filamentous)				
Oscillatoria sp	21	--	--	--
Euglenophyta (euglenoids)				
Euglena sp	--	--	--	--
(cryptomonads)				
Cryptomonas sp	8	--	13	--
Pyrrhophyta (fire algae)				
(dinoflagellates)				
Glenodinium sp	--	--	13	--
Total count (cells/mL)	690	68	110	230
Genera-diversity index	1.8	0.7	2.2	2.4
Pollution-tolerance index	16	3	0	3

Table 9.--Phytoplankton data collected in the Porter County watershed of the Kankakee River basin on July 20, 1978

[Cell counts by U.S. Geological Survey; mL, milliliter]

Organism	Cell count (cells/mL)				
	Site 8	Site 22	Site 13A	Site 13B	Site 24
Chlorophyta (green algae)					
<u>Ankistrodesmus</u> sp	-----	-----	---	14	15
<u>Carteria</u> sp	31	-----	---	----	-----
<u>Chlamydomonas</u> sp	220	14	---	14	-----
<u>Dictyosphaerium</u> sp	-----	-----	---	57	-----
<u>Pediastrum</u> sp	-----	120	---	----	-----
Chrysophyta (yellow-brown algae and diatoms)					
(centric diatoms)					
<u>Melosira</u> sp	-----	-----	---	29	-----
(pennate diatoms)					
<u>Achnanthes</u> sp	-----	-----	45	57	-----
<u>Cocconeis</u> sp	-----	-----	270	170	-----
<u>Cymbella</u> sp	220	29	45	130	29
<u>Diatoma</u> sp	-----	100	---	14	-----
<u>Eunotia</u> sp	470	-----	---	----	-----
<u>Fragilaria</u> sp	-----	-----	---	----	44
<u>Gomphonema</u> sp	250	43	45	110	-----
<u>Opephora</u> sp	-----	-----	---	14	-----
<u>Synedra</u> sp	160	560	---	----	-----
(naviculoids)					
<u>Caloneis</u> sp	-----	-----	---	14	-----
<u>Navicula</u> sp	-----	29	45	130	29
<u>Nitzschia</u> sp	2,100	140	---	86	-----
Cyanophyta (blue-green algae)					
<u>Anacystis</u> sp	-----	-----	---	----	430
(filamentous)					
<u>Oscillatoria</u> sp	-----	600	---	300	-----
Euglenophyta (euglenoids)					
<u>Chroomonas</u> sp	-----	29	---	----	-----
(cryptomonads)					
<u>Chryptomonas</u> sp	-----	14	22	29	-----
Total count (cells/mL	3,500	1,700	470	1,200	1,300
Genera-diversity index	1.9	2.4	2.0	3.3	1.2
Pollution-tolerance index	10	10	0	12	1.0

Table 10.--Phytoplankton data collected in the Porter County watershed of the Kankakee River basin, August 29-31, 1978

[Cell counts by U.S. Geological Survey; mL, milliliter]

Organism	Cell count (cells/mL)						
	8-29	8-29	8-30	8-30	8-31	8-31	8-31
	Site 28	Site 51	Site 8	Site 22	Site 13A	Site 13B	Site 24
Chlorophyta (green algae)							
Ankistrodesmus sp	----	14	----	----	----	----	29
Chlamydomonas sp	----	72	----	----	43	----	14
Dictyosphaerium sp	----	-----	----	----	----	----	110
Gonium sp	----	-----	----	----	----	----	57
Pandorina sp	----	900	----	----	----	----	----
Scenedesmus sp	59	-----	----	----	----	----	110
Selenastrum sp	----	14	----	----	----	----	----
Chrysophyta (yellow-brown algae and diatoms)							
(centric diatoms)							
Cyclotella sp	----	57	----	----	58	----	----
Melosira sp	----	-----	----	----	----	59	29
(pennate diatoms)							
Achnanthes sp	----	43	----	15	29	----	----
Amphora sp	15	-----	----	----	----	----	14
Cocconeis sp	15	-----	----	----	100	15	57
Cymbella sp	----	-----	----	----	14	29	14
Fragilaria sp	----	-----	15	----	----	15	14
Gomphonema sp	59	57	15	----	58	15	14
Opephora sp	----	-----	----	----	43	----	----
Rhiocosphenia sp	----	-----	----	----	----	----	14
Rhopalodia sp	----	-----	----	----	14	----	----
Synedra sp	----	-----	15	----	----	----	----
(naviculoids)							
Caloneis sp	----	-----	----	----	----	----	14
Navicula sp	130	330	29	----	100	100	140
Nitzschia sp	59	130	----	----	120	15	160
Pinnularia sp	----	-----	----	----	----	15	----
Surirella sp	15	-----	----	----	----	----	----
Tubellaria sp	----	-----	----	----	----	--59	----
(yellow-brown algae)							
Dinobryon sp	----	-----	----	----	----	----	43

Table 10.--Phytoplankton data collected in the Porter County watershed of the Kankakee River basin, August 29-31, 1978--Continued

Organism	Cell count (cells/mL)						
	8-29	8-29	8-30	8-30	8-31	8-31	8-31
	Site 28	Site 51	Site 8	Site 22	Site 13A	Site 13B	Site 24
Cyanophyta (blue-green algae)							
(filamentous)							
Oscillatoria sp	----	1,200	----	----	----	----	----
Euglenophyta (euglenoids)							
Euglena sp	----	100	----	----	14	----	14
Lepocinclus sp	----	14	----	----	----	----	----
Phacus sp	----	-----	----	----	14	----	----
Trachelomonas sp	----	43	----	----	29	----	----
(cryptomonads)							
Eryptomonas sp	----	140	----	----	----	----	----
Total cell count (cells/mL)	340	3,100	73	15	630	320	860
Genera-diversity index	2.4	2.6	1.9	0	3.4	2.7	3.5
Pollution-tolerance index	11	22	0	0	8.0	4.0	10

Table 11.--Periphyton data collected in the Porter County watershed of the Kankakee River basin in the 23-day period from June 28 to July 20, 1978

[Analyses by U.S. Geological Survey; X, sample contains organism; D, dominant organism]

Organism	Site 13B	Site 24
Chrysophyta (yellow-brown algae and diatoms)		
(centric diatoms)		
Bacillariophyceae sp	X	X
Centrales sp	X	X
Coscinodiscaceae sp	X	X
Melosira sp	D	D
Stephandiscus sp	X	-
(pennate diatoms)		
Achnanthaceae sp	X	X
Achnanthes sp	X	-
Amphora sp	X	-
Cocconeis sp	D	D
Cymbella sp	X	-
Cymbellacea sp	X	-
Diatoma sp	X	X
Diatomaceae sp	X	X
Fragilariaceae sp	X	-
Gomphonema sp	X	-
Gomphonemataceae sp	X	-
Pennales sp	X	X
Rhoicosphinia sp	X	-
Synedra sp	X	-
(naviculoid)		
Cymatopleura sp	X	-
Navicula sp	X	-
Naviculaceae sp	X	-
Nitzschia sp	X	-
Nitzschiaceae sp	X	-
Surirellaceae sp	X	-