

**THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO**



**DEPARTMENT OF RESEARCH  
AND DEVELOPMENT**

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**1980 ANNUAL SUMMARY REPORT**

**WATER QUALITY WITHIN THE WATERWAYS SYSTEM OF  
THE METROPOLITAN SANITARY DISTRICT**

**OF GREATER CHICAGO**

**VOLUME 2**

**BIOLOGICAL**

**March 1984**

1980 ANNUAL SUMMARY REPORT  
WATER QUALITY WITHIN THE WATERWAYS SYSTEM  
OF THE METROPOLITAN SANITARY DISTRICT  
OF GREATER CHICAGO

VOLUME II

BIOLOGICAL

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## SUMMARY AND CONCLUSIONS

Samples were collected from the North Branch of the Chicago River (NBCR) between Lake-Cook Road and the confluence with the North Shore Channel (NSC) to characterize this segment of the waterway in terms of bacteria, periphyton, and fish populations.

### Bacteria

At the seven stations sampled in the NBCR, the total coliform counts ranged from  $5.0 \times 10^3$  to  $7.8 \times 10^4$  per 100 milliliters, the fecal coliform counts ranged from  $4.6 \times 10^2$  to  $7.8 \times 10^3$  per 100 milliliters, and the fecal streptococcus counts ranged from  $1.3 \times 10^2$  to  $1.9 \times 10^3$  per 100 milliliters. The "general use" criteria of 200 fecal coliform per 100 milliliters, established by the Illinois Pollution Control Board (IPCB), was not met at any station on the four dates the NBCR was sampled.

Standard plate count (SPC) in the NBCR ranged from  $4.2 \times 10^5$  to  $2.2 \times 10^6$  per 100 milliliters (geometric mean of  $1.1 \times 10^6$  per 100 milliliters). In comparison, the geometric means for standard plate count, calculated from three years of sampling (1975, 1976, and 1977), in the Chicago Sanitary and Ship Canal (CSSC) and in the Calumet-Sag Channel (CSC) were  $6.0 \times 10^7$  and  $3.7 \times 10^6$  per 100 milliliters, respectively.

In the NBCR, the counts for Pseudomonas aeruginosa ranged from  $2.2 \times 10^3$  to  $2.0 \times 10^4$  per 100 milliliters, and the

counts for Staphylococcus aureus were all found to be less than  $1.0 \times 10^1$  per 100 milliliters. The counts for Salmonella spp. ranged from less than  $1.6 \times 10^{-1}$  to  $5.3 \times 10^{-1}$  per 100 milliliters.

### Periphyton

The average total periphyton density at each station in the NBCR ranged from 68,450 to 449,700 cells per square centimeter with a mean of 225,100 cells per square centimeter. The average number of periphyton species ranged from 19.5 to 36.9 at each station in the NBCR with a mean of 32.7 species. It was found that two sets of periphyton species populations occurred in the NBCR, those associated with the stations upstream of NBCR/North Central Park Avenue (mean of 35 species of periphyton) and those associated with the station NBCR/North Central Park Avenue (mean of 19.5 species). Between NBCR/Dempster Street and NBCR/North Central Park Avenue, there was a 28 percent reduction in persistent species (species which appeared in at least 50 percent of the samples collected). A reduction in these hardier species suggested the addition of pollutants to the NBCR between these stations.

Chlorophyll a concentrations followed the trends of the average total periphyton densities and increased as the periphyton density increased. From NBCR/Dempster Street to NBCR/North Central Park Avenue, however, the periphyton density increased by 64 percent, but the chlorophyll a concentration

decreased by 46 percent. These data suggested that the diatoms counted at NBCR/North Central Park Avenue were physiologically stressed or dead and contained little intact extractable chlorophyll a.

The organic matter content followed the same trend as the average chlorophyll a concentrations with a reduction of 44 percent in average organic matter content between NBCR/Dempster Street and NBCR/North Central Park Avenue.

The autotrophic index (AI) is a ratio of the organic matter concentration to the chlorophyll a concentration. Based on the percentage of chlorophyllous biomass determined for a relatively clean stream (one to two percent), autotrophic index values above 200 indicate degradation of a waterway by organic wastes. The values calculated for each station on the NBCR ranged from 250 to 2,303 indicating that the NBCR is being degraded due to additions of organic wastes.

Equitability, the measure of species distribution within a community compared to an expected distribution based on the Shannon-Weaver species diversity index, was calculated for each station in the NBCR. According to Weber, values less than 0.50 indicate degraded water quality. All values calculated for the NBCR were less than 0.50, ranging from 0.05 to 0.12, and indicated poor water quality conditions in the NBCR study area.

## Fish

A total of 11 species of fish and two fish hybrids were collected from the ten sampling stations located on the NBCR in Cook and Lake Counties. Five species and an average of seven fish per ten minutes electrofishing were collected from the West Fork of the NBCR, eight species and 30 fish per ten minutes electrofishing from the Middle Fork of the NBCR, nine species and 15 fish per ten minutes electrofishing from the Skokie River (the Eastern Fork of the NBCR), and four species and three fish per ten minutes electrofishing from the farthest downstream stations on the NBCR (Glenview Road to Albany Avenue). Based on the numbers of species of fish identified, and on the abundance of fish collected per ten minutes electrofishing, the forks of the NBCR appeared to have a water quality more suitable to fish than the farthest downstream section (from Glenview Road to Albany Avenue).

The green sunfish, which is tolerant of a wide range of ecological conditions, was the most numerous species in all three forks of the NBCR (50 to 70 percent) as well as the downstream locations (44 percent). The assemblage of species collected from all NBCR stations was composed largely of species with a tolerance to a wide range of ecological conditions. This suggested that the water quality conditions were stressful to fish throughout the NBCR.

When compared with seven other streams of similar drainage area in the Chicagoland region, the NBCR was lower in

average and maximum number of fish species found, with the exception of the Little Calumet River. The NBCR contained an average of 2.6 species per collection day, with a maximum of six species per collection day, compared to the Little Calumet River which contained 1.9 species on the average per collection day with a maximum of five species per collection day. Salt Creek contained four species per collection day on the average, with a maximum of 13 species per collection day, and the upper end of Hickory Creek contained 10.1 species per collection day with a maximum of 20 species per collection day. On the basis of abundance of fish per unit effort (ten minutes electrofishing), NBCR had, on the average, 12 fish weighing 330 grams, compared to the Little Calumet River with 15 fish weighing 235 grams and Salt Creek with 11 fish weighing 262 grams, and Hickory Creek with 322 fish weighing 1,921 grams. These data suggested that the NBCR was similar in water quality to the Little Calumet River and Salt Creek.

#### Comparison of Bacteria, Periphyton, and Fish

Overall, the bacteria, periphyton, and fish population are in agreement and indicate that the NBCR in the study area is of poor water quality. The fish and periphyton data indicate that the water of the downstream section of the NBCR is of lesser quality than that of the upstream sections, indicating that significant quantities of pollutants are being added to the NBCR in the study area.

## INTRODUCTION

The Metropolitan Sanitary District of Greater Chicago (District) is responsible for the quality of the water in the streams and canals within its jurisdiction. In 1975, the District established its Ecosystematic Study Program to monitor these waterways. The biological monitoring activities in this program were provided by the Research and Development Department's (R & D) Biology Section. These monitoring studies were conducted by the following biology groups within the Section: Analytical Microbiology, Aquatic Ecology and Fisheries.

From 1975 to 1977, the deep draft waterways (Chicago and Calumet River systems) were studied (1,2,3). The monitoring efforts during 1978 and 1979 were concentrated in that portion of the Des Plaines River within Cook County (4,5). In 1980, that portion of the North Branch of the Chicago River (NBCR) above the confluence with the North Shore Channel (NSC) was monitored.

According to the 1973 Water Quality Standards, adopted by the Illinois Pollution Control Board (IPCB), the waters of the NBCR were designated for "General Use." By definition, this means that the water is to be protected "...for aquatic life, agricultural use, primary and secondary contact use, and most industrial uses...."

The objectives of this study were to observe the bacterial, periphytic algae, and fish populations in the NBCR.

Evaluation of the existing biological community structure is useful in detecting pollution and in quantifying the intensity of its effects. When a waterway is stressed due to pollutant additions, the more pollutant-tolerant organisms will increase in numbers of species and in abundance, while the less tolerant organisms will decrease. Effects of stress can be detected by examining population density estimates, species composition, and species diversity of the aquatic community. The R & D Biology Section monitored the bacteria, periphyton, and fish communities of the NBCR during 1980. These communities were monitored to establish the water quality conditions of this waterway.

## DESCRIPTION OF THE NORTH BRANCH OF THE CHICAGO RIVER

When the Wisconsinian glacier retreated, it left behind a system of lake-border moraines paralleling the western shore of Lake Michigan (6). From the sags formed between these moraines, arose the West Fork NBCR, the Middle Fork NBCR, and the Skokie River. The flow of these waters is southward until about four miles south of the tip of the Deerfield moraine (Touhy Avenue) where the NBCR turns southeastward toward Lake Michigan (Figure 1). The NBCR is intercepted by the NSC and directed into the reversed flow of the Chicago River in downtown Chicago. The lake-border moraines are composed of clayey till and are the major source of turbidity in the river system (6).

The drainage area of the entire NBCR system is 113 square miles (292 square kilometers); 52.3 square miles or 46 percent of the area is outside of the jurisdiction of the District (7). Within District jurisdiction, there are 44 combined sewer outfalls which discharge to the NBCR (8).

The West Fork of the NBCR at Dundee Road is at an elevation of 637.98 feet (194.456 meters) with an average 28-year discharge of 12.2 cubic feet per second (0.346 cubic meters per second). The maximum discharge occurred on July 13, 1957, with 930 cubic feet per second (26.3 cubic meters per second). It has been observed that at times no flow occurs (9) in the West Fork NBCR.



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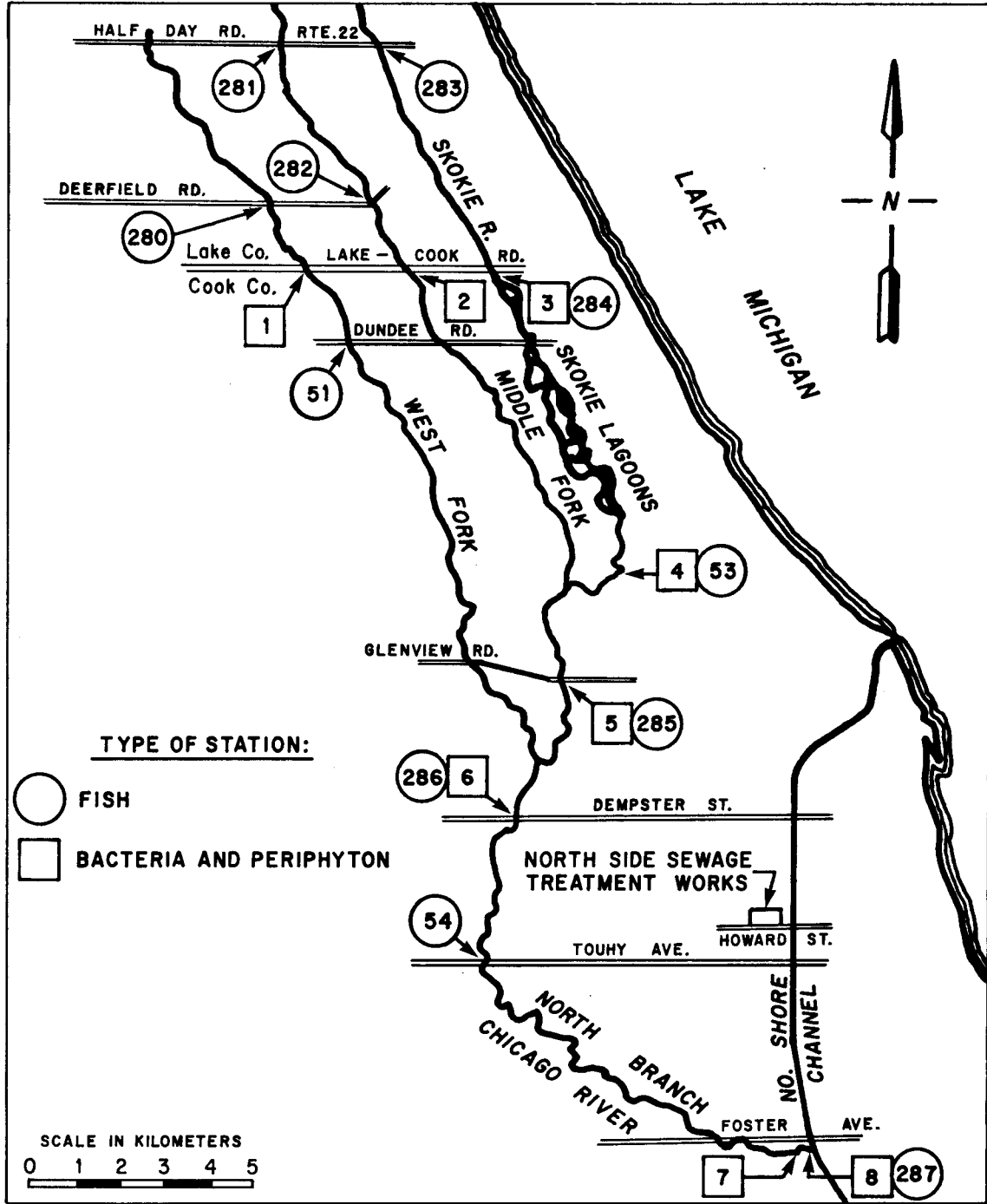


Figure 1  
BACTERIA, PERIPHYTON AND FISH SAMPLING STATIONS ON THE  
NORTH BRANCH OF THE CHICAGO RIVER 1980

The Middle Fork of the NBCR at Lake-Cook Road is at an elevation of 638.88 feet (194.731 meters) with an average 28-year discharge of 14.2 cubic feet per second (0.402 cubic meters per second). The maximum discharge occurred on March 5, 1976, with 550 cubic feet per second (15.6 cubic meters per second). It has been observed here, also, that at times there is no flow (9).

The Skokie River at Clavey Road is at an elevation of 622.83 feet (189.839 meters) with an average 13-year discharge of 22.3 cubic feet per second (0.632 cubic meters per second). The maximum discharge occurred on August 26, 1972, with 570 cubic feet per second (16.1 cubic meters per second). The minimum discharge occurred on October 13, 14, and 29, 1979, with 0.78 cubic feet per second (0.022 cubic meters per second) (9).

Figure 1 shows the NBCR and its location near Lake Michigan. The portion of the NBCR included in this study was the segment west and north of the confluence with the NSC.

DESCRIPTION OF THE BIOLOGICAL CHARACTERISTICS USED TO  
DETERMINE THE WATER QUALITY OF THE NORTH BRANCH  
OF THE CHICAGO RIVER

The biological elements studied to characterize this waterway were the bacteria, the periphyton, and the fish inhabiting various reaches of this stream. See Figure 1 for the location of the sampling stations and Tables 1 and 2 for the description of the bacterial and periphyton sampling stations, and the fish reaches sampled, respectively.

Bacteria

INDICATOR BACTERIA

Analyses for indicator bacteria such as total coliform (TC), fecal coliform (FC), and fecal streptococcus (FS) are used extensively by the District to determine the sanitary quality of water.

STANDARD PLATE COUNT (SPC)

An empirical procedure which gives an estimate of the total microbial population.

PSEUDOMONAS AERUGINOSA

This ubiquitous organism is a common soil and aquatic species and can be an agent of middle and outer ear infections, chronic ulcerations of the skin, and many wound and burn infections.

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TABLE 1

SAMPLING SITES ON THE NORTH BRANCH OF THE CHICAGO  
RIVER (NBCR) FOR BACTERIA AND PERIPHYTON\*

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<u>Stations</u>	<u>Locations</u>
1	West Fork NBCR and Lake-Cook Road
2	Middle Fork NBCR and Lake-Cook Road
3	Skokie River and Lake-Cook Road
4	Skokie River and West Frontage Road to Edens Expressway
5	NBCR and Glenview Road
6	NBCR and Dempster Street
7	NBCR and North Central Park Avenue (Periphyton-only)
8	NBCR and Albany Avenue and Winona Street (Bacteria-only)

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\*Map of stations is keyed in Figure 1.

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TABLE 2

LIST OF FISH SAMPLING STATIONS\* ON THE NORTH BRANCH OF  
THE CHICAGO RIVER (NBCR)

Cook County	
Stations	Locations
51	West Fork, NBCR, River Mile 27.2, upstream of Dundee Road, T42N/R12E/S9NE, Northbrook
282	Middle Fork, NBCR, River Mile 28.6, upstream of Lake-Cook Road, T43N/R12E/S34SW, Deerfield
284	Skokie River, River Mile 29.7, downstream of Lake-Cook Road, in diversion channel, T42N/R12E/S2NE, Highland Park
53	Skokie River, River Mile 23.9, downstream of West Frontage Road, T42N/R13E/S30NE, Northfield
285	NBCR, River Mile 21.5, downstream of Glenview Road, T42N/R12E/S36SE, Glenview
286	NBCR, River Mile 18.3, upstream of Dempster St., T41N/R12E/S18SE, Morton Grove
287	NBCR, River Mile 7.6, 100 meters upstream of junction with North Shore Channel, adjacent to Albany Avenue, T40N/R13E/S12SW, Chicago

Table continued on following page

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TABLE 2 (CONTINUED)

LIST OF FISH SAMPLING STATIONS\* ON THE NORTH BRANCH OF  
THE CHICAGO RIVER (NBCR)

Lake County	
Stations	Locations
280	West Fork, NBCR, River Mile 29.7 downstream of Deerfield Road, T42N/R12E/S29SE, Deerfield
281	Middle Fork, NBCR, River Mile 32.7 downstream of Half Day Road, T43N/R12E/S17SE, Highland Park
283	Skokie River, River Mile 33.4, upstream of Half Day Road, T43N/R12E/S15SW, Highland Park

\*See Figure 1 for location of fish sampling stations

## STAPHYLOCOCCUS AUREUS

This ubiquitous organism can be responsible for many common infections such as pimples, boils, and carbuncles, and can cause food poisoning.

## SALMONELLA SPP.

The genus Salmonella contains a variety of species, all of which are pathogenic for man or animals, and usually for both.

## Periphyton

### ORGANISMS

The term periphyton is a general one including "...the zoogleal and filamentous bacteria, attached protozoa, rotifers, and algae, and also the free-living microorganisms found swimming, creeping, or lodged among the attached forms" (10). For the purposes of this study, only the algal component of the periphyton was analyzed.

Periphyton were chosen for this study as they are more representative of water quality at the site sampled than are plankton. Periphyton are the basis of the food chains on which all other aquatic organisms depend. The physiological state of the periphyton algae, determined by the water quality, will, thus, influence the development of the biological community who feed upon them.

It is the population density and species composition of the algal component of the periphyton that provide water

quality information, especially the changes that occur between stations. Increases in population densities and number of species suggest a more favorable environment able to support the greater number of individuals, as well as a greater variety of species. One of the factors that may enhance the environment is the addition of nutrients, especially those that might previously have been in short supply. Other influencing factors include increased temperature and light, these are usually responsible for the seasonal variations found. Decreased population density and number of species imply a deleterious effect on the environment. Factors producing a deleterious environment range from the addition of ultra pure water, thereby diluting required nutrient levels below the minimum required levels, to the addition of too many nutrients encouraging the growth of too many organisms, thereby creating anoxic conditions. Gradations between these extremes are usual, and some workers in the field of evaluating water quality have defined species as pollutant-tolerant and clean water organisms (17,19), and by their presence and absence are guided in evaluating a particular environment.

#### CHLOROPHYLL A

All healthy, growing, and reproducing algae of the periphyton contain chlorophyll a. Analysis of chlorophyll a provides a confirming or alternate measure of periphytic algal biomass.



## ORGANIC MATTER

All organisms are composed of organic matter, and its analysis is a measure of the total biomass present—living and dead. Its measurement, therefore, provides an estimate of the oxygen demand placed upon the system. It also provides a measure of the nonchlorophyllous biomass present when the chlorophyll content is considered.

## AUTOTROPHIC INDEX

The Autotrophic Index, or the AI, is a ratio of the organic matter concentration to the chlorophyll a concentration and, thus, is a measure of nonchlorophyllous biomass. Excess nonchlorophyllous biomass is indicative of the addition of organic wastes, such as sewage, to the environment.

## EQUITABILITY INDEX

The species within a population have a pattern of distribution natural for that population in a particular environment. In clean waters, the species are more or less evenly distributed; in natural waters, the distribution is skewed. A model for the distribution of species in a natural population was devised (16) and then compared with the Shannon-Weaver species diversity index (16), the result is the equitability index (16). This index is a measure of the actual distribution with a theoretical distribution, and the deviation provides a guide for determining the extent of water quality deterioration.

## Fish

Fish collections and analyses give the most meaningful index of water quality to the public and have been performed on the District waterways since 1974 (1,2,3,4,5). Fish occupy the upper levels of the aquatic food chains. Therefore, any changes in water quality that significantly affect the other kinds of organisms within the aquatic community will also affect the species composition and abundance of the fish population.

A knowledge of the assemblage of species and their numerical relationships provide an excellent biological picture of the watercourse and its well being. When such information is available over a long period of time, fish can be one of the most sensitive indicators of the quality of the aquatic environment (11).

### Description of the Sampling Locations and Frequency of Sampling

Seven sampling stations were chosen for the collection of bacteria, periphyton, and fish. Figure 1 shows the location of these stations. Table 1 gives a description of the location of the bacterial and periphyton collection stations, and Table 2 gives a description of the fish collection sites.

Samples for bacterial analyses were collected during May, July, September, and October. Periphyton samples were collected biweekly beginning March 26 and ending December 17. Fish samples were collected in June, July, and November.

## METHODS OF BIOLOGICAL ANALYSES OF WATERWAYS SAMPLES

### Bacteria

Water samples for bacterial analyses were collected in sterile one-gallon containers with enough sodium thiosulfate to neutralize 15 milligrams per liter of chlorine. All samples were taken with a bucket at the stream surface in the center of the waterway. The samples were transported on ice to the Research and Development Laboratory in Stickney, Illinois. Analyses were begun approximately six hours after the samples were collected.

#### INDICATOR BACTERIA

Total coliforms were estimated and verified according to the membrane filter (MF) procedures outlined in Standard Methods for the Examination of Water and Wastewater, 14th Edition (10). Fecal coliform determinations and verifications were carried out according to the MF technique described by Geldreich et al. (12). Fecal streptococcus were determined and verified by a technique described by Kenner et al. (14).

#### STANDARD PLATE COUNT (SPC)

SPC were performed using the pour plate technique described in Standard Methods (10).

#### PSEUDOMONAS AERUGINOSA

Analysis for P. aeruginosa were performed and confirmed according to a most probable number (MPN) procedure described

in Standard Methods (10).

#### STAPHYLOCOCCUS AUREUS

Analyses for S. aureus were performed and confirmed using a MF procedure in Standard Methods, 13th Edition (14).

#### SALMONELLA SPP.

Salmonella were estimated using a modification of the MPN technique described by Kenner and Clark (15). Presumptive Salmonella spp. were identified biochemically using the Analytical Profile Index (API 20<sup>®</sup>). Confirmation of isolates was performed with polyvalent Salmonella "O" antisera. Verification and further serotyping of the isolates was performed by the Illinois Department of Public Health (IDPH). Several isolates were submitted in duplicate or triplicate to the IDPH to assess the accuracy of serotyping.

#### Periphyton

Samplers for periphyton consisted of floats and a plastic cage containing eight microscope slides, held vertically, and perpendicular to the river current. These were placed in the river with a lead line anchoring each sampler to the river bank at seven locations (Figure 1 and Table 1). Periphyton were allowed to develop on the glass slides for two weeks at which time the entire cage of slides was replaced. The developed slides were kept on ice in the dark until delivered to the laboratory.

## POPULATION DENSITY AND COMPOSITION ANALYSES

In the laboratory, two developed slides were scraped with a razor blade for diatom analysis, the scrapings cleared of organic matter by treatment with 30 percent hydrogen peroxide, followed in 24 hours by the addition of a few crystals of dichromate. The mixture of cleared frustules, clay, silt, and sand was washed until the color of dichromate was absent and the colloidal clay had been removed. The residue was concentrated to 50 milliliters by settling, and a two milliliter aliquot was air dried on each of three cover slips (22 x 50 millimeters). The cover slips were mounted on microscope slides using Hydrax<sup>®</sup> mounting medium and examined microscopically for numbers of diatoms and species identification.

Two developed slides were scraped for nondiatom or soft-bodied organism analyses. The nondiatoms were fixed or preserved in a 0.5 percent (v/v) glutaraldehyde solution. The volume was adjusted to 10 milliliters by settling the sample and siphoning off the excess volume. A 0.1 milliliter aliquot of well mixed sample was placed on each of three cover slips (22 x 50 millimeters) and sealed to microscope slides with nail polish. The organisms were microscopically enumerated and identified.

Total count, derived from the summation of diatom and nondiatom counts were calculated and expressed as cells per square centimeter of slide area.

## CHLOROPHYLL A

The scrapings from two developed slides were placed in a tissue grinder with 90 percent (v/v) acetone and ground at 500 revolutions per minute for three minutes. The sample was allowed to steep in acetone in the dark at 4°C for a maximum of 24 hours. The extract was centrifuged at over 500 times gravity (xg) for approximately 20 minutes to remove turbidity, and the supernatant was scanned in a Beckman DK-2A<sup>®</sup> spectrophotometer from 750 to 600 nanometers. The United Nations Educational, Scientific, and Cultural Organization (UNESCO) equations for chlorophyll a (trichromatic method) were used to determine chlorophyll a concentrations in extract and extrapolated to the original sample (16).

## ORGANIC MATTER

The remaining developed slides were dried at 105°C, weighed, ashed in a muffle furnace at 600°C, dried to constant weight, and reweighed. The difference between the dried and ashed weights was, by definition, the organic matter. The organic matter yields were standardized to weight of organic matter per square centimeter of microscope slide.

## AUTOTROPHIC INDEX

The autotrophic index (AI), the ratio of the organic matter concentration to the chlorophyll a concentration, is a measure of how much of the total biomass is chlorophyllous (16). Weber (17) reported that in relatively clean waters,

chlorophyll a is one to two percent of the total biomass and that if the AI value exceeds 100, excessive heterotrophic growth has occurred due to the addition of organic wastes such as sewage. Thus, an AI greater than 100 would indicate degradation in water quality. Standard Methods, 14th Edition (10) states that, "Normal AI values range from 50 to 200. Larger AI values indicate poor water quality." Therefore, AI values greater than 200 indicate poor water quality.

#### EQUITABILITY INDEX

Equitability is a comparison of the number of species in a sample with the number of species expected from a "natural" community model. The expected number of species is determined from the Shannon-Weaver mean species diversity calculated from analysis of the sample. Equitability may range from 0 to 1 and is very sensitive to slight levels of water quality degradation. Slight levels of water quality degradation reduce equitability values to less than 0.5, with more severe levels of degradation equitability values would be in the range of 0.0 to 0.3 (16).

#### Fish

Fish were collected from eleven sampling stations along the NBCR, including its forks, in Cook and Lake Counties, Illinois. Seven stations were located in Cook County, and four stations were located in Lake County. The locations of

these stations are noted in Figure 1 and described in Table 2.

Fish collections were carried out in Cook County twice during 1980 (July and November) at station numbers 51 (West Fork NBCR/Dundee Road), 282 (Middle Fork NBCR/Lake-Cook Road), 284 (Skokie River/Lake-Cook Road), 285 (NBCR/Glenview Road), 286 (NBCR/Dempster Street), and 287 (NBCR/Albany Avenue).

An exception to this occurred at station number 53 (Skokie River/West Frontage Road) where road construction operations prevented sample collections in July.

Three fish collections were also carried out on June 13 at station number 280 (West Fork NBCR/Deerfield Road), 281 (Middle Fork NBCR/Half Day Road), and 283 (Skokie River/Half Day Road) on each fork of the NBCR in Lake County.

During 1980, all fish were collected by use of a 12-volt direct current backpack electrofisher, often followed by a 15-foot, 3/16-inch mesh minnow seine. The stunned fish were collected with dip nets.

Generally, a 40-meter section of stream was marked off by use of an optical range finder, and fish were shocked on both sides of the stream for a total of 80 meters of shoreline. When the stream was narrow, an 80-meter section was sampled in line (as at site number 284). In some cases, an additional length of stream was included. Electrofishing time was noted for all samples.

Large fish were identified to species, weighed to the



nearest gram or portion of a pound, and measured for standard and total length to the nearest millimeter. They were then returned to the stream of capture. Small fish were preserved in 10 to 15 percent formalin and identified, weighed, and measured in the laboratory.

## RESULTS

### Bacteria

Results of the bacterial analyses performed on the samples collected May 6, July 4, September 2, and October 28 are presented in Table 3. The TC, FC, and FS analyses were subjected to confirmation tests. In 1980, confirmation rates of 77.2 percent, 94.9 percent, and 96.6 percent for the TC, FC, and FS indicator bacteria, respectively, were found for typical colonies found in the analysis as shown in Table 4. These rates of confirmation are normal for these bacterial analyses. The Salmonella spp. isolated from two stations from each of the four sampling runs were subjected to serotyping with the results shown in Table 5. The identified Salmonella species were typical isolates found in the general population.

### Periphyton

#### POPULATION DENSITY AND SPECIES COMPOSITION

The average total periphyton density for each station, over the sampling period March 26 through December 17, 1980, is presented in Table 6 along with the corresponding average number of species for each station.

In Table 7, the average number of persistent species and pollutant-tolerant persistent species are presented. Persistent species were defined as those species appearing in at least 50 percent of the samples collected at each station.

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TABLE 3

BACTERIAL COUNTS IN THE NORTH BRANCH OF THE CHICAGO RIVER (NBCR)  
 GEOMETRIC AVERAGE OF FOUR SAMPLING RUNS:  
 MAY 5, JULY 7, SEPTEMBER 2 AND OCTOBER 28, 1980

STATION <sup>1</sup>	TC <sup>2</sup> Per 100 ml	FC <sup>3</sup> Per 100 ml	FS <sup>4</sup> Per 100 ml	SPC <sup>5</sup> Per 100 ml	PA <sup>6</sup> Per 100 ml	SA <sup>7</sup> Per 100 ml	SAL <sup>8</sup> Per 100 ml
West Fork NBCR Lake-Cook Rd.	1.5x10 <sup>4</sup>	9.5x10 <sup>2</sup>	9.8x10 <sup>2</sup>	2.1x10 <sup>6</sup>	1.7x10 <sup>4</sup>	<1.0x10 <sup>1</sup>	5.3x10 <sup>-1</sup>
Middle Fork NBCR Lake-Cook Rd.	1.8x10 <sup>4</sup>	1.9x10 <sup>3</sup>	1.2x10 <sup>3</sup>	1.0x10 <sup>6</sup>	5.5x10 <sup>3</sup>	<1.0x10 <sup>1</sup>	2.0x10 <sup>-1</sup>
Skokie River Lake-Cook Rd.	5.0x10 <sup>3</sup>	5.7x10 <sup>2</sup>	2.5x10 <sup>2</sup>	7.0x10 <sup>5</sup>	4.7x10 <sup>3</sup>	<1.0x10 <sup>1</sup>	<1.9x10 <sup>-1</sup>
Skokie River Frontage Road	5.4x10 <sup>3</sup>	4.6x10 <sup>2</sup>	1.3x10 <sup>2</sup>	4.2x10 <sup>5</sup>	2.2x10 <sup>3</sup>	<1.0x10 <sup>1</sup>	<1.6x10 <sup>-1</sup>
NBCR Glenview Rd.	7.3x10 <sup>4</sup>	7.8x10 <sup>3</sup>	1.6x10 <sup>3</sup>	1.6x10 <sup>6</sup>	2.0x10 <sup>4</sup>	<1.0x10 <sup>1</sup>	4.9x10 <sup>-1</sup>
NBCR Dempster St.	2.7x10 <sup>4</sup>	4.6x10 <sup>3</sup>	1.4x10 <sup>3</sup>	1.0x10 <sup>6</sup>	8.5x10 <sup>3</sup>	<1.0x10 <sup>1</sup>	3.4x10 <sup>-1</sup>
NBCR Albany & Winona	5.0x10 <sup>4</sup>	4.5x10 <sup>3</sup>	1.9x10 <sup>3</sup>	2.2x10 <sup>6</sup>	8.5x10 <sup>3</sup>	<1.0x10 <sup>1</sup>	<1.5x10 <sup>-1</sup>

- |                             |                                       |
|-----------------------------|---------------------------------------|
| 1. Figure 1                 | 5. SPC = Standard Plate Count         |
| 2. TC = Total Coliform      | 6. PA = <u>Pseudomonas aeruginosa</u> |
| 3. FC = Fecal Coliform      | 7. SA = <u>Staphylococcus aureus</u>  |
| 4. FS = Fecal Streptococcus | 8. SAL = <u>Salmonella</u>            |

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TABLE 4

TOTAL COLIFORM (TC), FECAL COLIFORM (FC), AND FECAL STREPTOCOCCUS (FS)  
COLONY CONFIRMATIONS ON THE NORTH BRANCH OF THE CHICAGO RIVER  
DURING 1980

	TC		FC		FS	
	Typical Colonies	Atypical Colonies	Typical Colonies	Atypical Colonies	Typical Colonies	Atypical Colonies
Number confirmed	105	4	130	5	139	11
Confirmations Attempted	136	27	137	26	144	13
Percent Confirmed	77.2	14.8	94.9	19.2	96.5	84.6

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TABLE 5

SALMONELLA SEROTYPES ISOLATED FROM THE NORTH BRANCH OF THE  
CHICAGO RIVER (NBCR) DURING 1980

<u>Date</u>	<u>Station*</u>	<u>Serotype</u>	<u>Number Isolated</u>
5-6-80	NBCR and Glenview Road	Oranienburg	3
5-6-80	NBCR and Dempster Street	Oranienburg	3
7-7-80	Skokie River and Lake-Cook Road	Typhimurium	2
7-7-80	NBCR and Glenview Road	Typhimurium	1
		Thompson	1
		6,7:15 monoplastic	1
9-2-80	West Fork NBCR and Lake-Cook Road	Thompson	1
		Virchow	3
9-2-80	NBCR and Dempster Street	Thompson	1
10-28-80	West Fork NBCR and Lake-Cook Road	Indiana	3
10-28-80	Middle Fork NBCR and Lake-Cook Road	Manhattan	1
		Typhimurium	2
		Heidelberg	1
		Java	1
		Bureilly	3

\*See Figure 1 for station location.

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TABLE 6

PERIPHYTON IN THE NORTH BRANCH  
OF THE CHICAGO RIVER (NBCR) DURING 1980

Station Name	Station Number	Average Total Periphyton (organisms/cm <sup>2</sup> )	Average Number of Species
West Fork	1	174,900	33.4
Middle Fork	2	68,450	36.9
Skokie River	3	128,700	34.9
Frontage Road	4	449,700	33.1
Glenview Road	5	198,700	34.5
Dempster Street	6	210,100	36.9
North Central Park Avenue	7	345,300	19.5

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TABLE 7

PERSISTENT PERIPHYTIC SPECIES AND THE NUMBER OF PERSISTENT POLLUTANT-TOLERANT  
IN THE NORTH BRANCH OF THE CHICAGO RIVER (NBCR) DURING 1980

	West Fork	Middle Fork	Skokie River	Frontage Road	Glenview Road	Dempster Street	North Central Park Avenue
Number of Station*	1	2	3	4	5	6	7
Number of Samples	18	17	17	11	13	17	6
Number of Persistent Species**	23	27	26	26	16	25	18
Number of Persistent Pollutant- Tolerant Species***	7	7	7	8	5	9	7
Percent Persistent Pollutant- Tolerant Species	30.4	25.9	26.9	30.8	31.3	36.0	38.9

\*See Figure 1 for station location.

\*\*Number of Persistent Species - the number of species which appeared in at least 50 percent of the samples collected.

\*\*\*Pollutant-tolerant species as listed by Palmer (12).

## CHLOROPHYLL A

Average chlorophyll a concentrations for each station are presented in Table 8.

## ORGANIC MATTER CONTENT

Average organic matter concentration for each station is presented in Table 8.

## AUTOTROPHIC INDEX

The AI values presented in Table 8 were calculated from the average chlorophyll a and organic matter concentrations also presented in Table 8.

## EQUITABILITY INDEX

The equitability values for all sampling stations in the NBCR are presented in Table 8.

## Fish

The catch of fish per ten minutes electrofishing for the Cook County and Lake County collections are presented in Tables 9 and 10, respectively. The total number of species and the average number and weight of fish per ten minutes electrofishing are presented in Table 11 for the forks of the NBCR and collectively for the stations farther downstream. Table 12 presents the percent composition by number and weight of fish collected per ten minutes electrofishing for the forks of the NBCR and collectively for the stations of the NBCR farther downstream. Comparisons of the fish collections from the



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TABLE 8

CHEMICAL ANALYSES OF PERIPHYTON AND ECOLOGICAL INDICES FOR  
THE NORTH BRANCH OF THE CHICAGO RIVER (NBCR) DURING 1980

Station Name	Station Number	Average Organic Matter Content ( $\mu\text{g}/\text{cm}^2$ )	Average Chlorophyll a Concentration ( $\mu\text{g}/\text{cm}^2$ )	Autotrophic Index	Equitability Index
West Fork	1	252	0.315	800	0.05
Middle Fork	2	175	0.076	2303	0.07
Skokie River	3	205	0.326	629	0.08
Frontage Road	4	366	1.372	267	0.12
Glenview Road	5	234	0.823	284	0.12
Dempster Street	6	417	1.669	250	0.11
North Central Park Avenue	7	234	0.907	258	0.08

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TABLE 9

NUMBER OF FISH TAKEN PER TEN MINUTES ELECTROFISHING  
FROM THE NORTH BRANCH OF THE CHICAGO RIVER AND  
ITS FORKS IN COOK COUNTY DURING 1980\*

Fish Species	Station Number and Location						
	51 Dundee Road West Fork	282 Lake-Cook Road Middle Fork	282 Lake-Cook Road Skokie River	53 W. Frontage Road Skokie River	285 Glenview Road North Branch	286 Dempster Street Chicago	287 Albany Avenue River
	----- Number of Fish Per 10 Minutes -----						
Goldfish	3.00	0.84					
Carp					0.49	0.44	
Golden Shiner	1.00	5.59		0.58			
Fathead minnow	0.95	1.98					0.47
White sucker		3.07			0.97		
Black bullhead				0.58			
Green sunfish		4.34	15.67	10.40	4.41		
Pumpkinseed				0.58		2.14	
Bluegill		0.40		1.16			
Largemouth bass	2.30	5.53		0.58			
Total Number Per Ten Minutes	7.25	21.75	15.67	13.88	5.87	2.58	0.47

\*July and November 1980, data combined.

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TABLE 10

NUMBER OF FISH TAKEN PER TEN MINUTES ELECTROFISHING  
 FROM THE FORKS OF THE NORTH BRANCH  
 OF THE CHICAGO RIVER IN LAKE COUNTY  
 DURING JUNE 1980

Fish Species	Station Number and Location		
	280 Deerfield Road West Fork	281 Half Day Road Middle Fork	283 Half Day Road Skokie River
	--Number of Fish Per Ten Minutes--		
Goldfish			0.84
Carp			5.07
Carp x Goldfish Hybrid			1.27
Bluntnose minnow		1.22	
Fathead minnow	0.63		0.42
Black bullhead			1.69
Green sunfish	3.15	39.56	6.76
Bluegill		3.65	0.42
Green sunfish X Pumpkinseed Hybrid		0.61	
Total Number Per Ten Minutes	3.78	45.04	16.47

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TABLE 11

TOTAL NUMBER OF SPECIES COLLECTED AND AVERAGE NUMBER AND WEIGHT OF FISH  
TAKEN PER TEN MINUTES ELECTROFISHING IN THE FORKS AND THE DOWNSTREAM  
STATIONS OF THE NORTH BRANCH OF THE CHICAGO RIVER DURING 1980

Parameter	West Fork <sup>1</sup> NBCR <sup>1</sup>	Middle Fork <sup>2</sup> NBCR <sup>2</sup>	Skokie River <sup>3</sup>	Downstream Stations NBCR <sup>4</sup>
Total Number of Species (Hybrids not Included)	5	8	9	4
Average Number of Fish Per Ten Minutes Electrofishing	7	30	15	3
Average Weight of Fish (in grams) Per Ten Minutes Electrofishing	136	177	927	66

1. Stations 51 and 280
2. Stations 281 and 282
3. Stations 53, 283, and 284
4. Stations 285, 286, and 287

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TABLE 12

PERCENTAGE COMPOSITION BY NUMBER (% N) AND BY WEIGHT (% WT)  
OF FISH COLLECTED FROM THE NORTH BRANCH OF THE CHICAGO  
RIVER DURING 1980

Fish Species	West Fork <sup>1</sup>		Middle Fork <sup>2</sup>		Skokie River <sup>3</sup>		North Branch <sup>4</sup> Downstream Stations	
	% N	% Wt	% N	% Wt	% N	% Wt	% N	% Wt
Goldfish	18.75	62.53	1.67	19.14	2.02	2.74		
Carp					12.12	73.19	11.11	92.28
Carp x Goldfish hybrid <sup>5</sup>					3.03	18.44		
Golden shiner	6.25	1.18	5.00	13.94	1.01	0.01		
Bluntnose minnow <sup>5</sup>			1.67	0.09				
Fathead minnow	9.38	1.57	4.17	0.90	1.01	0.01	16.67	0.65
White sucker			5.83	18.58				
Black bullhead					5.05	1.13		
Green sunfish	50.00	32.81	63.33	36.45	70.71	4.43	44.44	5.57
Pumpkinseed					1.01	0.01	27.78	1.50
Bluegill			5.83	7.10	3.03	0.02		
Green x pumpkinseed hybrid <sup>5</sup>			0.83	2.80				
Largemouth bass	15.63	1.91	11.67	0.99	1.01	0.02		

1. Stations 280 and 51
2. Stations 281 and 282
3. Stations 283, 284, and 53
4. Stations 285, 286, and 287
5. Fish collected only in Lake County

NBCR and other waterways of the Chicagoland area are presented in Table 13. Complete data on the 1980 fish collections from the NBCR and its forks are listed in Appendix Tables AI-1 and AI-2.

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TABLE 13

AVERAGE CATCH PER TEN MINUTES ELECTROFISHING FOR BACKPACK/SEINE  
COLLECTIONS FROM THE CHICAGO WATERWAYS<sup>1</sup>

Waterway	Year	Number of Collections	Drainage Area (Square miles)	Number of Species Per Collection		Fish Per Ten Minutes Electrofishing	
				Average	Maximum	Number	Weight (grams)
Jackson Creek <sup>2</sup>	1976	7	52.7	9.1	19	78	618
Mill Creek <sup>2</sup>	1976	5	65.3	8.4	10	87	856
Hickory Creek <sup>2</sup>	1976	9	109	10.1	20	322	1,921
North Branch Chicago River	1976	4	113	3.5	6	19	179
North Branch Chicago River	1980	16	113	2.6	6	12	330
Salt Creek <sup>2</sup>	1976	6	150	4.0	13	11	262
Nippersink Creek <sup>3</sup>	1976	9	205	6.8	14	61	657
Little Calumet River	1976	13	291	1.9	5	15	235
DuPage River <sup>2</sup>	1976	14	376	8.7	15	134	2,889

1. All 1976 data from Reference 5
2. Tributary to Des Plaines River
3. Tributary to Fox River

## DISCUSSION

### Bacteria

The levels for the indicator bacteria, shown in Table 3, indicate domestic waste contamination of the NBCR and its forks with the average TC counts ranging from  $5.0 \times 10^3$  to  $7.3 \times 10^4$  per 100 milliliters, the average FC counts ranging from  $4.6 \times 10^2$  to  $7.8 \times 10^3$  per 100 milliliters, and the average FS counts ranging from  $1.3 \times 10^2$  to  $1.9 \times 10^3$  per 100 milliliters. It can also be seen from Table 3 that the "General Use" criteria of the IPCB, 200 FC per 100 milliliters, was not met at any station on any of the four dates when samples were collected.

The SPC reported in Table 3, ranging from  $4.2 \times 10^5$  to  $2.2 \times 10^6$  per 100 milliliters, with a geometric mean of  $1.1 \times 10^6$  per 100 milliliters, were less than those found in the man-made waterways of the District where the SPC ranged from  $2.9 \times 10^7$  to  $1.6 \times 10^{10}$  per 100 milliliters (1,2,3). The geometric means of SPC for the three-year period 1975, 1976, and 1977, for the Chicago Sanitary and Ship Canal and the Calumet-Sag Channel were  $6.0 \times 10^4$  and  $3.7 \times 10^6$  per 100 milliliters. Similarly, the SPC counts in the Des Plaines River in 1979 (5) ranged from  $1.4 \times 10^6$  to  $6.7 \times 10^6$  per 100 milliliters with a geometric mean of  $2.5 \times 10^6$  per 100 milliliters. These data indicated that the bacterial populations are less in the NBCR than in the man-made waterways of the District and close to the populations found in the Des Plaines River.



Pseudomonas aeruginosa represented approximately one percent of the SPC populations as shown in Table 3 and the Staphylococcus aureus and Salmonella proportion of the bacterial population were even less. This indicated that only a very small percentage of the bacterial flora in the NBCR consisted of these pathogens.

Geldreich reported in a review (18) that Salmonella occurred in less than 27.6 percent of fresh water samples when the fecal coliform concentration was 200 colony forming units per 100 milliliters. In this study, no Salmonella were recovered from samples with less than 200 FC colony forming units per 100 milliliters, indicating agreement with Geldreich's findings. Geldreich also found that the frequency of Salmonella recovery rose to 85.2 percent when the FC count was in the range of 200 to 2,000 colony forming units per 100 milliliters. However, in contrast to Geldreich, a 58.3 percent Salmonella recovery was found in this study for samples containing greater than 200 FC per 100 milliliters.

#### Periphyton

##### POPULATION DENSITY AND SPECIES COMPOSITION

According to Standard Methods (10), "...the periphyton show dramatic effects immediately below pollution sources.... Because the abundance and composition of the periphyton at a given location are governed by the quality at that point, observations of their condition generally are useful in

assessing conditions in streams."

The average total periphyton population densities in the NBCR during 1980 for all stations sampled ranged from 68,450 to 449,700 cells per square centimeter as shown in Table 6. The average number of species in the NBCR during 1980, for all the times sampled ranged from 19.5 to 36.9 species (Table 6).

Between Skokie River/Lake-Cook Road and Skokie River/Frontage Road, the average total periphyton density increased from 128,700 to 449,700 cells per square centimeter, respectively. Because the average number of species changed little (34.9 to 33.1 species, respectively), the data suggested that nutrient enrichment occurred between these two stations on the Skokie River.

From Table 6 it is seen that an increase in average total periphyton density occurred between NBCR/Dempster Street (210,000 cells per square centimeter) and NBCR/North Central Park Avenue (345,000 cells per square centimeter); but in this case, a 47 percent reduction in the average number of species occurred, from 36.9 to 19.5 species. These data suggest the introduction of pollutants somewhere in the ten miles between the two stations.

Because the species composition of the periphyton varied from station-to-station, and with time through the year, and since we were concerned with average or standard conditions, it was decided to examine more closely only those species which appeared with a frequency of 50 percent or more at each

station through the year. These species are defined as persistent (Table 7) as opposed to ephemeral, where a species might appear only once or twice at a station throughout the year, sometimes with a very low density. The number of persistent species at all stations ranged from 16 to 27 with the lower numbers occurring at the downstream stations on the NBCR (Table 7). Elimination of these hardier periphyton species with distance downstream indicated a poorer water quality with distance downstream in the NBCR.

Within this subset of persistent species is another subset, that of the pollutant-tolerant species as defined by Palmer (17). The number of species within this sub-subset ranged from five to nine (Table 7) at all stations with the upstream stations of the NBCR along Lake-Cook Road showing the presence of seven pollutant-tolerant persistent species. Because of the small variation among stations and lack of a consistent trend between stations, this indicated similar water quality throughout the system.

On the basis of relative numbers, the percentage of pollutant-tolerant species ranged from 25.9 to 38.9 percent (Table 7) with the higher percentages occurring downstream. These data indicated that pollutant levels increased with distance downstream in the NBCR.

#### CHLOROPHYLL a

According to Standard Methods (10), "The chlorophyll

content of attached communities is a useful index of the biomass of the phytoperiphyton." The concentration of chlorophyll a (Table 8) ranged from 0.076 to 1.669 micrograms per square centimeter. The chlorophyll a concentrations reflected and confirmed the periphyton population densities (Table 6) by following the same trends, except at NBCR/North Central Park Avenue. At this station where the periphyton density increased 64 percent over the next upstream station, NBCR/Dempster Street (Figure 1), the chlorophyll a concentration decreased 46 percent from that found at NBCR/Dempster Street. Unless the dividing periphyton cells produce cells of less biomass (accomplished by reduction of vacuolation) containing fewer and smaller chloroplasts with less chlorophyll a, the only plausible explanation which accounts for the results is that the diatom frustules counted were dead and empty of organic matter. As stated in Standard Methods (10), "... periphyton often acts as a graveyard for dead diatoms of planktonic as well as periphytic origin." Therefore, the counts at NBCR/North Central Park Avenue as given in Table 6, were probably raised by the presence of dead cells.

#### ORGANIC MATTER CONTENT

The organic matter content (Table 8) ranged from 195 to 417 micrograms per square centimeter at all stations on the NBCR during 1980. The organic matter content followed the same trends as did the chlorophyll a concentrations (Table 8)

and periphyton density (Table 6). The reduction of organic matter content at NBCR/North Central Park Avenue (234 micrograms per square centimeter) from the organic matter content at NBCR/Dempster Street (417 micrograms per square centimeter) is the same as the reduction of chlorophyll a concentration (44 vs. 46 percent) between these stations. This lends support to the hypothesis that the periphyton counts were elevated at NBCR/North Central Park Avenue due to the presence of dead cells.

#### AUTOTROPHIC INDEX

According to Standard Methods (10), "The Autotrophic Index (AI) is a means of relating changes...." The AI is the ratio of organic matter content to chlorophyll a concentration. Weber (16) found that chlorophyll a concentrations of one to two percent of organic matter content occurred in relatively clean streams and stated that AI values greater than 100 indicated the predominance of nonchlorophyllous biomass encouraged by the addition of organic wastes such as sewage. Standard Methods (10), on the other hand, states, "Normal AI values range from 50 to 200. Larger AI values indicate poor water quality." All of the AI values calculated for the stations sampled in the NBCR (Table 8) were found to be greater than 200 and, thus, indicated poor water quality.

It was noted that the highest AI values occurred at the upstream stations, where the forks of the NBCR crossed Lake-

Cook Road into Cook County, thereby indicating that the waters were already of poor quality. However, according to Standard Methods (10), "Depending on the community, its location and growth habit, and method of sample collection, there may be large amounts of nonliving organic material that may inflate the numeration and produce disproportionately high AI values." This hypothesis was checked for all stations by dividing the organic matter content by the periphyton density in order to determine the average weight per cell. This revealed that the weight per cell at Middle Fork NBCR/Lake-Cook Road (2.56 nanograms per cell) was greater than at other stations (average 1.52 nanograms per cell at West Fork NBCR/Lake-Cook Road and Skokie River/Lake-Cook Road). These data suggested the presence of heterotrophs or nonliving organic material at Middle Fork NBCR/Lake-Cook Road which increased the AI value and may account for the lower periphyton density at this station. On the other hand, the very low average weight per cell found at NBCR/North Central Park Avenue (0.68 nanograms per cell) is due to dead cells increasing the average total periphyton density (already shown by the relatively lower chlorophyll a and organic matter concentrations). The low average weight per cell (0.81 nanograms per cell) found at Skokie River/ Frontage Road was probably also due to the presence of dead periphyton cells.

## EQUITABILITY INDEX

Equitability is a measure of the evenness of the distribution of species within a theoretical population compared with the expected distribution predicted by the Shannon-Weaver species diversity index (16). Weber (16) stated that values ranged from zero to one and that slight degradation of water quality was detected by values of 0.50 and that values less than 0.3 indicated moderate to severe degradation of water quality. All of the values calculated from the NBCR (Table 8) were less than 0.3, the station values ranged from 0.05 to 0.12. This indicated poor water quality in the NBCR within the study area.

### Comparison of Bacterial and Plankton Data

As shown in Table 3, fecal coliform levels at the farthest upstream stations (West Fork NBCR/Lake-Cook Road) ranged from  $5.7 \times 10^2$  to  $1.9 \times 10^3$  counts per 100 milliliters, and ranged from  $4.5 \times 10^3$  to  $7.8 \times 10^3$  counts per 100 milliliters at the three farthest downstream stations (NBCR/Glenview Road, NBCR/Dempster Street, and NBCR/Albany and Winona). This indicates that the waters of the NBCR and its forks become progressively more contaminated with bacteria as the water flows through the study area, probably from the numerous combined sewer overflows which exist there.

The periphyton counts exhibit a similar trend to that of the fecal coliform data. As shown in Table 6, the lowest

periphyton populations are found at the three farthest upstream stations (West Fork NBCR/Lake-Cook Road, Middle Fork NBCR/Lake-Cook Road, and Skokie River/Lake-Cook Road) and ranged from 68,450 to 174,900 organisms/cm<sup>2</sup>; while at the three farthest downstream stations (Glenview Road NBCR, Dempster Street NBCR, and North Central Park NBCR), periphyton counts ranged from 198,700 to 345,300 organisms per square centimeter.

As shown in Table 7, the periphyton persistent species is generally decreased with travel downstream in the NBCR study area. The number of persistent species at the three farthest upstream stations (West Fork NBCR, Middle Fork NBCR, and Skokie River) ranged from 17 to 18 and was only six at the farthest downstream station at North Central Park Avenue. This indicates significant additions of pollutants in the study area.

As shown in Table 7, the percent pollutant tolerant periphyton species increased in travel downstream. At the three farthest upstream stations on the NBCR (West Fork, Middle Fork, and Skokie River) the percent persistent periphyton species ranged from 25.9 to 30.4 percent. While at the two farthest downstream stations (Dempster Street and North Central Park Avenue), the percent persistent pollutant-tolerant periphyton species ranged from 36.0 to 38.9 percent. This increase in pollutant-tolerant species with travel down-



stream is an indication of the significant addition of pollutants in the study area.

The periphyton and fecal coliform data, therefore, both indicate that there are significant additions of pollutants to the NBCR and its forks in the study area as a result of the numerous combined sewer overflows present.

As shown in Table 6, a large increase in periphyton counts occurred from Lake-Cook Road (128,700 organisms per square centimeter) to Frontage Road (449,700 organisms per square centimeter) in the Skokie River. However, the fecal coliform counts at these two stations remained relatively constant being  $5.7 \times 10^2$  and  $4.6 \times 10^2$  counts per 100 milliliters at the Lake-Cook Road and Frontage Road stations, respectively. This indicates that a large amount of nutrients are being added to these stations from point and nonpoint sources, but that bacterial inputs are moderate.

As shown in Table 6, at the three farthest downstream stations in the NBCR study area (Glenview Road, Dempster Street, and North Central Park Avenue), there was a substantial increase in periphyton counts with travel downstream from 198,000 organisms per square centimeter (Glenview Road) to 345,300 (North Central Park Avenue).

On the other hand, as shown in Table 3, the fecal coliform counts between the Glenview Road/NBCR and Albany and Winona/NBCR stations remained fairly constant being  $7.8 \times 10^3$  counts per 100 milliliters at the Glenview Road NBCR station

and  $4.5 \times 10^3$  counts per 100 milliliters at the Albany and Winona NBCR stations. Again, this indicates that substantial inputs of nutrients are being added to these stations, while only moderate amounts of bacteria enter the waterways.

The bacterial data for the NBCR indicates that the river system is receiving large additions of domestic wastes, since Table 3 shows that FC counts exceed the IPCB "General Use" standard of 200 counts per 100 milliliters every station sampled and ranged from 460 to 7,800 per 100 milliliters. The periphyton corroborated the bacterial data because, as shown in Table 8, the AI for the periphyton community for all stations exceeded 500, indicating poor water quality throughout the study area as a result of inputs of pollutants. Also, the calculation of the Equitability Index (Table 8) from the periphyton data showed that all values were less than 0.3 indicating moderate to severe degradation of water quality within the study reach.

It can, therefore, be concluded that the periphyton and bacteria data are in overall agreement. These data both indicate significant additions of pollutants to the study area resulting in lower water quality conditions downstream. They both also indicate the NBCR is overall of poor water quality.

### Fish

The number of fish per unit effort at the upstream stations (West Fork NBCR, Middle Fork NBCR, and Skokie River

stations located at or near Lake-Cook Road) ranged from eight to 22 per ten minutes electrofishing at West Fork NBCR/Dundee Road and Middle Fork NBCR/Lake-Cook Road, respectively, as shown in Table 9. The number of fish per unit effort at the downstream stations (NBCR/Glenview Road, NBCR/Dempster Street, and NBCR/Albany Avenue) ranged from six to 0.5 per ten minutes electrofishing at NBCR/Glenview Road and NBCR/Albany Avenue, respectively, as shown in Table 9. In general, fish were more abundant at the upstream stations than at the downstream stations on the NBCR.

The number of fish per unit effort from the June Lake County collections ranged from four to 45 per ten minutes electrofishing at West Fork/Deerfield Road, and Middle Fork/Half Day Road, respectively, as shown in Table 10.

A total of eleven species and two hybrids of fish were collected from the entire NBCR in Cook and Lake Counties during 1980. The bluntnose minnow was the only species which occurred in the Lake County collection and not in the Cook County collection (Tables 9 and 10). The two hybrids, carp x goldfish and green sunfish x pumpkinseed, also occurred only in the Lake County collections. In general, the species composition of the forks of the NBCR in Lake County did not appear much different from the forks of the NBCR in Cook County.

The number of species collected at the upstream stations ranged from five to nine species in the West Fork NBCR and

Skokie River, respectively, whereas only four species were collected at the downstream stations as shown in Table 11. The average number of fish per unit effort ranged from seven to 30 fish per ten minutes electrofishing in the West and Middle Forks NBCR, respectively, compared to three fish per ten minutes electrofishing at the downstream stations. Similarly, in terms of biomass per unit effort, the average weight per unit effort ranged from 136 to 927 grams per ten minutes electrofishing in the West Fork NBCR and Skokie River, respectively, compared with 66 grams per ten minutes electrofishing at the downstream stations as shown in Table 11. It appears, therefore, that the forks of the NBCR have a better water quality for fish life than the downstream section based on numbers of fish species, average number of fish per unit effort, and biomass of fish per unit effort.

#### Comparison of Bacteria, Periphyton, and Fish Populations

The bacterial data for the NBCR indicated that the river system received significant quantities of domestic wastes since the IPCB "General Use" standard of 200 FC per 100 milliliters was exceeded at every station sampled and ranged from 460 to 7,800 per 100 milliliters.

The periphyton data corroborated the bacterial data in that it was found that the hardier species of periphyton decreased with distance downstream in the NBCR indicating that water of poorer quality was encountered in the downstream sec-

tions, and that additions of pollutants to the NBCR in the study area were occurring. Calculation of the AI for the periphyton community in the study area revealed, that at all stations, AI values exceeded 200, indicating poor water quality throughout the study reach. Calculation of the Equitability Index from the periphyton data revealed a picture quite similar to that revealed by the AI and indicated that the NBCR in the study area was of poor water quality.

Fish population data corroborated the bacterial and periphyton data and showed in the main that the NBCR contained fish which were tolerant of a wide range of water quality conditions and that this indicated that the NBCR had water of poor quality. In a similar manner to that found for periphyton persistent and pollutant-tolerant species, it was noted that the upstream sections of the NBCR contained greater numbers of fish and more fish species than the downstream sections, indicating that significant quantities of pollutant were entering the NBCR in the study area.

Fecal coliform levels are specified by the IPCB as one measure of water quality. Fish and plankton populations are not currently part of either state or federal water quality standards. However, fish and plankton data support the fecal coliform data and are routinely used throughout the U.S. in water quality assessment. The position of fish at the top of the aquatic food chain in relation to plankton, bacteria and

invertebrates also helps to provide an integrated view of the watershed's environment. Plankton are a source of food for fish and invertebrates and are a direct indication of the level of nutrients present in a stream from pollution inputs. Both plankton and fish data compliment FC data, and all three are reliable indicators of water quality.

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APPENDIX I

FISH DATA COLLECTED FROM THE NORTH BRANCH OF THE CHICAGO RIVER  
DURING 1980

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE AI-1

ELECTROFISHING RESULTS (TOTAL NUMBERS AND WEIGHTS, PERCENTAGES AND CATCH PER 10 MINUTES) FOR FISH COLLECTED FROM THE NORTH BRANCH OF THE CHICAGO RIVER AND ITS FORKS DURING 1980

ST. NO.	STATION NAME	STREAM *	DATE	SPECIES NAME	NO. FISH	NO. PER 10 MIN.	%TOT. NUMBER	TOTAL WT. (gm)	WT. (gm) PER 10 MIN.	%TOT. WEIGHT
280	DEERFIELD RD	W.FK.NBCR	6/13	FATHEAD MINNOW	1	0.63	16.67	2.00	1.26	7.630
280	DEERFIELD RD	W.FK.NBCR	6/13	GREEN SUNFISH	5	3.15	83.33	24.21	15.26	92.370
281	HALF DAY RD	M.FK.NBCR	6/13	BLUNTNOSE MINNOW	2	1.22	2.70	0.64	0.39	0.220
281	HALF DAY RD	M.FK.NBCR	6/13	GREEN SUNFISH	65	39.56	87.84	224.25	136.49	76.160
281	HALF DAY RD	M.FK.NBCR	6/13	BLUEGILL	6	3.65	8.11	49.32	30.02	16.750
281	HALF DAY RD	M.FK.NBCR	6/13	GREEN X PUMPKINSEED	1	0.61	1.35	20.23	12.31	6.870
283	HALF DAY RD	SKOKIE R.	6/13	GOLDFISH	2	0.84	5.13	235.88	99.61	2.840
283	HALF DAY RD	SKOKIE R.	6/13	CARP	12	5.07	30.77	6300.00	2660.47	75.850
283	HALF DAY RD	SKOKIE R.	6/13	CARP X GOLDFISH	3	1.27	7.69	1587.57	670.43	19.110
283	HALF DAY RD	SKOKIE R.	6/13	FATHEAD MINNOW	1	0.42	2.56	1.22	0.52	0.010
283	HALF DAY RD	SKOKIE R.	6/13	BLACK BULLHEAD	4	1.69	10.26	92.68	39.14	1.120
283	HALF DAY RD	SKOKIE R.	6/13	GREEN SUNFISH	16	6.76	41.03	88.32	37.30	1.060
283	HALF DAY RD	SKOKIE R.	6/13	BLUEGILL	1	0.42	2.56	0.30	0.13	0.004
51	DUNDEE RD	W.FK.NBCR	7/3	FATHEAD MINNOW	1	0.90	6.67	4.08	3.66	3.350
51	DUNDEE RD	W.FK.NBCR	7/3	GREEN SUNFISH	10	8.97	66.67	116.10	104.13	95.340
51	DUNDEE RD	W.FK.NBCR	7/3	LARGEMOUTH BASS	4	3.59	26.67	1.60	1.43	1.310
282	LAKE COOK RD	M.FK.NBCR	7/3	GOLDFISH	1	0.79	2.63	120.82	95.36	43.830
282	LAKE COOK RD	M.FK.NBCR	7/3	GOLDEN SHINER	6	11.18	15.79	100.56	79.37	36.480
282	LAKE COOK RD	M.FK.NBCR	7/3	FATHEAD MINNOW	5	3.95	13.16	6.50	5.13	2.360
282	LAKE COOK RD	M.FK.NBCR	7/3	GREEN SUNFISH	11	8.68	28.95	38.72	30.56	14.050
282	LAKE COOK RD	M.FK.NBCR	7/3	BLUEGILL	1	0.79	2.63	1.91	1.51	0.690

Table continued on following page.

\* NBCR=NORTH BRANCH OF THE CHICAGO RIVER, W.FK.=WEST FORK, M.FK.=MIDDLE FORK.

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE I-1 (continued)

ELECTROFISHING RESULTS (TOTAL NUMBERS AND WEIGHTS, PERCENTAGES AND CATCH PER 10 MINUTES) FOR FISH COLLECTED FROM THE NORTH BRANCH OF THE CHICAGO RIVER AND ITS FORKS DURING 1980

ST. NO.	STATION NAME	STREAM *	DATE	SPECIES NAME	NO. FISH	NO.PER 10 MIN.	ZTOT. NUMBER	TOTAL WT.(gm)	WT.(gm) PER 10 MIN.	ZTOT. WEIGHT
282	LAKE COOK RD	M.FK.NBCR	7/3	LARGEMOUTH BASS	14	11.05	36.84	7.14	5.64	2.590
284	LAKE COOK RD	SKOKIE R.	7/3	NO FISH	0	0.00	0.00	0.00	0.00	0.000
284	LAKE COOK RD	SKOKIE R.	7/3	GREEN SUNFISH	1	2.00	100.00	5.35	10.70	100.000
285	GLENVIEW RD	NBCR	7/1	GREEN SUNFISH	4	4.95	100.00	17.38	21.50	100.000
286	DEMPSTER ST	NBCR	7/11	CARP	1	0.88	100.00	396.89	348.76	100.000
287	ALBANY AVE	NBCR	7/3	NO FISH	0	0.00	0.00	0.00	0.00	0.000
287	ALBANY AVE	NBCR	7/3	NO FISH	0	0.00	0.00	0.00	0.00	0.000
51	DUNDEE RD	W.FK.NBCR	11/19	GOLDFISH	6	6.00	54.55	269.82	269.82	95.170
51	DUNDEE RD	W.FK.NBCR	11/19	GOLDEN SHINER	2	2.00	18.18	5.08	5.08	1.790
51	DUNDEE RD	W.FK.NBCR	11/19	FATHEAD MINNOW	1	1.00	9.09	0.69	0.69	0.240
51	DUNDEE RD	W.FK.NBCR	11/19	GREEN SUNFISH	1	1.00	9.09	1.26	1.26	0.440
51	DUNDEE RD	W.FK.NBCR	11/19	LARGEMOUTH BASS	1	1.00	9.09	6.65	6.65	2.350
282	LAKE COOK RD	M.FK.NBCR	11/19	GOLDFISH	1	0.88	12.50	17.23	15.11	11.390
282	LAKE COOK RD	M.FK.NBCR	11/19	WHITE SUCKER	7	6.14	87.50	134.05	117.59	88.610
284	LAKE COOK RD	SKOKIE R.	11/18	GREEN SUNFISH	35	30.70	100.00	87.15	76.45	100.000
53	W.FRONTAGE RD	SKOKIE R.	11/19	GOLDEN SHINER	1	0.58	4.17	0.47	0.27	0.220
53	W.FRONTAGE RD	SKOKIE R.	11/19	BLACK BULLHEAD	1	0.58	4.17	4.67	2.70	2.230
53	W.FRONTAGE RD	SKOKIE R.	11/19	GREEN SUNFISH	18	10.40	75.00	200.52	115.91	95.620
53	W.FRONTAGE RD	SKOKIE R.	11/19	PUMPKINSEED	1	0.58	4.17	0.78	0.45	0.370
53	W.FRONTAGE RD	SKOKIE R.	11/19	BLUEGILL	2	1.16	8.33	1.26	0.73	0.600
53	W.FRONTAGE RD	SKOKIE R.	11/19	LARGEMOUTH BASS	1	0.58	4.17	2.00	1.16	0.950
285	GLENVIEW RD	NBCR	11/18	CARP	1	0.97	14.29	9.02	8.73	48.080

Table continued on following page.

\* NBCR=NORTH BRANCH OF THE CHICAGO RIVER, W.FK.=WEST FORK, M.FK.=MIDDLE FORK.

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE AI-1 (continued)

ELECTROFISHING RESULTS (TOTAL NUMBERS AND WEIGHTS, PERCENTAGES AND CATCH PER 10 MINUTES) FOR FISH COLLECTED FROM THE NORTH BRANCH OF THE CHICAGO RIVER AND ITS FORKS DURING 1980

ST. NO.	STATION NAME	STREAM *	DATE	SPECIES NAME	NO. FISH	NO. PER 10 MIN.	%TOT. NUMBER	TOTAL WT.(gm)	WT.(gm) PER 10 MIN.	%TOT. WEIGHT
285	GLENVIEW RD	NBCR	11/18	FATHEAD MINNOW	2	1.94	28.57	2.62	2.54	13.970
285	GLENVIEW RD	NBCR	11/18	GREEN SUNFISH	4	3.87	57.14	7.12	6.89	37.950
286	DEMPSTER ST	NBCR	11/18	PUMPKINSEED	5	4.28	100.00	6.60	5.65	100.000
287	ALBANY AVE	NBCR	11/18	FATHEAD MINNOW	1	0.93	100.00	0.24	0.22	100.000

\* NBCR=NORTH BRANCH OF THE CHICAGO RIVER, W.FK.=WEST FORK, M.FK.=MIDDLE FORK.

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THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE AI-2

MEAN, MINIMUM AND MAXIMUM TOTAL LENGTH (TL) AND WEIGHT (WT) FOR FISH COLLECTED FROM  
THE NORTH BRANCH OF THE CHICAGO RIVER AND ITS FORKS DURING 1980

ST. NO.	STATION NAME	STREAM *	DATE	SPECIES NAME	NO. FISH	MEAN TL(mm)	MIN TL(mm)	MAX TL(mm)	MEAN WT(gm)	MIN WT(gm)	MAX WT(gm)
280	DEERFIELD RD	W.FK.NBCR	6/13	FATHEAD MINNOW	1	53.00	53	53	2.00	2.00	2.00
280	DEERFIELD RD	W.FK.NBCR	6/13	GREEN SUNFISH	5	59.00	45	72	4.84	1.84	8.53
281	HALF DAY RD	M.FK.NBCR	6/13	BLUNTNOSE MINNOW	2	30.50	23	38	0.32	0.10	0.53
281	HALF DAY RD	M.FK.NBCR	6/13	GREEN SUNFISH	65	52.66	37	94	3.45	0.87	17.84
281	HALF DAY RD	M.FK.NBCR	6/13	BLUEGILL	6	80.33	49	94	8.22	1.50	13.54
281	HALF DAY RD	M.FK.NBCR	6/13	GREEN X PUMPKINSEED	1	105.00	105	105	20.23	20.23	20.23
283	HALF DAY RD	SKOKIE R.	6/13	GOLDFISH	2	175.50	82	269	117.94	9.08	226.80
283	HALF DAY RD	SKOKIE R.	6/13	CARP	12	322.92	180	410	525.00	86.41	907.18
283	HALF DAY RD	SKOKIE R.	6/13	CARP X GOLDFISH	3	331.33	263	380	529.19	226.80	907.18
283	HALF DAY RD	SKOKIE R.	6/13	FATHEAD MINNOW	1	48.00	48	48	1.22	1.22	1.22
283	HALF DAY RD	SKOKIE R.	6/13	BLACK BULLHEAD	4	102.25	53	140	23.17	2.07	45.81
283	HALF DAY RD	SKOKIE R.	6/13	GREEN SUNFISH	16	59.75	34	102	5.52	0.77	22.78
283	HALF DAY RD	SKOKIE R.	6/13	BLUEGILL	1	30.00	30	30	0.30	0.30	0.30
51	DUNDEE RD	W.FK.NBCR	7/3	FATHEAD MINNOW	1	67.00	67	67	4.08	4.08	4.08
51	DUNDEE RD	W.FK.NBCR	7/3	GREEN SUNFISH	10	74.00	51	100	11.61	2.77	25.95
51	DUNDEE RD	W.FK.NBCR	7/3	LARGEMOUTH BASS	4	29.50	28	32	0.40	0.35	0.51
282	LAKE COOK RD	M.FK.NBCR	7/3	GOLDFISH	1	168.00	168	168	120.82	120.82	120.82
282	LAKE COOK RD	M.FK.NBCR	7/3	GOLDEN SHINER	6	107.33	76	130	16.76	5.00	24.19
282	LAKE COOK RD	M.FK.NBCR	7/3	FATHEAD MINNOW	5	47.40	43	53	1.30	0.86	1.88
282	LAKE COOK RD	M.FK.NBCR	7/3	GREEN SUNFISH	11	55.55	51	60	3.52	2.44	4.90
282	LAKE COOK RD	M.FK.NBCR	7/3	BLUEGILL	1	52.00	52	52	1.91	1.91	1.91

Table continued on following page.

\* NBCR=NORTH BRANCH OF THE CHICAGO RIVER, W.FK.=WEST FORK, M.FK.=MIDDLE FORK.

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE AI-2 (continued)

MEAN, MINIMUM AND MAXIMUM TOTAL LENGTH (TL) AND WEIGHT (WT) FOR FISH COLLECTED FROM  
THE NORTH BRANCH OF THE CHICAGO RIVER AND ITS FORKS DURING 1980

ST. NO.	STATION NAME	STREAM *	DATE	SPECIES NAME	NO. FISH	MEAN TL(mm)	MIN TL(mm)	MAX TL(mm)	MEAN WT(gm)	MIN WT(gm)	MAX WT(gm)
282	LAKE COOK RD	M.FK.NBCR	7/3	LARGEMOUTH BASS	14	34.07	31	39	0.51	0.32	0.69
284	LAKE COOK RD	SKOKIE R.	7/3	NO FISH	0	0.00	0	0	0.00	0.00	0.00
284	LAKE COOK RD	SKOKIE R.	7/3	GREEN SUNFISH	1	60.00	60	60	5.35	5.35	5.35
285	GLENVIEW RD	NBCR	7/1	GREEN SUNFISH	4	59.25	52	74	4.35	2.91	8.10
286	DEMPSTER ST	NBCR	7/11	CARP	1	305.00	305	305	396.89	396.89	396.89
287	ALBANY AVE	NBCR	7/3	NO FISH	0	0.00	0	0	0.00	0.00	0.00
287	ALBANY AVE	NBCR	7/3	NO FISH	0	0.00	0	0	0.00	0.00	0.00
51	DUNDEE RD	W.FK.NBCR	11/19	GOLDFISH	6	120.67	96	148	44.97	15.93	87.00
51	DUNDEE RD	W.FK.NBCR	11/19	GOLDEN SHINER	2	63.00	62	64	2.54	2.54	2.54
51	DUNDEE RD	W.FK.NBCR	11/19	FATHEAD MINNOW	1	39.00	39	39	0.69	0.69	0.69
51	DUNDEE RD	W.FK.NBCR	11/19	GREEN SUNFISH	1	41.00	41	41	1.26	1.26	1.26
51	DUNDEE RD	W.FK.NBCR	11/19	LARGEMOUTH BASS	1	78.00	78	78	6.65	6.65	6.65
282	LAKE COOK RD	M.FK.NBCR	11/19	GOLDFISH	1	93.00	93	93	17.23	17.23	17.23
282	LAKE COOK RD	M.FK.NBCR	11/19	WHITE SUCKER	7	113.71	97	138	19.15	11.69	30.38
284	LAKE COOK RD	SKOKIE R.	11/18	GREEN SUNFISH	35	44.11	29	84	2.49	0.55	13.17
53	W.FRONTAGE RD	SKOKIE R.	11/19	GOLDEN SHINER	1	38.00	38	38	0.47	0.47	0.47
53	W.FRONTAGE RD	SKOKIE R.	11/19	BLACK BULLHEAD	1	64.00	64	64	4.67	4.67	4.67
53	W.FRONTAGE RD	SKOKIE R.	11/19	GREEN SUNFISH	18	75.06	41	125	11.14	1.40	39.88
53	W.FRONTAGE RD	SKOKIE R.	11/19	PUMPKINSEED	1	35.00	35	35	0.78	0.78	0.78
53	W.FRONTAGE RD	SKOKIE R.	11/19	BLUEGILL	2	33.00	32	34	0.63	0.58	0.68
53	W.FRONTAGE RD	SKOKIE R.	11/19	LARGEMOUTH BASS	1	52.00	52	52	2.00	2.00	2.00
285	GLENVIEW RD	NBCR	11/18	CARP	1	83.00	83	83	9.02	9.02	9.02

Table continued on following page.

\* NBCR=NORTH BRANCH OF THE CHICAGO RIVER, W.FK.=WEST FORK, M.FK.=MIDDLE FORK.

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE AI-2 (continued)

MEAN, MINIMUM AND MAXIMUM TOTAL LENGTH (TL) AND WEIGHT (WT) FOR FISH COLLECTED FROM  
THE NORTH BRANCH OF THE CHICAGO RIVER AND ITS FORKS DURING 1980

ST. NO.	STATION NAME	STREAM *	DATE	SPECIES NAME	NO. FISH	MEAN TL(mm)	MIN TL(mm)	MAX TL(mm)	MEAN WT(gm)	MIN WT(gm)	MAX WT(gm)
285	GLENVIEW RD	NBCR	11/18	FATHEAD MINNOW	2	47.50	46	49	1.31	1.11	1.51
285	GLENVIEW RD	NBCR	11/18	GREEN SUNFISH	4	43.75	35	50	1.78	0.92	2.41
286	DEMPSTER ST	NBCR	11/18	PUMPKINSEED	5	38.00	30	46	1.32	0.56	2.22
287	ALBANY AVE	NBCR	11/18	FATHEAD MINNOW	1	25.00	25	25	0.24	0.24	0.24

\* NBCR=NORTH BRANCH OF THE CHICAGO RIVER, W.FK.=WEST FORK, M.FK.=MIDDLE FORK.



APPENDIX II

RESULTS OF CHEMICAL ANALYSIS OF RIVER  
SAMPLES COLLECTED QUARTERLY AT  
ALBANY AVENUE, GLENVIEW ROAD,  
AND WEST FRONTAGE ROAD

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE AII-1

1980 NORTH BRANCH CHICAGO RIVER CHEMICAL DATA  
COLLECTED AT ALBANY AVENUE

Constituent	Date of Collection			
	5/6/80	7/1/80	9/2/80	10/28/80
Flouride	0.70	0.59	0.34	0.50
Phenol (µg/l)	3	0	0	0
Chloride	172	140	N.A.	93
Total-P	0.82	1.00	0.77	0.73
Sol. P	0.30	0.98	0.47	0.52
Sulfate	71	45	33	136
Cyanide	0.011	0.005	0.006	0.014
FOG	14	15	0	2
TOC	32	39	N.A.	11
Turbidity (JTV)	9	13	70	40
Alkalinity	235	184	147	153
MBAS	0.181	0.148	0.041	0.078
Temp (Deg. C)	17.0	19.0	22.0	6
DO	-	3.1	6.3	9.7
Zinc	<0.1	<0.1	<0.1	<0.1
Cadmium	<0.02	<0.02	<0.02	<0.02
Copper	<0.02	<0.02	<0.02	0.01
Chromium	<0.02	<0.02	<0.02	0
Iron	0.2	0.3	1.7	0.7
Nickel	<0.01	<0.01	<0.01	<0.01
Lead	0.08	0.03	0.08	0.04
Manganese	0.08	0.07	0.13	0.10
Selenium	<0.2	<0.2	<0.2	<0.2
Arsenic	<0.2	<0.2	<0.2	<0.2
Silver	<0.02	<0.02	<0.02	<0.02
Barium	<0.1	<0.1	<0.1	<0.1
Mercury (µg/l)	<0.05	<0.05	<0.05	0.5
Total Solids	792	688	694	562
T. Sus. Solids	67	14	215	30
T. Vol. Sus.	38	3	18	7
Solids				
Kjeldahl-N	3.6	1.7	2.5	1.5
Ammonia-N	0	0.5	0.6	0
Organic N	3.6	1.2	1.9	1.5
NO <sub>2</sub> +NO <sub>3</sub> -N	1.58	1.80	1.26	2.52

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THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE AII-1 (continued)

1980 NORTH BRANCH CHICAGO RIVER CHEMICAL DATA  
COLLECTED AT ALBANY AVENUE

Constituent	Date of Collection			
	5/6/80	7/1/80	9/2/80	10/28/80
COD	92	32	71	40
BOD	21	6	8	7
pH (units)	7.9	7.5	7.3	7.9

Note: All constituents in mg/l unless otherwise noted;  
N.A. - no analysis performed; < = below detection limit.

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE AII-2

1980 NORTH BRANCH CHICAGO RIVER CHEMICAL DATA  
COLLECTED AT GLENVIEW ROAD

Constituent	Date of Collection			
	5/6/80	7/1/80	9/2/80	10/25/80
Flouride	0.75	0.65	0.33	0.53
Phenol (µg/l)	0	3	3	0
Chloride	168	133	-	106
Total-P	0.61	0.94	0.64	0.81
Soluble-P	0.30	0.77	0.51	0.67
Sulfate	35	42	64	149
Cyanide	0.009	0.005	0.005	0.012
FOG	9	23	4	6
TOC	41	34	N.A.	18
Turbidity (JTV)	13	6	38	18
Alkalinity	222	209	150	218
MBAS	0.085	0.258	0.039	0.070
Temp (Deg. C)	16.0	18.0	22.0	7
DO	-	4.9	6.6	N.A.
Zinc	<0.1	<0.1	<0.1	<0.1
Cadmium	<0.02	<0.02	<0.02	<0.02
Copper	<0.02	<0.04	<0.02	<0.02
Chromium	<0.02	<0.02	<0.02	<0.02
Iron	0.3	0.3	1.2	0.8
Nickel	<0.01	<0.01	<0.01	<0.01
Lead	0.06	0.03	0.03	0.02
Manganese	0.08	0.07	0.11	0.05
Selenium	<0.2	<0.2	<0.2	<0.2
Arsenic	<0.2	<0.2	<0.2	<0.2
Silver	<0.02	<0.02	<0.02	<0.2
Barium	<0.1	<0.1	<0.1	<0.1
Mercury (µg/l)	0.4	0.2	0.05	0.2
Total Solids	756	702	552	498
T. Sus. Solids	53	31	97	30
T. Vol. Sus.	16	3	67	9
Solids				
Kjeldahl-N	1.9	2.2	1.6	1.6
Ammonia-N	0	0.5	0.3	0.1
Organic N	1.9	1.7	1.3	1.5
NO <sub>2</sub> +NO <sub>3</sub> -N	1.89	2.38	1.21	3.40

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THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE AII-2 (continued)

1980 NORTH BRANCH CHICAGO RIVER CHEMICAL DATA  
COLLECTED AT GLENVIEW ROAD

Constituent	Date of Collection			
	5/6/80	7/1/80	9/2/80	10/28/80
COD	57	42	48	43
BOD	10	11	6	6
pH (units)	8.5	7.9	7.8	7.9

Note: All constituents in mg/l unless otherwise noted;  
N.A. = no analysis performed; < = below detection limit.

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE AII-3

1980 NORTH BRANCH CHICAGO RIVER CHEMICAL DATA  
COLLECTED AT WEST FRONTAGE ROAD ON THE  
SKOKIE RIVER

Constituent	Date of Collection			
	5/6/80	7/1/80	9/2/80	10/28/80
Flouride	1.15	0.66	0.50	0.59
Phenol (µg/l)	0	5	0	2
Chloride	176	127	N.A.	108
Total-P	0.80	1.14	1.02	1.09
Soluble-P	0.38	0.91	0.88	0.91
Sulfate	122	42	43	140
Cyanide	0.011	0.008	0.006	0.015
FOG	7	26	1	0
TOC	30	36	N.A.	11
Turbidity (JTV)	10	17	40	24
Alkalinity	223	190	214	209
MBAS	0.066	0.129	0.046	0.018
Temp (Deg. C)	16.5	21.0	23.5	7
DO	-	6.2	4.9	11.1
Zinc	<0.1	<0.1	<0.1	<0.1
Cadmium	<0.02	<0.02	<0.02	<0.02
Copper	<0.02	<0.02	<0.02	<0.02
Chromium	<0.02	<0.02	<0.02	<0.02
Iron	0.2	0.4	0.7	0.8
Nickel	<0.01	<0.01	<0.01	<0.01
Lead	0.09	0	0.06	0.03
Manganese	0.07	0.06	0.02	0.05
Selenium	<0.2	<0.2	<0.2	<0.2
Arsenic	<0.2	<0.2	<0.2	<0.2
Silver	<0.02	<0.02	<0.02	<0.02
Barium	<0.1	<0.1	<0.1	<0.1
Mercury	0.2	<0.005	0.3	0.1
Total Solids	756	708	692	580
T. Vol. Solids	N.A.	N.A.	N.A.	N.A.
T. Sus. Solids	52	102	52	35
T. Vol. Sus.	22	55	12	10
Solids				
Kjeldahl N	2.7	2.2	2.0	1.7
Ammonia-N	0	0.2	0.4	0
Organic N	2.7	2.0	1.6	1.7
NO <sub>2</sub> +NO <sub>3</sub> -N	2.31	3.48	1.88	4.57

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THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE AII-3 (continued)

1980 NORTH BRANCH CHICAGO RIVER CHEMICAL DATA  
 COLLECTED AT WEST FRONTAGE ROAD ON THE  
 SKOKIE RIVER

Constituent	Date of Collection			
	5/6/80	7/1/80	9/2/80	10/28/80
COD	56	45	37	42
BOD	13	10	6	6
pH (units)	8.5	7.9	8.3	8.1

Note: All constituents in mg/l unless otherwise noted;  
 N.A. = no analysis performed; < = below detection limit.