THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

DEPARTMENT OF RESEARCH AND DEVELOPMENT

REPORT NO. 84-2-B

1981 ANNUAL SUMMARY REPORT

WATER QUALITY WITHIN THE WATERWAY SYSTEM OF THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

VOLUME 2

BIOLOGICAL

June 1985

DEPARTMENT OF RESEARCH AND DEVELOPMENT

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WATER QUALITY WITHIN THE WATERWAYS SYSTEM OF THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

VOLUME II
BIOLOGICAL

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SUMMARY AND CONCLUSIONS

Bacteria

At the seven stations sampled on the North Branch of the Chicago River (NBCR) in 1981, the total coliform counts ranged from 1.2×10^3 to 5.0×10^5 per 100 milliliters, the fecal coliform counts ranged from 8.5×10^1 to 3.3×10^4 per 100 milliliters, and the fecal streptococcus counts ranged from 4.6×10^1 to 5.7×10^3 per 100 milliliters. The "General Use" criteria of 200 fecal coliform per 100 milliliters, based on a minimum of five samples taken over not more than a 30-day period, established by the Illinois Pollution Control Board (IPCB), was not met on any of the four dates on which the NBCR was sampled.

Standard plate counts ranged from 5.2×10^3 to 2.0×10^5 per milliliter. These counts were comparable to those found in the artificial deep-draft waterways in metropolitan Chicago in 1975, 1976, and 1977.

The counts for *Pseudomonas aeruginosa* ranged from 2.7×10^3 to 4.6×10^3 per 100 milliliters and the counts for *Salmonella* ranged from 1.5×10^{-1} to 4.2×10^{-1} per 100 milliliters.

Periphyton

A 20 percent reduction in the average number of periphyton species occurred between the NBCR/Dempster Street and NBCR/North Central Park Avenue stations. The number of persistent species (species occurring in one-half or more of the samples collected) declined by 35 percent between these same stations, which indi-

cated that the number of hardier periphyton species was being reduced between these stations.

The average periphyton concentration decreased from 165,000 organisms per square centimeter at the NBCR/Glenview Road station to 70,000 organisms per square centimeter at the NBCR/Dempster Street station, a reduction of 58 percent.

Chlorophyll a concentrations followed the pattern exhibited by the population of persistent species and the average periphyton population, declining from 1.237 micrograms per square centimeter at the NBCR/Glenview Road station to 0.413 micrograms per square centimeter at the NBCR/Dempster Street station, a reduction of 67 percent.

The autotrophic index devised by Weber is a ratio of the organic matter concentration to the chlorophyll a concentration. Using a relatively clean stream as a baseline, Weber determined that the autotrophic index values above 100 indicated degradation of the water by organic wastes such as sewage. The values calculated for each station sampled on the NBCR ranged from 112 to 770.

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 the periphyton community at each station. 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 0.02 to 0.10, showing poor water quality conditions in the NBCR study area.

The decline in the number of periphyton species, persistent periphyton species, periphyton densities, and chlorophyll a concentrations between upstream and downstream stations on the NBCR, all supported the conclusion that the NBCR was receiving significant amounts of pollutants from the numerous combined sewer overflows (CSOs) and nonpoint pollutional sources in the study area.

This conclusion is further supported by the derived parameters of autotrophic index and equitability. Based upon these parameters, the overall water quality of the NBCR in the study area was relatively poor.

Fish

A total of 12 species of fish and fish hybrids were collected from ten stations located on the NBCR in Cook and Lake Counties. Based on the numbers of species of fish collected, the Middle Fork of the NBCR and the Skokie River had a greater diversity of species (11 each) than the West Fork of the NBCR (six species) or the downstream stations, from Glenview Road to Albany Avenue (eight species), and therefore, had a better water quality than the latter two sections. However, the abundance of individual fish collected was relatively constant in terms of catch per 10 minutes electrofishing with an average of 11 fish per 10 minutes in the West Fork, 21 in the Middle Fork, 13 in the Skokie River, and 14 in the downstream section. As in 1980, the lowest number of species (one species) and the lowest catch per unit effort (four fish per 10 minutes electrofishing) oc-

curred at the Albany Avenue station which is the farthest downstream station on the NBCR.

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 as well as at the downstream locations. The assemblage of species collected from all NBCR stations was largely composed 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. This situation is due to the large number of combined sewer outfalls and sources of nonpoint pollution in the study area.

When compared with seven other streams of similar drainage area in the Chicagoland region, the NBCR was low in average and maximum species per sample and in abundance of fish. Based on fish data, the NBCR appears to be similar in water quality to the Little Calumet River and to Salt Creek.

INTRODUCTION

The Metropolitan Sanitary District of Greater Chicago (District) is responsible for the quality of the water in the streams and the canals within its jurisdiction. The District established its Ecosystematic Study Program in 1975, to monitor these waterways. The activities under this monitoring program are provided by the Research and Development Department's Biology Section. The field monitoring activities are handled by the following groups within the Biology Section: Analytical Microbiology, Aquatic Ecology, and Fisheries.

From 1975-1977, the deep-draft waterways (Chicago and Calumet 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 and 1981, that portion of the North Branch of the Chicago River (NBCR) within Cook County, and above its confluence with the North Shore Channel (NSC) was monitored (6).

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." This means that the waters must meet the General Standards which are designed to protect the state's water, "...for aquatic life, agricultural use, primary and secondary contact use, and most industrial uses, and ensure the aesthetic quality of the State's aquatic environment."

The objectives of this study were to determine the bacterial, periphytic algae, and fish populations in the NBCR. Evaluation of the existing biological community structure in a waterway 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 abundance and the less tolerant ones will decrease. Effects of stress can be detected by examining population density estimates, species composition, and species diversity of the aquatic community. The District's Biology Section monitored the bacteria, periphyton, and fish communities of the NBCR during 1981 in order to establish the water quality conditions of this waterway.

DESCRIPTION OF THE NORTH BRANCH OF THE CHICAGO RIVER

The Wisconsinian glacier left behind a system of lake-border moraines paralleling the western shore of Lake Michigan (12). From the sags formed between these moraines arose the West Fork of the NBCR, the Middle Fork of the NBCR, and the Skokie River. The flow of the NBCR is southward until about four miles south of the tip of the Deerfield moraine (Touhy Avenue) where the NBCR turns southeastward toward Lake Michigan. The NBCR is intercepted by the NSC and diverted into the reversed flow of the Chicago River in downtown Chicago (7).

The drainage area of the entire NBCR system is 113 square miles (292 square kilometers); 52.3 square miles or 46 percent lies outside the jurisdiction of the District (8). Within the District jurisdiction are 41 combined sewer outfalls discharging to the NBCR (9).

The West Fork of the NBCR at Dundee Road is at an elevation of 637.98 feet (194.456 meters) with an average discharge over 28 years of 12.2 cubic feet per second (0.346 cubic meters per second) (10). The maximum discharge occurred July 13, 1957, with 930 cubic feet per second (26.3 cubic meters per second) (10).

The Middle Fork of the NBCR at Lake-Cook Road is at an elevation of 638.88 feet (194.731 meters) with an average discharge over 28 years of 14.2 cubic feet per second (0.402 cubic meters per second) (10). The maximum discharge occurred March 5, 1976, with 550 cubic feet per second (15.6 cubic meters per second)

(10). There were times when no flow was observed in either the West Fork or the Middle Fork of the NBCR (10).

The Skokie River at Clavey Road is at an elevation of 622.83 feet (189.839 meters) with an average discharge over 13 years of 22.3 cubic feet per second (0.632 cubic meters per second) (10). The maximum discharge occurred August 26, 1972, with 570 cubic feet per second (16.1 cubic meters per second) (10). The minimum discharge occurred October 13, 14, 29, 1979, with 0.78 cubic feet per second (0.022 cubic meters per second) (10).

Figure 1 outlines the path of flow of the NBCR and its forks, and its position relative to Lake Michigan. The portion of the NBCR included in this study was the segment west and north of the confluence with the NSC. The stations from which samples were taken are marked and designated according to type of sample collected.

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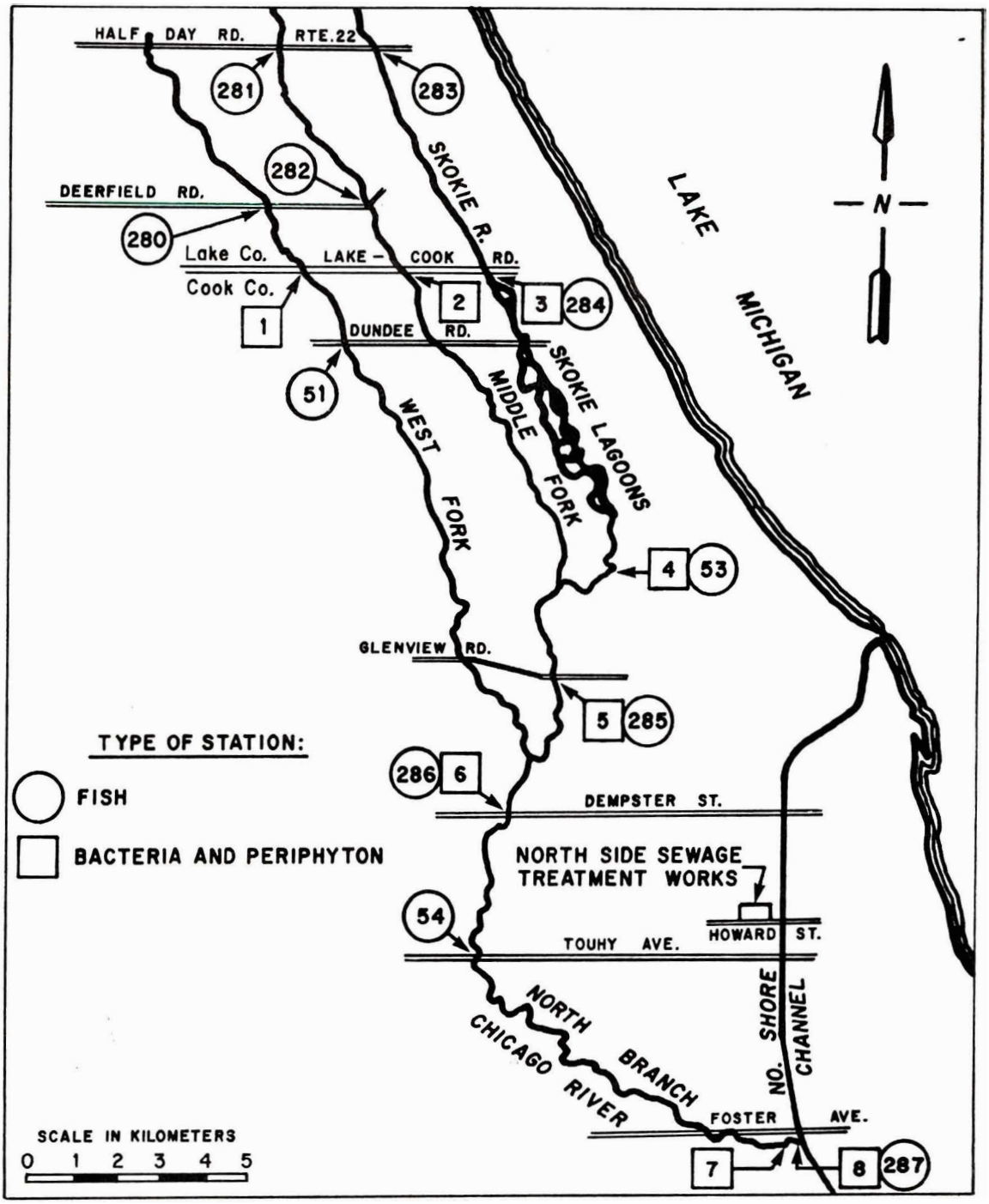

Figure 1

BACTERIA, PERIPHYTON AND FISH SAMPLING STATIONS ON THE NORTH BRANCH OF THE CHICAGO RIVER 1981

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

Bacteria

INDICATOR BACTERIA

Bacterial analyses such as total coliform (TC), fecal coliform (FC), and fecal streptococcus (FS) tests are used extensively by the District to indicate the sanitary quality of water.

STANDARD PLATE COUNT (SPC)

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

PSEUDOMONAS AERUGINOSA

This ubiquitous organism is a causative agent of outer and middle ear infections, chronic ulcerations of the skin, and many burn and wound infections.

SALMONELLA

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

Periphyton

PERIPHYTON POPULATION ANALYSIS

Algae are the base of all aquatic food chains by virtue of their ability to convert inorganic substances to organic sub-

stances through the process of photosynthesis which is dependent on the availability of light (turbidity) and the presence of chlorophyll.

Periphyton are generally defined as microfloral growth on a substrate. This definition includes a variety of zoogleal and filamentous bacteria, protozoans, rotifers, algae, and associated trapped organisms (11). In this study, only the algal fraction was analyzed. The periphytic algae were preferentially sampled and analyzed because they are the most numerous under the conditions where the littoral zone approximates the surface area such as in streams or rivers. They are stationary, therefore, exposed to all the variations in concentration levels of constituents in the surface water.

Because of their short generation times, periphyton algae are very responsive to their environment. A clean, undisturbed water environment produces a great variety of periphyton algal species with none dominant in terms of density. An environment rich in the major nutrients (nitrogen, phosphorus, and potassium), carbon dioxide, and trace elements produces a high density population of periphyton algae with one to several dominant species. Toxic levels of compounds in an environment tend to reduce both the density of periphyton organisms and the number of species.

CHLOROPHYLL a

The concentrations of chlorophyll a are a measure of photosynthetic potential and biomass of chlorophyllous organ-

isms. According to Weber (12) the chlorophyll content of the biomass grown in relatively clean waters is one to two percent.

ORGANIC MATTER

The organic matter content of a sample is a measure of the total biomass. This biomass may be made up of chlorophyllous and nonchlorophyllous organisms and the latter may be significant in water degraded by dissolved or particulate organic enrichment (12).

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 (1,2,3,4,5,6). Fish occupy the upper levels of the aquatic food chains as the ultimate aquatic consumer. Therefore, 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 fish species in a stream and the numerical relationships of these species provides an excellent biological picture of the watercourse and its well being. When such information is available over a long period of time, fishes can be one of the most sensitive indicators of the quality of the aquatic environment (13).

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, October, and November. Periphyton samples were collected biweekly beginning February 25, and ending December 16. Fish samples were collected in June, July, and November.

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TABLE 1

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

Station Number	Locations
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)

*Figure 1 for map of station locations

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TABLE 2

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

Station Number	Locations
Cook County	
51	West Fork, NBCR, River Mile 27.2, upstream and downstream of Dundee Road, T42N/R12E/S9NE, Northbrook
282	Middle Fork, NBCR, River Mile 28.6 upstream of Lake-Cook Road, T43N/R12E/S34SW, Deerfield and downstream of Lake-Cook Road, T42N/R12E/S3NE, Northbrook
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)

Station Number	Locations
Lake County	
289	West Fork, NBCR, River Mile 32.2-32.8, downstream of Half Day Road, T43N/R11E/S13SE, Lincolnshire
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 and downstream of Half Day Road, T43N/R12E/S15SW, Highland Park

*Figure 1 for location of fish sampling stations.

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 chlorine. All samples were taken at the stream surface in the center of the waterway on the upstream side of the bridge. The samples were transported on ice to the Research and Development Laboratory in Stickney, Illinois. Analyses were begun approximately six hours after collection of the first sample and within two hours of collection of the last sample.

INDICATOR BACTERIA (TC, FC, AND FS)

Total coliform, FC, and FS analyses were performed according to Standard Methods (11). Typical and atypical colonies were confirmed. Typical colonies for TC were red with a greenish metallic sheen, atypical colonies varied in color, shape, or size of the colonies. Typical colonies for FC were blue, atypical colonies varied in color, shape, or size. Typical colonies for FS were salmon to red in color, atypical colonies varied in color, shape, or size.

STANDARD PLATE COUNT (SPC)

Standard plate counts were performed according to Standard Methods (11).

PSEUDOMONAS AERUGINOSA

Pseudomonas aeruginosa analyses were performed and con-

firmed according to a most probable number (MPN) procedure described in Standard Methods (11).

SALMONELLA

Salmonella were estimated using a modification of the MPN technique described by Kenner and Clark (14). Presumptive Salmonella were identified biochemically using the Analytical Profile Index (API-20) system for identification of Enterobacteriaceae. Confirmation of isolates was performed with polyvalent Salmonella "O" antisera. Verification and further serotyping of the isolates were performed by the Illinois Department of Public Health and to increase confidence in the results several isolates were submitted in duplicate and triplicate to assess the accuracy of the serotyping.

Periphyton

Samplers for periphyton consisted of a plastic cage containing eight microscope slides, held in a vertical position to prevent sedimentation of suspended solids. The cage was kept suspended one centimeter below the surface of the water by floats. These samplers were anchored in place with a lead line attached to a stationary object on the river bank. Periphyton were allowed to develop on the glass slides for a period of two weeks. After this period of growth, the entire cage was replaced and the slides were wrapped in aluminum foil and kept iced until delivered to the laboratory. In the laboratory the slides were removed from the cages and randomly segregated for each analysis. Generally, two slides each were used for the

diatom, nondiatom, chlorophyll a, and biomass determinations to insure proper representation of specimens and material.

PERIPHYTON POPULATION ANALYSIS

After digestion, sample aliquots were mounted as appropriate for diatom analysis (12) and examined microscopically (x800) for identification and enumeration of the organisms.

After the nondiatoms were fixed by glutaraldehyde and concentrated by sedimentation, a volume of 0.1 milliliters was mounted on a slide. These organisms were identified and enumerated at a total magnification of 640. The convention for counting both diatoms and nondiatoms was to count 300 microscopic fields or 500 organisms (short count), whichever came first. Total counts, diatoms plus nondiatoms, were calculated and expressed as organisms per square centimeter of developed slide area.

Populations for individual species were determined and the Shannon-Weaver species diversity index computed (12). Using this index and the number of species, the equitability of the sample was calculated using the tables devised by Lloyd and Ghelardi (12).

CHLOROPHYLL A

The extracts were centrifuged at over 500 x g for approximately 20 minutes to remove turbidity and the supernatant scanned in a Beckman DK-2A Spectrophotometer (bandpass six nanometers at 663 nanometers) from 750 to 600 nanometers. The United Nations Educational, Scientific, and Cultural Organi-

zation (UNESCO) equations for chlorophyll a (trichromatic method) were used to determine chlorophyll a concentrations in the extract and extrapolated to the original sample (12).

ORGANIC MATTER

Slides dried at 105°C were cooled in a desiccator and weighed. They were then ashed in a muffle furnace at 550 to 600°C for one-half hour, cooled, and weighed again. The difference in weight (the ash-free dry weight) is, by definition, the organic matter. The yields of organic matter were stanhdardized to weight of organic matter per square centimeter of developed microscope slide.

The autotrophic index (AI), relating the organic matter content to the chlorophyll a content, was calculated using Weber's equations (12) as follows:

$$\text{Autotrophic Index} = \frac{\text{Ash-free Weight}(mg/m^2)}{\text{Chlorophyll a } (mg/m^2)}$$

Fish

During 1981, 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 along a total of 80 meters of shoreline. When the stream was narrow, an 80 meter section on only one side was sampled (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 10-15 percent formalin and identified, weighed, and measured in the laboratory.

RESULTS

Bacteria

Sampling runs for bacterial analyses were performed on May 5, July 7, October 6, and November 4, 1981. Geometric means of the resultant data are presented in Table 3.

INDICATOR BACTERIA

Total Coliform. The three forks of the NBCR at Lake Cook Road differ in TC counts with geometric means of 1.2×10^3 TC per 100 milliliters in the Skokie River, 1.1×10^4 TC per 100 milliliters in the Middle Fork NBCR, and 8.7×10^4 TC per 100 milliliters in the West Fork NBCR. The Skokie River TC counts increased to a geometric mean of 1.0×10^4 TC per 100 milliliters at West Frontage Road. There was no increase in the geometric mean of TC counts after the confluence of the Skokie River with the Middle Fork NBCR at Glenview Road. After the confluence of this combined stream with the West Fork NBCR above Dempster Street, there was an increase in TC counts to 5.0×10^5 TC per 100 milliliters. A decrease in TC counts occurred between Dempster Street and Albany Avenue and Winona Street where the counts were 1.5×10^4 TC per 100 milliliters (Table 3). The confirmation rate for TC (Table 4) during this study for typical colonies was 62.8 percent. A normal range for confirmation rates is 60 to 70 percent for colonies presumed to be TC.

Fecal Coliform. Each of the three forks of the NBCR at Lake-Cook Road differed in FC counts. A geometric mean of 8.5×10^1 FC per 100 milliliters was found in the Skokie River. At

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TABLE 3

GEOMETRIC MEAN OF BACTERIAL COUNTS FOR THE NORTH BRANCH OF THE CHICAGO RIVER (NBCR) 1981

Station Number (Figure 1)	TC[1]	FC[2]	FS[3]	SPC[4]	P. aeruginosa[5]	Salmonella
	Counts*					
Lake-Cook Road (1) West Fork NBCR	8.7×10^{4}	1.3×10^{4}	2.2×10^{3}	7.2×10^{4}	6.0×10^{2}	$<4.2 \times 10^{-1}$
Lake-Cook Road (2) Middle Fork NBCR	1.1×10^{4}	1.0×10^{3}	7.5×10^{2}	2.9×10^{4}	3.1×10^{2}	$<1.5 \times 10^{-1}$
Lake-Cook Road (3) Skokie River	1.2×10^{3}	8.5×10^{1}	4.6×10^{1}	5.2×10^{3}	2.7×10^{2}	$<1.6 \times 10^{-1}$
West Frontage Road to Edens Expressway (4) Skokie River	1.0×10^{4}	2.7×10^{3}	8.1×10^{2}	1.7×10^{4}	2.5×10^{2}	$<1.5 \times 10^{-1}$
Glenview Road (5) North Branch of Chicago River	1.3×10^{4}	2.4×10^{3}	7.4×10^{2}	3.9×10^{4}	4.7×10^{2}	$<1.5 \times 10^{-1}$
Dempster Street (6) North Branch of Chicago River	5.0×10^{5}	3.3×10^{4}	5.7×10^{3}	2.0×10^{5}	4.6×10^{3}	$<2.6 \times 10^{-1}$
Albany Avenue and Winona Street (8) North Branch of Chiicago River	1.5×10^{4}	4.1×10^{3}	1.2×10^{3}	2.8×10^{4}	4.1×10^{2}	$<2.0 \times 10^{-1}$

[1]TC = Total Coliform, [2]FC = Fecal Coliform, [3]FS = Fecal Streptococcus, [4]SPC = Standard Plant Count, [5]P. aeruginosa = Pseudomonas aeruginosa

*Values shown are the geometric average of four samples taken May 5, July 7, October 6, and November 4, 1981 and are given as counts per 100 milliliters except for SPC which is given as counts per milliliter.

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TABLE 4

TOTAL COLIFORM (TC), FECAL COLIFORM (FC), AND FECAL STREPTOCOCCUS (FS) COLONY CONFIRMATIONS IN THE NORTH BRANCH OF THE CHICAGO RIVER DURING 1981

	TC		FC		FS	
	Typical* Colonies	Atypical** Colonies	Typical Colonies	Atypical Colonies	Typical Colonies	Atypical Colonies
Number of Colonies Confirmed	93	4	124	5	167	2
Number of Colonies Tested	148	30	143	26	173	2
Percent Confirmed	62.8	13.3	90.2	19.2	96.5	100

*Typical Colonies - TC, red with greenish metallic sheen; FC, blue; FS, salmon to red.
**Atypical Colonies - Variations in color, size, or shape of typical colonies.

the Middle Fork NBCR the geometric mean of the FC counts was 1.0 x 10^3 per 100 milliliters, while at the West Fork NBCR the geometric mean of the FC counts was 1.3 x 10^4 per 100 milliliters (Table 3). There was an increase in the geometric means of the FC counts in the Skokie River to 2.7 x 10^3 per 100 milliliters at West Frontage Road. There was no change in the geometric means of the FC counts when the Skokie River combined with the Middle Fork NBCR at Glenview Road, but the geometric means of the FC counts increased with the confluence of the West Fork NBCR to 3.3 x 10^4 FC per 100 milliliters at Dempster Street. No change in the geometric means of FC counts occurred over the following ten mile reach to the confluence with the NSC.

The confirmation rate for typical FC colonies (Table 4) tested during this study was 90.2 percent as compared to 94.9 percent in 1980. The normal range of FC confirmations was 90 to 95 percent (15).

Fecal Streptococcus. The station located on Lake-Cook Road and the Skokie River with a geometric mean FS count of 4.6 x 10^1 per 100 milliliters differed by an order of magnitude from the 7.5 x 10^2 FS per 100 milliliters at Middle Fork NBCR and two orders of magnitude from the 2.2 x 10^3 FS per 100 milliliters at West Fork NBCR. The latter two stations exhibited little difference between them. The geometric mean of the FS counts in the Skokie River at Lake-Cook Road increased to 8.1 x 10^2 FS per 100 milliliters at West Frontage Road. No further change occurred in the FS counts in the NBCR to its confluence with the NSC (Table 3).

The confirmation rate for the identification of typical and atypical colonies presumed to be FS in this study was 96.5 (Table 4) compared to 96.5 percent in 1980. The normal range of confirmation rates for FS is 90 to 100 percent (15).

STANDARD PLATE COUNTS

The SPC geometric means varied from a low of 5.2×10^3 to a high of 2.0×10^5 per milliliter in the NBCR and its forks. The low SPC geometric mean of 5.2×10^3 per milliliter occurred at Lake-Cook Road and the Skokie River which differed significantly from the 7.2×10^4 SPC per milliliter at Lake-Cook Road and the West Fork NBCR and the 2.0×10^5 SPC per milliliter at Dempster Street after confluence of the NBCR with the West Fork NBCR. Counts at the remaining stations varied only slightly (Table 3).

PSEUDOMONAS AERUGINOSA

The densities of P. aeruginosa at all stations, given as geometric means, ranged from 2.5×10^2 to 4.6×10^3 per 100 milliliters (Table 3).

SALMONELLA

No significant variation in Salmonella counts was observed, the counts at all stations of the NBCR being on the order of 10^{-1} per 100 milliliters (Table 3).

Geldreich (16) reported that Salmonella occurred in less than 27.6 percent of fresh water samples when the FC concentration was 200 or less per 100 milliliters. In this study Sal-

monella were recovered in one of two samples which contained less than 200 FC per 100 milliliters.

Geldreich also reported that the frequency of Salmonella rose to 85.2 percent when FC counts were in the range of 200 to 2,000 per 100 milliliters. For this range of FC in the NBCR during 1981, only six of 26 samples (26.1 percent) were found to contain Salmonella, considerably fewer positives than predicted by Geldreich.

Serotyping of the Salmonella spp. isolated produced the species data presented in Table 5. All of the species listed are routinely isolated in clinical laboratories in the metropolitan Chicago area.

Periphyton

Periphyton samples were collected on a biweekly basis beginning February 25 and ending December 16. A total of 20 sampling runs were made during 1981. Of a possible 140 samples, 117 were collected and analyzed (85 percent sampler recovery) for periphyton population densities and species composition, chlorophyll a concentration, and organic matter concentration.

PERIPHYTON POPULATION ANALYSIS

For the stations sampled in the NBCR and its forks, the average periphyton concentration ranged from 61,000 organisms per square centimeter at North Central Park Avenue, the farthest downstream station in the NBCR study area, to 294,000 organisms per square centimeter at Lake-Cook Road in the West Fork NBCR

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TABLE 5

SALMONELLA SEROTYPES ISOLATED FROM THE NORTH BRANCH OF THE CHICAGO RIVER (NBCR) DURING 1981

Date	Station*	Serotype	Number Isolated
5/5/81	West Fork NBCR and Lake-Cook Road	S. mississippi	1
		S. anatum	1
		S. typhimurium	3
5/5/81	Skokie River and Lake-Cook Road	S. agona	1
5/5/81	NBCR and Dempster Street	S. anatum	3
		S. heidelberg	1
7/7/81	West Fork NBCR and Lake-Cook Road	S. enteritidis	2
10/6/81	NBCR and Albany and Winona	S. typhimurium	1
		S. oranienburg	1
11/3/81	West Fork NBCR and Lake-Cook Road	S. typhimurium	1
11/3/81	NBCR and Dempster Street	S. chester	1

*Description of stations in Table 1 and locations in Figure 1.

(Table 6), one of the farthest upstream stations (Figure 1). As shown in Table 6, the average periphyton population densities generally decreased with distance downstream.

The average number of species per station (Table 6) varied in the forks of the NBCR from 33.3 at Lake-Cook Road in the West Fork NBCR to 38.8 at Lake-Cook Road in the Skokie River. The average number of species in the Skokie River increased to 43.7 at West Frontage Road. The average number of species remained approximately the same in the NBCR after confluence with the Middle and West Forks of the NBCR at Glenview Road and Dempster Street, respectively. Over the ten mile reach between Dempster Street and North Central Park Avenue, in the NBCR, the average number of species decreased to 34.3.

The species appearing in one-half or more of the samples collected at each station were defined as persistent species and their number per station is presented in Table 7. Those upstream stations located on the forks of the NBCR on Lake-Cook Road contained 25 to 28 of these persistent species. The number of persistent species increased in the Skokie River to 38 at West Frontage Road and remained at 38, after confluence of the Skokie River with the Middle Fork of the NBCR, at Glenview Road. However, after confluence of the NBCR with the West Fork of the NBCR, the number of persistent species decreased to 34 at Dempster Street in the NBCR and ten miles farther downstream to 22 species at the North Central Park Avenue station.

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TABLE 6

ANALYSES OF PERIPHYTON SAMPLES COLLECTED FROM THE NORTH BRANCH OF THE CHICAGO RIVER (NBCR) DURING 1981

Station Name	Numb r	Geometric Mean of Periphyton Densities (organisms/cm^2)	Average Number of Periphyton Specie Per Sample	Shannon-Weaver Diversity Index	Equitability	Average Organic Matter ($\mu g/cm^2$)	Concentration of Chlorophyll ($\mu g/cm^2$)	Autotrophic Index
West Fork NBCR	1	293,528	33.3	1.4706	0.0289	316.3	2.832	111.7
Middle Fork NBCR	2	148,192	38.3	3.1524	0.1040	194.3	0.690	281.6
Skokie River	3	237,425	38.8	2.1370	0.0484	275.0	1.344	204.6
Frontage Road	4	209,063	43.7	3.2669	0.0848	630.6	1.477	426.9
Glenview Road	5	163,577	41.5	2.9914	0.1047	219.5	1.237	177.4
Dempster Street	6	70,782	42.4	3.0592	0.1043	160.0	0.413	387.4
North Central Park Avenue	7	60,747	34.3	2 5956	0.0661	193.3	0.251	770 1

*Figure 1.

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TABLE 7

SUMMARY OF ALGAL SPECIES DATA, BY STATION, RELATED TO FREQUENCY OF APPEARANCE AND THE PRESENCE OF POLLUTANT-TOLERANT SPECIES IN THE NORTH BRANCH OF THE CHICAGO RIVER DURING 1981

Name of Station	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	20	17	19	18	12	13	19
Number of Species**	25	27	28	38	38	34	22
Number of Pollutant-Tolerant Species***	10	15	14	18	19	19	13
Percent Pollutant-Tolerant Species	40.0	55.6	50.0	47.4	50.0	55.9	59.1

*Figure 1 for station locations.
**Number of species appearing at a frequency > 50 percent of the samples collected at each station (Persistent Species).
***Pollutant tolerant species as listed by Palmer (17).

The number of persistent species were further subdivided by segregating those organisms defined by Palmer (17) as pollutant-tolerant. The results of this segregation are presented in Table 7. The number of pollutant-tolerant species found at the, upstream stations, located on the forks of the NBCR at Lake-Cook Road, ranged from 10 to 15 species. At West Frontage Road in the Skokie River, the number of pollutant-tolerant species increased to 18, at Glenview Road, after confluence of the Skokie River and the Middle Fork of the NBCR, the number of pollutant-tolerant species increased to 19 and at Dempster Street, after confluence of the NBCR with the West Fork NBCR, the number of pollutant-tolerant species was 19. A decrease in the number of pollutant-tolerant species was observed at North Central Park Avenue in the NBCR to 13 species.

CHLOROPHYLL a

The results of periphyton chlorophyll a analyses are reported in Table 6 as averages for each station sampled on the NBCR and its forks. Chlorophyll a is one to two percent of the total periphyton biomass grown in surface waters relatively free of organic contamination (12) and consequently is an estimate of the biomass.

ORGANIC MATTER

As with chlorophyll a the ash-free dry weight is a measure of the organic matter content or biomass of a sample. The aver-

age organic matter content for each station is presented in Table 6.

AUTOTROPHIC INDEX

The autotrophic index is the ratio of the organic matter concentration to the chlorophyll a concentration (12). When the ratio exceeds 100 the presumption is that there is soluble or particulate organic contamination present resulting in the growth of excess nonchlorophyllous microorganisms. The autotrophic index results are presented in Table 6 for each station on the NBCR.

EQUITABILITY AND DIVERSITY INDEX

Equitability is a measure of the evenness of the distribution of species within a population compared to a theoretical distribution based on the Shannon-Weaver species diversity index (12). The diversity index and equitability were calculated for each station and are presented in Table 6. Equitabilities normally range from zero to one (12) except in the unusual circumstance where the actual distribution is more even than the theoretical model of a natural distribution (12). Values of equitability of 0.5 indicate slight organic contamination and values from 0.3 to zero indicate moderate to severe organic contamination. During 1981, all samples collected from the NBCR had equitability values less than 0.3 as shown in Table 6.

Fish

The catch of fish per 10 minutes electrofishing for the Cook County and Lake County collections are presented in Tables

8 and 9, respectively. The total number of species and the average number and weight of fish per 10 minutes electrofishing are presented in Table 10 for the forks of the NBCR and collectively for the stations farther downstream. Table 11 presents the percent composition by number and weight of fish collected per 10 minutes electrofishing for the forks of the NBCR and collectively for the stations farther downstream. Comparisons of the fish collections from the NBCR and other waterways of the Chicagoland area are presented in Table 12. Complete data on the 1981 fish collections from the NBCR and its forks are listed in Appendix Tables AI-1 through AI-6.

TABLE 8
NUMBER OF FISH TAKEN PER TEN MINUTES ELECTROFISHING
FROM THE NORTH BRANCH OF THE CHICAGO RIVER (NBCR)
AND ITS FORKS IN COOK COUNTY DURING 1981

Fish Species	Station Number and Location*						
	West Fork NBCR 51 Dundee Road	Middle Fork NBCR 282 Lake-Cook Road	Skokie River 284 Lake-Cook Road	Skokie River 33 W. Frontage Road	NBCR 285 Glenview Road	NBCR 286 Dempster Street	NBCR 287 Albany Avenue
	Number of Fish Per Ten Minutes Electrofishing						
Goldfish		0.38					
Carp	0.15	0.45	0.54	0.37	0.45		
Carp x Goldfish Hybrid	0.15						
Golden shiner	1.37						
Fathead minnow	0.30	0.64		7.38	2.24	0.93	
White sucker		2.63		0.19			
Black bullhead				1.01		0.93	
Black bullhead (young-of-the-year)				42.88			
Green sunfish	11.53	7.99	3.44	12.27	10.71	11.59	4.35
Pumpkinseed		0.19		0.46	0.30		
Orangespotted sunfish			0.37	0.46			
Bluegill	0.46	1.35		0.64	0.23	4.03	

Table continued on following page.

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TABLE 8 (continued)

NUMBER OF FISH TAKEN PER TEN MINUTES ELECTROFISHING
FROM THE NORTH BRANCH OF THE CHICAGO RIVER (NBCR)
AND ITS FORKS IN COOK COUNTY DURING 1981

Fish Species	Station Number and Location*						
	West Fork NBCR 51 Dundee Road	Middle Fork NBCR 282 Lake-Cook Road	Skokie River 284 Lake-Cook Road	Skokie River 33 W. Frontage Road	NBCR 285 Glenview Road	NBCR 286 Dempster Street	NBCR 387 Albany Avenue
	Number of Fish Per Ten Minutes Electrofishing						
Bluegill (young-of-the year)						6.8	
Green x Bluegill hybrid				0.19			
Largemouth bass	0.91	0.45		1.06	0.67	0.62	
Black crappie					0.23	0.31	
Total Number Per Ten Minutes	14.86	14.08	4.35	66.91*	14.83	25.23**	4.35

*Station numbers and locations keyed to Figure 1.
**Total is 24.03 fish per ten minutes without black bullhead youn-of-the-year.
***Total is 18.41 fish per ten minutes without bluegill young-of-the-year.

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TABLE 9

NUMBER OF FISH TAKEN PER 10 MINUTES ELECTROFISHING
FROM THE FORKS OF THE NORTH BRANCH
OF THE CHICAGO RIVER IN LAKE COUNTY
DURING 1981

Fish Species	Station Number and Location*		
	289 Half Day Road West Fork	281 Half Day Road Middle Fork	283 Half Day Road Skokie River
	--------Number of Fish Per 10 Minutes Electrofishing------		
Carp			1.30
Carp x Goldfish Hybrid			0.26
Golden shiner		0.79	0.26
Fathead minnow	0.68	2.36	2.60
Black bullhead		0.39	
Green sunfish		17.70	3.64
Bluegill	0.34	12.98	0.26
Green x Bluegill Hybrid		0.39	
Largemouth bass	2.70	0.79	
Black crappie		0.79	0.26
Total Number Per 10 Minutes Electrofishing	3.72	36.19	8.58

*Figure 1

TABLE 10

TOTAL NUMBER OF FISH SPECIES COLLECTED AND AVERAGE NUMBER AND WEIGHT OF FISH TAKEN PER 10 MINUTES ELECTROFISHING IN THE FORKS AND THE DOWNSTREAM STATIONS OF THE NORTH BRANCH OF THE CHICAGO RIVER DURING 1981

Parameter	West Fork[1] NBCR	Middle Fork[2] NBCR	Skokie River	Downstream Stations NBCR
Total Number of Species (Hybrids Not Included)	6	11	11	8
Average Number of Fish Per 10 Minutes Electrofishing	11	21	13[5]	14[6]
Average weight of Fish (in grams) per 10 Minutes Electrofishing	79	392	509[5]	40[6]

[1]Stations 51 and 289, Figure 1.

[2]Stations 281 and 282, Figure 1.

[3]Stations 53, 283, and 284, Figure 1.

[4]Stations 285, 286, and 297, Figure 1.

[5]Young-of-year bullheads from the July collection at West Frontage Road (Station 53) not included.

[6]Young-of-year bluegill from the July collection at Dempster Street (Station 286) not included.

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TABLE 11

PERCENTAGE COMPOSITION BY NUMBER (% N) AND BY WEIGHT (%WT) OF FISH COLLECTED FROM THE NORTH BRANCH OF THE CHICAGO RIVER DURING 1981

Fish Species	West Fork		Middle Fork		Skokie River		North Branch Lower Channel	
	% N	% Wt	% N	% Wt	% N	% Wt	% N	% Wt
Goldfish			1.34	9.83				
Carp	1.33	3.15	0.67	1.72	6.02	83.61		
Carp x Goldfish hybrid	1.33	59.88			0.60	4.12		
Golden shiner	9.33	3.19	1.34	0.39	0.60	0.02		
Fathead minnow	4.00	0.17	5.37	1.35	30.12	0.20	11.02	1.34
White sucker			4.70	32.66	0.60	0.01		
Black bullhead			0.67	0.38	1.81*	0.40*	2.54	0.16
Green sunfish	60.00	32.02	57.05	38.95	50.60	10.10	66.10	94.47
Pumpkinseed			0.67	0.36	1.20	0.07	0.85	0.37
Orangespotted sunfish					1.81	0.27		
Bluegill	5.33	0.61	24.16	12.74	2.41	0.14	11.86**	1.75**
Green x Bluegill hybrid			0.67	0.59	0.60	0.92		
Largemouth bass	18.67	0.98	2.01	0.07	3.01	0.14	4.24	1.29
Black crappie			1.34	0.96	0.60	0.01	1.69	0.50
Total Number of Species (Hybrids Not Included)	6		11		11		8	

*Does not include 240 black bullhead young-of-the-year from July collection at Station 53, West Frontage Road, Skokie River; because only one swarm was sighted, the distribution was extremely patchy.

**Does not include 22 bluegill young-of-the-year from July collection at Station 286, Dempster Street, North Branch Chicago River, because these young were so small that most escaped through the mesh of the collection nets. To count the young retained would bias the data.

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TABLE 12

AVERAGE CATCH PER 10 MINUTES ELECTROFISHING FOR BACKPACK/SEINE COLLECTIONS FROM THE CHICAGO WATERWAYS[1,2]

Waterway	Year	Number of Collections	Drainage Area (Square Miles)	Number of Species Per Collection		Average Fish Per 10 Minutes Electrofishing	
				Average	Maximum	Number	Weight (g)
Jackson Creek[3]	1976	7	52.7	9.1	19	78	618
Mill Creek[3]	1976	5	65.3	8.4	10	87	856
Hickory Creek[3]	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
North Branch Chicago River	1981	16	113	4.3	7	15	260
Salt Creek[3]	1976	6	150	4.0	13	11	262
Nippersink Creek[4]	1976	9	205	6.8	14	61	657
Little Calumet River	1976	13	291	1.9	5	15	235
DuPage River[3]	1976	14	376	8.7	15	134	2,889

[1]All 1976 data from Reference 2 (Dennison, 1978).

[2]All 1980 data from Reference 3.

[3]Tributary to Des Plaines River.

[4]Tributary to Fox River.

DISCUSSION

Bacteria

INDICATOR BACTERIA

Total Coliform. The TC counts increased significantly from Lake-Cook Road to West Frontage Road, on the Skokie River, from 1.2×10^3 to 1.0×10^4 per 100 milliliters, Table 3. No change in TC counts was noted at the confluence of the Skokie River with the Middle Fork NBCR to form the NBCR above Glenview Road. The TC counts in the Middle Fork NBCR at Lake-Cook Road were 1.1×10^4 per 100 milliliters and after the confluence with the Skokie River the TC counts at Glenview Road were 1.3×10^4 per 100 milliliters (Table 3). The TC counts did increase after confluence of the NBCR with the West Fork NBCR at Dempster Street. The West Fork NBCR at Lake-Cook Road had TC counts of 8.7×10^4 per 100 milliliters and after the confluence with the NBCR, the TC counts increased to 5.0×10^5 per 100 milliliters at Dempster Street (Table 3). A significant reduction in TC occurred over the 10 mile reach to the confluence of the NBCR with the NSC. The TC counts in the NBCR at Albany Avenue and Winona Street were 1.5×10^4 per 100 milliliters (Table 3) just above the confluence of the NBCR with the NSC.

Fecal Coliform. The FC counts increased significantly in the Skokie River from Lake-Cook Road (8.5×10^1 per 100 milliliters) to West Frontage Road (2.7×10^3 per 100 milliliters). Confluence of the Skokie River with the Middle Fork NBCR showed no change in FC counts. The FC counts in the Middle Fork NBCR at Lake-Cook Road were 1.0×10^3 per 100 milliliters and the FC

counts in the NBCR at Glenview Road, after confluence with the Skokie River, were 2.4×10^3 per 100 milliliters (Table 3). The confluence of the NBCR with the West Fork NBCR resulted in a significant increase of FC at Dempster Street in the NBCR. The West Fork NBCR at Lake-Cook Road had FC counts of 1.3×10^4 per 100 milliliters and below the confluence with the NBCR at Dempster Street the FC counts in the NBCR were 3.3×10^4 per 100 milliliters. During the flow of the NBCR over the next ten-mile reach, to the confluence with the NSC, the FC counts were reduced to 4.1×10^3 per 100 milliliters at Albany Avenue and Winona Street.

The "General Use" criteria set by the IPCB sets a limit of 200 FC colony forming units per 100 milliliters as a geometric average of no less than five samples collected over a 30-day period. The geometric average of the stations do not apply and cannot be compared on the basis of this criterion since only four samples were collected over a period of 183 days. On the basis that seven samples were collected each date, and that for each date the geometric average exceeded the IPCB limit of 200 FC per 100 milliliters, it can be said that the NBCR and its forks contain water of degraded quality.

Fecal Streptococcus. The FS counts in the Skokie River increased from 4.6×10^1 per 100 milliliters at Lake-Cook Road to 8.1×10^2 per 100 milliliters at West Frontage Road (Table 3). The confluence of the Skokie River with the Middle Fork NBCR produced no change in FS counts. The FS counts in the Middle Fork NBCR at Lake-Cook Road were 7.5×10^2 per 100 milliliters,

and at Glenview Road in the NBCR, after the confluence of the Skokie River and the Middle Fork NBCR, the FS counts were 7.4 x 10^3 per 100 milliliters. There was an increased FS count from 7.4 x 10^2 per 100 milliliters at Glenview Road to 5.7 x 10^3 per 100 milliliters at Dempster Street after confluence of the NBCR with the West Fork NBCR. The West Fork NBCR, at Lake-Cook Road, had an FS count of 2.2 x 10^3 per 100 milliliters (Table 3 and Figure 1). A slight decrease in FS counts occurred during the ten-mile reach between Dempster Street (5.7 x 10^3 FS per 100 milliliters) and Albany Avenue and Winona Street (1.2 x 10^3 FS per 100 milliliters) in the NBCR above the confluence with the NSC.

STANDARD PLATE COUNTS

The SPC were an estimate of the total bacterial population present in the system. The SPC increased in the Skokie River from Lake-Cook Road (5.2 x 10^3 per milliliter) to West Frontage Road (1.7 x 10^4 per milliliter) Table 3. Confluence of the Skokie River with the Middle Fork NBCR showed no increased SPC at Glenview Road in the NBCR. The SPC in the Middle Fork NBCR at Lake-Cook Road was 2.9 x 10^4 per milliliter and after confluence with the Skokie River the SPC in the NBCR at Glenview Road was 3.9 x 10^4 per milliliter (Table 3). The SPC in the West Fork NBCR at Lake-Cook Road was 7.2 x 10^4 per milliliter and after confluence with the NBCR the SPC counts at Dempster Street in the NBCR was 2.0 x 10^5 per milliliter (Table 3). During the ten-mile reach between Dempster Street and Albany

Avenue and Winona Street in the NBCR the SPC were reduced to 2.8 x 10^4 per milliliter prior to the confluence of the NBCR with the NSC (Table 3).

The levels of SPC were comparable to those found in Chicago's deep-draft waterways (1,2,3).

PSEUDOMONAS AERUGINOSA

No changes in P. aeruginosa were noted in the Skokie River from Lake-Cook Road (2.7 x 10^2 per milliliter) to West Frontage Road (2.5 x 10^2 per milliliter) Table 3. Confluence of the Skokie River with the Middle Fork NBCR showed no increase in P. aeruginosa at Glenview Road in the NBCR below this confluence. The P. aeruginosa counts in the Middle Fork NBCR at Lake-Cook Road were 3.1 x 10^2 per milliliter and the P. aeruginosa counts at Glenview Road in the NBCR were 4.7 x 10^2 per milliliter (Table 3). Confluence of the NBCR with the West Fork NBCR resulted in an increased concentration of P. aeruginosa at Dempster Street in the NBCR. The P. aeruginosa counts at Lake-Cook Road in the West Fork NBCR were 6.0 x 10^2 per milliliter and the P. aeruginosa counts at Dempster Street in the NBCR were 4.6 x 10^3 per milliliter (Table 3). During the following ten mile reach to Albany Avenue and Winona Street, just prior to the confluence of the NBCR with the NSC, the number of P. aeruginosa were reduced to 4.1 x 10^2 (Table 3).

SALMONELLA

All of the Salmonella results were reported at the detection limit or less. The range of values was from less than 1.5 X 10^{-1} to less than 4.2 x 10^{-1} per 100 milliliters (Table 3) indicating no real differences between the stations sampled on the NBCR and its forks.

Periphyton

PERIPHYTON POPULATION ANALYSIS

In the Skokie River from Lake-Cook Road to West Frontage Road, the average periphyton density decreased from 237,000 organisms per square centimeter to 209,000 organisms per square centimeter, a decrease of ten percent (Table 6). The average number of species increased in the Skokie River from Lake-Cook Road to West Frontage Road from 39 to 44 species, an increase of about 13 percent Table 6. Because some stations are more likely than others to contain ephemeral, opportunistic, accidental, or rare species, it was decided to also look at those species that persisted in the environment sampled. These persistent species were defined as those that appeared with a frequency of 50 percent or more at each station. The number of persistent species increased in the Skokie River from Lake-Cook Road to West Frontage Road, from 28 to 38 species, an increase of 36 percent (Table 7). A subset of these persistent species were those species defined by Palmer (17) as being pollutant-tolerant. These pollutant-tolerant species increased in the Skokie River

from Lake-Cook Road (14 species) to West Frontage Road (18 species), an increase of 29 percent (Table 7). Thus, the rate of pollutant-tolerant species increase (29 percent) was lower than the rate of persistent species increase (36 percent) indicating a desirable trend in water quality. The water quality was still considered poor, however, when the number of pollutant-tolerant species among the persistent species was examined. On the Skokie River at Lake-Cook Road, 50 percent of the persistent species were pollutant-tolerant and at West Frontage Road 47.4 percent of the persistent species were pollutant-tolerant.

Confluence of the Skokie River with the Middle Fork of the NBCR, results in the formation of the NBCR. The average periphyton density in the Middle Fork of the NBCR at Lake-Cook Road was 148,000 organisms per square centimeter and was composed of an average of 38 species (Table 6). The average number of persistent species was 27, of which 15, or 55.6 percent, were pollutant-tolerant species (Table 7). At Glenview Road in the NBCR, after the confluence of the Middle Fork NBCR with the Skokie River, the average periphyton density was 164,000 organisms per square centimeter (Table 6). This was approximately the average of the periphyton densities found at West Frontage Road in the Skokie River and Lake Cook Road in the Middle Fork NBCR. The average number of species at Glenview Road in the NBCR was 42 (Table 6). This was the average of the average number of species at West Frontage Road in the Skokie River (44 species) and Lake-Cook Road in the Middle Fork NBCR (39 spe-

cies). This indicated that the species composition in the two streams was similar. This was borne out by the fact that the average number of persistent species found at Glenview Road in the NBCR (38 species) was the same as that found at West Frontage Road in the Skokie River and included all of the 27 persistent species found at Lake-Cook Road in the Middle Fork NBCR (Table 7). Fifty percent of the persistent species found at Glenview Road in the NBCR were found to be pollutant-tolerant (Table 7).

Confluence of the NBCR with the West Fork NBCR occurred above the sampling station at Dempster Street in the NBCR. The periphyton density at Lake-Cook Road in the West Fork NBCR was 294,000 organisms per square centimeter (the highest periphyton density reported). This population was composed of 33 species on the average (Table 6). The average number of persistent species at Lake-Cook Road in the West Fork NBCR was 25 species of which 40 percent were pollutant-tolerant species (Table 7). At Dempster Street in the NBCR, below the confluence of the West Fork NBCR and the NBCR, the periphyton density was 70,800 organisms per square centimeter. The average number of species found at Dempster Street in the NBCR was 42 species, higher than the 33 species found in the West Fork NBCR at Lake-Cook Road and about the same as the 42 species found at Glenview Road in the NBCR (Table 6). This indicated that the species found in the West Fork NBCR were represented among the species found at Glenview Road in the NBCR. The number of persistent species found at Dempster Street in the NBCR was 34 species, a loss of

four among persistent species found at Glenview Road in the NBCR (Table 7). The number of pollutant-tolerant species found at Dempster Street and at Glenview Road on the NBCR was 19. The loss of 10.5 percent of the persistent species from Glenview Road in the NBCR to Dempster Street in the NBCR was not due to any loss of pollutant-tolerant species, but to a loss of pollutant-intolerant species. This suggested that a significant addition of pollutants may have occurred either in the NBCR between Glenview Road and Dempster Street, or in the West Fork NBCR between Lake-Cook Road and its confluence with the NBCR. These pollutant additions come from the numerous combined sewer overflows in the area.

After Dempster Street in the NBCR, the NBCR flows ten miles to its confluence with the NSC. The final periphyton sampling station was located approximately one mile upstream of the confluence of the NBCR with the NSC in the NBCR at North Central Park Avenue. The average periphyton density at North Central Park Avenue in the NBCR was 60,700 organisms per square centimeter, a decrease of 14 percent of the periphyton density found at Dempster Street in the NBCR (Table 6). The average number of species found at North Central Park Avenue in the NBCR was 34 species, a decrease of 19 percent from the number of species found at Dempster Street in the NBCR. The average number of persistent species found at North Central Park Avenue in the NBCR was 22, a decrease of 35 percent from the number of persistent species found at Dempster Street in the NBCR (Table 7). The number of pollutant-tolerant species found at North

Central Park Avenue was 13, a decrease of 32 percent from the number of pollutant-tolerant species found at Dempster Street in the NBCR (Table 7).

All of the periphyton population data was shown to be lower at North Central Park Avenue in the NBCR compared to Dempster Street in the NBCR, indicating stress in the aquatic environment at this station. It should be noted that at Dempster Street in the NBCR that the periphyton density and the average number of persistent species had already been reduced from the values found upstream. These data indicated that a significant addition of pollutants occurred in the NBCR between Dempster Street and North Central Park Avenue of such a nature and concentration as to reduce the number of pollutant-tolerant species by 32 percent. Again, these pollutant additions come from the numerous combined sewer outfalls in this area.

CHLOROPHYLL a

There was a close correspondence in the trends of periphyton population density and chlorophyll a concentrations (Figure 2). The only exception occurred at Lake-Cook Road in the Skokie River where a high periphyton population (237,000 organisms per square centimeter) resulted in a low chlorophyll a concentration (1.344 micrograms per square centimeter). One explanation is that the periphyton counted at this station were dead and empty of extractable chlorophyll. As stated in Standard Methods (11) "...periphyton often acts as a graveyard for dead diatoms of planktonic, as well as periphytic origin." Therefore, the peri-

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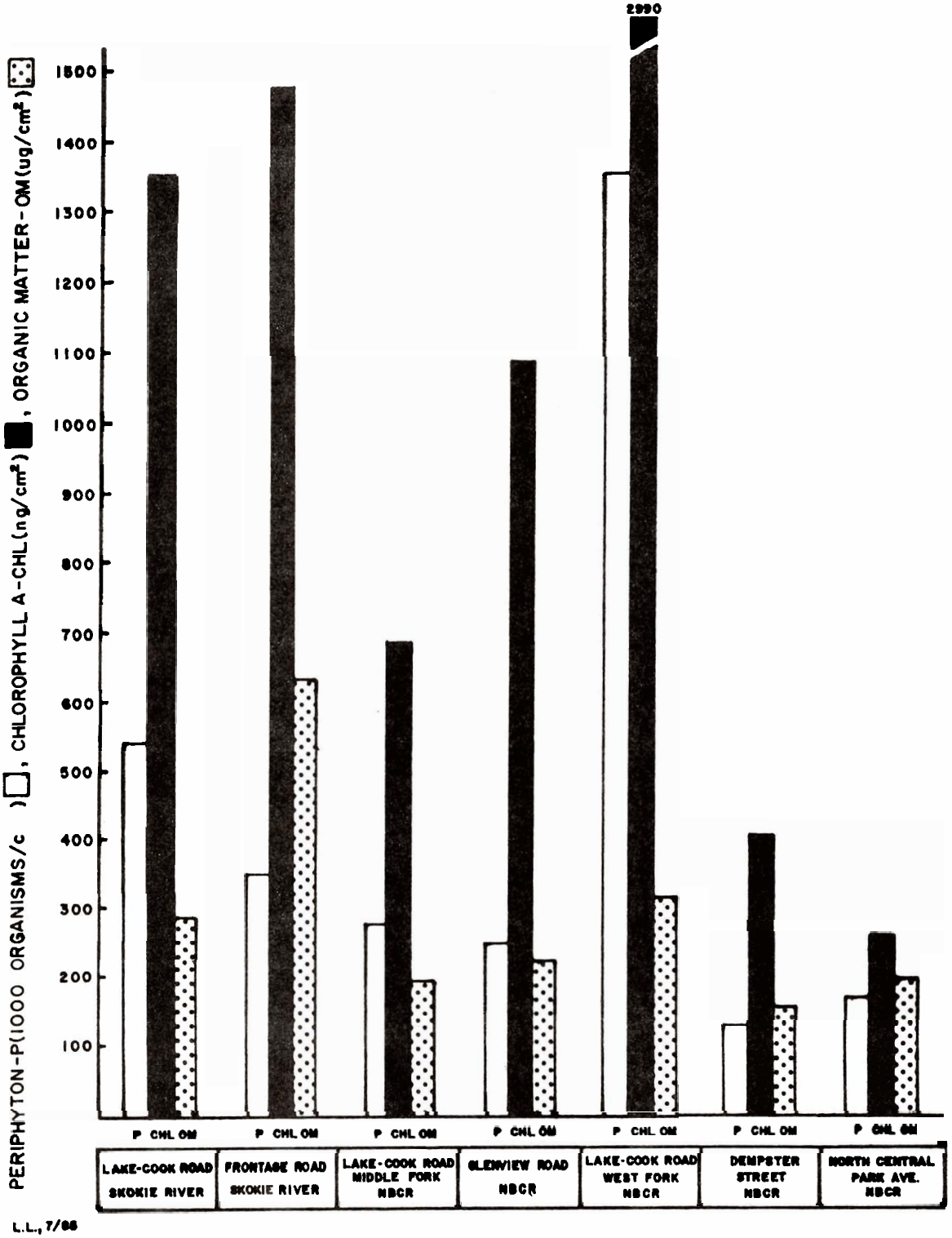
FIGURE 2

COMPARISON OF PERIPHYTON POPULATIONS WITH CHLOROPHYLL A AND ORGANIC MATTER CONCENTRATIONS FROM THE NORTH BRANCH OF THE CHICAGO RIVER (NBCR) - 1981



L.L., 7/86

phyton population, as given in Table 6, for this station was actually much lower in density, probably on the order of 170,000-180,000 organisms per square centimeter.

The close correspondence of the periphyton populations and chlorophyll a concentrations confirmed the magnitude and trends given for the periphyton populations in Table 6.

ORGANIC MATTER

The correspondence of organic matter concentrations with periphyton populations was not as clear as it was for chlorophyll a and the periphyton populations (Figure 2). The trend of organic matter concentrations followed the trend of the chlorophyll a concentrations, except at North Central Park Avenue where an increase in organic matter concentration was shown while the chlorophyll a concentrations and periphyton populations both showed a decrease (Figure 2). One explanation would be that heterotrophic organisms accumulated along with nonchlorophyllous debris at this station. This would indicate degradation of the NBCR between Dempster Street and North Central Park Avenue by the addition of significant amounts of organic matter from the numerous combined sewer outfalls in the area.

The accumulation of empty diatom frustules at Lake-Cook Road in the Skokie River was confirmed by the decrease in the organic matter concentration (Figure 2). As noted previously, the lower chlorophyll a concentrations at this station had already led to the supposition that the dead organisms counted inflated the periphyton population. The decrease in the organic

matter concentration shows that the dead "organisms" counted were not composed of organic matter. Since diatoms are enclosed in silica frustules they were most likely responsible for the inflated counts.

The relatively high organic matter concentration at West Frontage Road (631 micrograms per square centimeter) suggested that organic debris and a large heterotrophic population had accumulated. This indicated the significant addition of organic matter to the Skokie River between Lake-Cook Road and West Frontage Road, again, undoubtedly due to the combined sewer outfalls in the study area.

AUTOTROPHIC INDEX

The autotrophic index (Table 6), calculated for each sample and then averaged for each station (12), indicated that the NBCR is polluted throughout the study area since all values exceeded the limit of 100 which may indicate organic pollution (12). This number was based on the empirical observation that chlorophyll a made up one to two percent of the biomass grown in a relatively clean stream (12). When the ratio of organic matter to chlorophyll a exceeds 100 it is due to growth of nonchlorophyllous organisms which may be encouraged by the introduction of organic matter. The polluted condition of the NBCR is due to the numerous combined sewer outfalls and nonpoint sources of pollution in the study area.

EQUITABILITY

This index is derived from the distribution of species

within a community based upon predictions, using the Shannon-Weaver species diversity index, on a theoretical population. The values for the NBCR during 1981 (Table 6) were calculated from the average Shannon-Weaver species diversity index for each station (Table 6) and the total number of periphyton species found at that station (12). According to Weber (12), slight concentrations of pollutants introduced into waters were detected at an index value of 0.5, while moderate to severe concentrations of pollutants were detected at index values less than 0.3. As seen in Table 6, all of the equitability values calculated for the NBCR sampling stations in 1981 were at or below 0.1. These data indicated that the NBCR, during 1981, was severely polluted at all stations sampled. Again, this water quality condition is due to the numerous combined sewer outfalls and nonpoint sources of pollution in the NBCR study area.

Comparison of Bacterial and Periphyton Populations in the NBCR

The "General Use" stream standard for FC of 200 colony forming units per 100 milliliters, based on a minimum of five samples for a period of time not exceeding 30 days, was not met on any of the days samples were collected from the NBCR and its forks. This is due to the fact that the NBCR receives combined sewer overflows and nonpoint sources containing domestic wastes.

In general, the waters of the Skokie River at Lake-Cook Road were bacteriologically cleaner than the waters at any other station sampled (Table 3). On the average, the waters of the Skokie River at Lake-Cook Road contained 1.2×10^3 TC per 100

milliliters, 8.5 x 10^1 FC per 100 milliliters, 4.6 x 10^1 FS per 100 milliliters, 5.2 x 10^3 SPC per milliliters, 2.7 x 10^2 P. aeruginosa per 100 milliliters, and less than 0.16 Salmonella per 100 milliliters. These values for the indicator bacteria, TC, FC, and FS, were at least an order of magnitude less than were found in the other two forks of the NBCR at Lake-Cook Road and at the stations downstream of Lake-Cook Road and the Skokie River.

The waters at Dempster Street in the NBCR contained the highest indicator bacteria counts (5.0 x 10^4 TC per 100 milliliters, 3.3 x 10^4 FC per 100 milliliters, and 5.7 x 10^3 per 100 milliliters) suggesting that fecal pollution in the NBCR increases with distance downstream (Table 3). These trends for the bacteria were evident in 1980 and of the same order of magnitude. This supports the notion of continuity from year to year.

During 1981 the periphyton population geometric means were on the order of 10^5 organisms per square centimeter except at the last two downstream stations on the NBCR at Dempster Street and North Central Park Avenue where the periphyton population densities were on the order of 10^4 organisms per square centimeter (Table 6). This trend with the concomittant loss of 19 percent of the average number of species between Dempster Street (42 average number of periphyton species per sample) and North Central Park Avenue (34 average number of periphyton species per sample) suggested addition of pollutants injurious to periphyton. This trend was also shown in 1980 where a 46 percent

reduction in the average number of periphyton species occurred between Dempster Street (37 species) and North Central Park Avenue (20 species) (6). Although the periphyton population density in 1980 was shown to increase, it was demonstrated with the chlorophyll a and organic matter data that the population density was inflated by dead cells.

During 1981 there was a loss in population density between Glenview Road (163,577 organisms per square centimeter) and Dempster Street (60,747 organism per square centimeter) of 63 percent with a concomittant loss of chlorophyll a of 80 percent (Table 6). These data support the notion of a loss of chlorophyllous organisms in the downstream reaches of the NBCR. The highest autotrophic index (770) occurred at North Central Park Avenue indicating additions of soluble or particulate organic matter upstream of this station. The average AI at all stations exceeded Weber's limit of 100 for degradation by organic matter (12) and five of the seven stations exceeded Standard Method's limit of 200 for polluted waters (11) indicating that the entire NBCR system had been enriched by the addition of organic materials (Table 6). The equitability index values were all at 0.10 or less, indicating degradation of the system (Table 6). Proportion of persistent pollutant-tolerant species was greatest at the downstream stations indicating that the system became degraded with distance downstream (Table 7).

Overall, the fecal coliform results (Table 3) and the periphyton results (Tables 6 and 7), both support the conclusion that the NBCR and its forks are polluted by combined sewer over-

flow and nonpoint sources, and that the effects of pollution increase with distance downstream.

Fish

Fish were collected from seven sampling stations along the NBCR, including its forks in Cook County, Illinois. The locations of these stations are noted in Figure 1 and are described in Table 2.

Fish collections were carried out in Cook County twice during the year (July and November) at station numbers 51 (Dundee Road, West Fork), 282 (Lake-Cook Road, Middle Fork), 284 (Lake-Cook Road, Skokie River), 53 (West Frontage Road, Skokie River), 285 (Glenview Road, NBCR), and 286 (Dempster Street, NBCR).

An exception to this occurred at station number 287 (Albany Avenue, NBCR) where torrential flow conditions prevented fish collection in July.

Fish were also collected from three locations on the forks of the North Branch in Lake County during the period June 23 through July 14, 1981. These stations were: numbers 289 (Half Day Road, West Fork), 281 (Half Day Road, Middle Fork) and 283 (Half Day Road, Skokie River), noted in Figure 1 and described in Table 2.

Fish were most abundant at Station 53, West Frontage Road, Skokie River, with 67 fish per 10 minutes electrofishing (Table 8), 24 fish per 10 minutes electrofishing if young-of-the- year black bullheads are excluded) and with nine species of fish collected, and at Station 286, Dempster Street, with 25 fish per

10 minutes electrofishing (18 fish per 10 minutes electrofishing if young-of-the-year bluegills are excluded) and seven species of fish collected.

Fish were least abundant at Station 284, Lake-Cook Road, Skokie River, with four fish per 10 minutes electrofishing and three species of fish collected (Table 8) and at Station 287, Albany Avenue, NBCR, also with four fish per 10 minutes electrofishing and one species of fish collected.

There was little difference among the other three stations, with Station 51, Dundee Road, West Fork (six species of fish), Station 282, Lake-Cook Road, Middle Fork (eight species of fish), and Station 286, Dempster Street (seven species of fish) having 14 to 15 fish per 10 minutes electrofishing.

In Lake County (Table 9), fish were most abundant in the Middle Fork at Half Day Road (Station 281), with 36 fish per 10 minutes electrofishing and eight species collected. Fish were less numerous at Half Day Road on the Skokie River (Station 283) with nine fish per 10 minutes electrofishing and six species collected, and at Half Day Road on the West Fork (Station 289) with four fish per 10 minutes electrofishing and three species collected.

A total of 12 species of fish and two fish hybrids were collected from the North Branch of the Chicago River in Cook and Lake Counties.

Based on numbers of species of fish collected (Table 10), the Middle Fork of the North Branch of the Chicago River and the Skokie River have a greater diversity of species (11 species

each) than the West Fork (six species) or the downstream stations, from Glenview Road to Albany (eight species) and presumably better water quality than the latter two sections.

The number of species in a stream system depends on the number of relatively unmodified habitats available (13). Changes in water quality would directly affect the fish in its habitat and would be a modification of the habitat. Presumably, poor water quality would result in a relatively small number of spec- ies of fish at any given location in a stream. Therefore, it would appear that the downstream section of the North Branch of the Chicago River has poorer water quality than the upstream sections.

From the percentage composition of the catch from the entire North Branch of the Chicago River collections during 1981 (Table 11), it can be seen that the ecologically tolerant green sunfish was by far the most numerically abundant species comprising 60 percent of the catch in the West Fork, NBCR, 57 percent in the Middle Fork NBCR, 51 percent in the Skokie River, and 66 percent at the downstream stations.

The green sunfish tolerates a wide range of conditions, but it does best where few other sunfishes occur. It tolerates extremes of turbidity, dissolved oxygen, temperature, and flow (18). The predominance of the environmentally tolerant green sunfish throughout the NBCR suggests that the water quality conditions are such that only a relatively hardy fish species can become abundant.

Other fish found in the NBCR collection which are known to be tolerant of a wide range of ecological conditions include the goldfish, carp, golden shiner, fathead minnow, white sucker, hblack bullhead, orangespotted sunfish, bluegill, and largemouth bass (18, 19, 20). The latter two species are intolerant of continuous high turbidity and siltation (4) and, thus, would be somewhat less tolerant than the former seven species to variable environmental conditions.

This assemblage of 10 to 12 species of fish in the NBCR known to be tolerant to a wide (though variable) range of ecological conditions, suggested that water quality conditions in the NBCR were limiting the fish populations to those of the hardier species. This situation is a result of the numerous combined sewer outfalls and nonpoint sources of pollution in the NBCR study area.

The overall density of fish, as well as the diversity of species present in the NBCR, was low compared with other streams in the Chicagoland area with drainage areas of 52.7 to 376 square miles in size. The drainage area of the NBCR is 113 square miles (8). A comparison of these streams in terms of fish collections gathered by use of backpack electrofisher and minnow seines, in order to compare data obtained by use of the same method, was presented in Table 12. The 1980 NBCR collections were generally low in average and maximum numbers of species collected per sample and in number and weight of fish collected per 10 minutes electrofishing, when compared with the

other Chicago area streams in Table 13. Using average number of species per collection and average number of fish per 10 minutes electrofishing as indicators of water quality, with the assumption that the greater the number of species the greater the capability of building and maintaining stable populations with improved water quality, the NBCR appears to be relatively poor in water quality when compared with other streams in the Chicago area with drainage areas of similar size (Table 12). The NBCR with an average of 4.3 species per collection during 1981 and 15 fish per 10 minutes electrofishing, appears to be most similar to the Little Calumet River (Table 12) with 1.9 species per collection and 15 fish per 10 minutes electrofishing, and to Salt Creek with four species per collection and 11 fish per 10 minutes electrofishing.

These three waterways are much lower in water quality than Jackson Creek which had good species diversity (20) or, especially, Hickory Creek which is the outstanding stream in the Des Plaines River system (13).

Comparison of Bacteria, Periphyton, and Fish Populations in the NBCR

The bacterial data for the NBCR indicated that the river system received significant quantities of domestic wastes since the IPCB "General Use" stream standard of 200 FC per 100 milliliters was exceeded each day the river and its forks were sampled (Table 3).

The periphyton data corroborated the bacterial data as it was found that the less hardy species of periphyton decreased

with distance downstream in the NBCR, indicating that water of poorer quality was encountered in the downstream sections, and that additions of pollutants to the NBCR in the study area were occurring. Calculation of the Autotrophic Index for the periphyton community in the NBCR study area revealed, that at all but two stations, Autotrophic Index 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 Autotrophic Index 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 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 pollultant-tolerant species, it was noted that two out of three of the upstream forks of the NBCR contained more fish species than the downstream sections, indicating that significant quantities of pollutants were entering the NBCR.

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

teria, and invertebrates also helps to provide an integrated view of the watershed's environment. Periphyton 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 periphyton and fish data compliment FC data, and all three can be reliable indicators of water quality.

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APPENDIX I

FISH DATA COLLECTED FROM THE NORTH BRANCH OF THE CHICAGO RIVER DURING 1981

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 1981

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
290	HALF DAY RD	W.FK.NBCR	7/2	FATHEAD MINNOW	2	1.94	66.67	0.41	0.40	17.01
290	HALF DAY RD	W.FK.NBCR	7/2	BLUEGILL	1	0.97	33.33	2.00	1.94	82.99
289	HALF DAY RD	W.FK.NBCR	7/2	LARGEMOUTH BASS	8	4.16	100.00	1.41	0.73	100.00
281	HALF DAY RD	M.FK.NBCR	6/23	GOLDEN SHINER	2	1.81	2.94	8.06	7.28	1.23
281	HALF DAY RD	M.FK.NBCR	6/23	FATHEAD MINNOW	3	2.71	4.41	13.41	12.11	2.04
281	HALF DAY RD	M.FK.NBCR	6/23	BLACK BULLHEAD	1	0.90	1.47	7.88	7.12	1.20
281	HALF DAY RD	M.FK.NBCR	6/23	GREEN SUNFISH	30	27.10	44.12	360.90	326.02	54.89
281	HALF DAY RD	M.FK.NBCR	6/23	BLUEGILL	30	27.10	44.12	238.80	215.72	36.32
281	HALF DAY RD	M.FK.NBCR	6/23	GREEN X BLUEGILL	1	0.90	1.47	12.39	11.19	1.88
281	HALF DAY RD	M.FK.NBCR	6/23	BLACK CRAPPIE	1	0.90	1.47	16.00	14.45	2.43
281	HALF DAY RD	M.FK.NBCR	6/23	FATHEAD MINNOW	3	2.09	12.50	11.37	7.92	6.67
281	HALF DAY RD	M.FK.NBCR	6/23	GREEN SUNFISH	15	10.45	62.50	143.40	99.93	84.10
281	HALF DAY RD	M.FK.NBCR	6/23	BLUEGILL	3	2.09	12.50	10.83	7.55	6.35
281	HALF DAY RD	M.FK.NBCR	6/23	LARGEMOUTH BASS	2	1.39	8.33	0.78	0.54	0.46
281	HALF DAY RD	M.FK.NBCR	6/23	BLACK CRAPPIE	1	0.70	4.17	4.14	2.89	2.43
283	HALF DAY RD	SKOKIE R.	7/14	CARP	5	1.92	19.23	3068.15	1180.06	97.09
283	HALF DAY RD	SKOKIE R.	7/14	FATHEAD MINNOW	9	3.46	34.62	4.41	1.70	0.14
283	HALF DAY RD	SKOKIE R.	7/14	GREEN SUNFISH	10	3.85	38.46	85.10	32.73	2.69
283	HALF DAY RD	SKOKIE R.	7/14	BLUEGILL	1	0.38	3.85	2.18	0.84	0.07
283	HALF DAY RD	SKOKIE R.	7/14	BLACK CRAPPIE	1	0.38	3.85	0.40	0.15	0.01
283	HALF DAY RD	SKOKIE R.	6/25	NO FISH	0	0.00	0.00	0.00	0.00	0.00
283	HALF DAY RD	SKOKIE R.	6/25	GOLDEN SHINER	1	1.43	100.00	1.80	2.57	100.00

TABLE CONTINUED ON FOLLOWING PAGE.

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 1981

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
283	HALF DAY RD	SKOKIE R.	7/14	CARP X GOLDFISH	1	0.80	16.67	326.00	261.22	89.32
283	HALF DAY RD	SKOKIE R.	7/14	FATHEAD MINNOW	1	0.80	16.67	0.44	0.35	0.12
283	HALF DAY RD	SKOKIE R.	7/14	GREEN SUNFISH	4	3.21	66.67	38.56	30.90	10.56
51	DUNDEE RD	W.FK.NBCR	7/14	CARP X GOLDFISH	1	1.80	6.67	415.00	230.56	93.18
51	DUNDEE RD	W.FK.NBCR	7/14	GOLDEN SHINER	3	1.67	20.00	18.54	10.30	4.16
51	DUNDEE RD	W.FK.NBCR	7/14	GREEN SUNFISH	5	2.78	33.33	6.50	3.61	1.46
51	DUNDEE RD	W.FK.NBCR	7/14	BLUEGILL	1	0.56	6.67	0.76	0.42	0.19
51	DUNDEE RD	W.FK.NBCR	7/14	LARGEMOUTH BASS	5	2.78	33.33	4.55	2.53	1.02
51	DUNDEE RD	W.FK.NBCR	7/14	CARP	1	0.67	7.14	21.85	14.57	14.23
51	DUNDEE RD	W.FK.NBCR	7/14	GOLDEN SHINER	2	1.33	14.29	1.04	0.69	0.68
51	DUNDEE RD	W.FK.NBCR	7/14	GREEN SUNFISH	8	5.33	57.14	128.40	85.60	83.61
51	DUNDEE RD	W.FK.NBCR	7/14	BLUEGILL	2	1.33	14.29	1.48	0.99	0.96
51	DUNDEE RD	W.FK.NBCR	7/14	LARGEMOUTH BASS	1	0.67	7.14	0.80	0.53	0.52
282	LAKE-COOK RD	M.FK.NBCR	7/23	FATHEAD MINNOW	12	15.33	42.86	7.44	9.50	9.01
282	LAKE-COOK RD	M.FK.NBCR	7/23	GREEN SUNFISH	11	14.05	39.29	55.88	71.37	67.68
282	LAKE-COOK RD	M.FK.NBCR	7/23	PUMPKINSEED	2	2.55	7.14	9.88	12.62	11.97
282	LAKE-COOK RD	M.FK.NBCR	7/23	BLUEGILL	3	3.83	10.71	9.36	11.95	11.34
282	LAKE-COOK RD	M.FK.NBCR	7/23	CARP	1	0.90	7.69	36.04	32.47	6.26
282	LAKE-COOK RD	M.FK.NBCR	7/23	FATHEAD MINNOW	1	0.90	7.69	2.12	1.91	0.37
282	LAKE-COOK RD	M.FK.NBCR	7/23	WHITE SUCKER	5	4.50	38.46	395.25	356.08	68.61
282	LAKE-COOK RD	M.FK.NBCR	7/23	GREEN SUNFISH	2	1.80	15.38	125.34	112.92	21.76
282	LAKE-COOK RD	M.FK.NBCR	7/23	BLUEGILL	3	2.70	23.08	16.56	14.92	2.87
282	LAKE-COOK RD	M.FK.NBCR	7/23	LARGEMOUTH BASS	1	0.90	7.69	0.74	0.67	0.13

TABLE CONTINUED ON FOLLOWING PAGE

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 1981

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
282	LAKE-COOK RD	RESERVOIR	7/23	GREEN SUNFISH	53	27.85	92.98	301.04	158.19	89.26
282	LAKE-COOK RD	RESERVOIR	7/23	GREEN X BLUEGILL	2	1.05	3.51	9.24	4.86	2.74
282	LAKE-COOK RD	RESERVOIR	7/23	BLUEGILL	1	0.53	1.75	6.97	3.66	2.07
282	LAKE-COOK RD	RESERVOIR	7/23	LARGEMOUTH BASS	1	0.53	1.75	20.00	10.51	5.93
284	LAKE-COOK RD	SKOKIE R.	6/30	CARP	3	1.07	50.00	2413.00	861.79	99.50
284	LAKE-COOK RD	SKOKIE R.	6/30	GREEN SUNFISH	3	1.07	50.00	12.24	4.37	0.50
53	W.FRONTAGE RD	SKOKIE R.	7/7	FATHEAD MINNOW	40		93.02	10.80		22.88
53	W.FRONTAGE RD	SKOKIE R.	7/7	WHITE SUCKER	1		2.33	0.89		1.89
53	W.FRONTAGE RD	SKOKIE R.	7/7	BLACK BULLHEAD	1		2.33	25.75		54.56
53	W.FRONTAGE RD	SKOKIE R.	7/7	GREEN SUNFISH	1		2.33	9.76		20.68
53	W.FRONTAGE RD	SKOKIE R.	7/7	BLACK BULLHEAD	240	88.50	88.89	32.22	11.88	6.40
53	W.FRONTAGE RD	SKOKIE R.	7/7	GREEN SUNFISH	26	9.59	9.63	388.96	143.42	77.24
53	W.FRONTAGE RD	SKOKIE R.	7/7	GREEN X BLUEGILL	1	0.37	0.37	73.13	26.97	14.52
53	W.FRONTAGE RD	SKOKIE R.	7/7	BLUEGILL	1	0.37	0.37	6.83	2.52	1.36
53	W.FRONTAGE RD	SKOKIE R.	7/7	LARGEMOUTH BASS	2	0.74	0.74	2.42	0.89	0.48
285	GLENVIEW RD	NBCR	7/16	CARP	2	1.13	7.14	0.40	0.23	0.31
285	GLENVIEW RD	NBCR	7/16	FATHEAD MINNOW	8	4.51	28.57	2.00	1.13	1.54
285	GLENVIEW RD	NBCR	7/16	GREEN SUNFISH	13	7.34	46.43	121.81	68.74	93.92
285	GLENVIEW RD	NBCR	7/16	NO FISH	0	0.00	0.00	0.00	0.00	0.00
285	GLENVIEW RD	NBCR	7/16	LARGEMOUTH BASS	3	1.69	10.71	1.74	0.98	1.34
285	GLENVIEW RD	NBCR	7/16	BLACK CRAPPIE	1	0.56	3.57	0.76	0.43	0.59
285	GLENVIEW RD	NBCR	7/16	FATHEAD MINNOW	2	4.30	100.00	0.58	1.25	100.00
285	GLENVIEW RD	NBCR	7/16	NO FISH	0	0.00	0.00	0.00	0.00	0.00

TABLE CONTINUED FOLLOWING PAGE.

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 1981

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
286	DEMPSTER ST	NBCR	7/21	FATHEAD MINNOW	2	1.67	3.28	0.56	0.47	0.67
286	DEMPSTER ST	NBCR	7/21	BLACK BULLHEAD	3	2.50	4.92	0.54	0.45	0.65
286	DEMPSTER ST	NBCR	7/21	GREEN SUNFISH	18	15.00	29.51	74.52	62.10	89.25
286	DEMPSTER ST	NBCR	7/21	BLUEGILL	13	10.83	21.31	2.86	2.38	3.43
286	DEMPSTER ST	NBCR	7/21	SUNFISH FRY	22	18.33	36.07	1.54	1.28	1.84
286	DEMPSTER ST	NBCR	7/21	LARGEMOUTH BASS	2	1.67	3.28	2.58	2.15	3.09
286	DEMPSTER ST	NBCR	7/21	BLACK CRAPPIE	1	0.83	1.64	0.90	0.75	1.08
286	DEMPSTER ST	NBCR	7/21	FATHEAD MINNOW	1	0.71	20.00	1.32	0.93	5.95
286	DEMPSTER ST	NBCR	7/21	GREEN SUNFISH	4	2.83	80.00	20.88	14.78	94.05
51	DUNDEE RD	W.FK.NBCR	11/19	GOLDEN SHINER	2	1.20	5.71	2.54	1.52	2.81
51	DUNDEE RD	W.FK.NBCR	11/19	FATHEAD MINNOW	1	0.60	2.86	0.79	0.47	0.87
51	DUNDEE RD	W.FK.NBCR	11/19	GREEN SUNFISH	32	19.13	91.43	87.04	52.03	96.32
282	LAKE-COOK RD	M.FK.NBCR	11/17	GREEN SUNFISH	7	20.90	100.00	20.90	62.39	100.00
282	LAKE-COOK RD	M.FK.NBCR	11/17	GOLDFISH	2	0.85	5.41	205.42	87.52	30.90
282	LAKE-COOK RD	M.FK.NBCR	11/17	FATHEAD MINNOW	1	0.43	2.70	1.35	0.58	0.20
282	LAKE-COOK RD	M.FK.NBCR	11/17	WHITE SUCKER	2	0.85	5.41	287.18	122.36	43.20
282	LAKE-COOK RD	M.FK.NBCR	11/17	GREEN SUNFISH	31	13.21	83.78	163.37	69.61	24.58
282	LAKE-COOK RD	M.FK.NBCR	11/17	PUMPKINSEED	4	8.30	80.00	17.82	36.97	64.29
53	W.FRONTAGE RD	SKOKIE R.	11/19	ORANGESPOTTED SUNFISH	2		100.00	11.30		100.00
284	LAKE-COOK RD	SKOKIE R.	11/17	GREEN SUNFISH	4	8.30	80.00	17.82	36.97	64.29
284	LAKE-COOK RD	SKOKIE R.	11/17	ORANGESPOTTED SUNFISH	1	2.07	20.00	9.90	20.54	35.71
284	LAKE-COOK RD	SKOKIE R.	11/17	GREEN SUNFISH	4	4.47	100.00	17.79	19.88	100.00
53	W.FRONTAGE RD	SKOKIE R.	11/19	BLACK BULLHEAD	2	0.91	4.88	5.76	2.62	2.30

TABLE CONTINUED ON FOLLOWING PAGE.

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 1981

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
53	W.FRONTAGE RD	SKOKIE R.	11/19	GREEN SUNFISH	32	14.58	78.05	229.12	104.38	91.36
53	W.FRONTAGE RD	SKOKIE R.	11/19	PUMPKINSEED	2	0.91	4.88	5.54	2.52	2.21
53	W.FRONTAGE RD	SKOKIE R.	11/19	BLUEGILL	2	0.91	4.88	2.08	0.95	0.83
53	W.FRONTAGE RD	SKOKIE R.	11/19	LARGEMOUTH BASS	3	1.37	7.32	8.28	3.77	3.30
285	GLENVIEW RD	NBCR	11/12	GREEN SUNFISH	15	13.64	93.75	19.25	17.50	93.99
285	GLENVIEW RD	NBCR	11/12	PUMPKINSEED	1	0.91	6.25	1.23	1.12	6.01
285	GLENVIEW RD	NBCR	11/12	GREEN SUNFISH	11	19.40	100.00	53.43	94.23	100.00
286	DEMPSTER ST	NBCR	11/12	GREEN SUNFISH	11	12.33	100.00	17.33	19.43	100.00
286	DEMPSTER ST	NBCR	11/12	GREEN SUNFISH	2	4.24	100.00	2.07	4.39	100.00
287	ALBANY AVE	NBCR	11/12	GREEN SUNFISH	4	4.35	100.00	6.13	6.67	100.00

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

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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 1981

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)
290	HALF DAY RD	W.FK.NBCR	7/2	FATHEAD MINNOW	2	26.50	24	29	0.21	0.13	0.28
290	HALF DAY RD	W.FK.NBCR	7/2	BLUEGILL	1	50.00	50	50	2.00	2.00	2.00
289	HALF DAY RD	W.FK.NBCR	7/2	LARGEMOUTH BASS	8	24.13	22	25	0.18	0.13	0.21
281	HALF DAY RD	M.FK.NBCR	6/23	GOLDEN SHINER	2	68.50	62	75	4.03	2.76	5.30
281	HALF DAY RD	M.FK.NBCR	6/23	FATHEAD MINNOW	3	65.00	57	76	4.47	3.00	6.57
281	HALF DAY RD	M.FK.NBCR	6/23	BLACK BULLHEAD	1	77.00	77	77	7.88	7.88	7.88
281	HALF DAY RD	M.FK.NBCR	6/23	GREEN SUNFISH	30	69.40	40	159	12.03	1.35	93.00
281	HALF DAY RD	M.FK.NBCR	6/23	BLUEGILL	30	68.47	46	127	7.96	1.70	44.00
281	HALF DAY RD	M.FK.NBCR	6/23	GREEN X BLUEGILL	1	88.00	88	88	12.39	12.39	12.39
281	HALF DAY RD	M.FK.NBCR	6/23	BLACK CRAPPIE	1	109.00	109	109	16.00	16.00	16.00
281	HALF DAY RD	M.FK.NBCR	6/23	FATHEAD MINNOW	3	60.67	53	69	3.79	2.12	5.27
281	HALF DAY RD	M.FK.NBCR	6/23	GREEN SUNFISH	15	66.67	44	140	9.56	1.87	60.00
281	HALF DAY RD	M.FK.NBCR	6/23	BLUEGILL	3	58.67	46	66	3.61	1.79	4.86
281	HALF DAY RD	M.FK.NBCR	6/23	LARGEMOUTH BASS	2	28.00	27	29	0.39	0.32	0.46
281	HALF DAY RD	M.FK.NBCR	6/23	BLACK CRAPPIE	1	67.00	67	67	4.14	4.14	4.14
283	HALF DAY RD	SKOKIE R.	7/14	CARP	5	259.80	51	427	613.63	2.58	1451.52
283	HALF DAY RD	SKOKIE R.	7/14	FATHEAD MINNOW	9	33.67	30	39	0.49	0.34	0.72
283	HALF DAY RD	SKOKIE R.	7/14	GREEN SUNFISH	10	59.50	30	108	8.51	0.50	38.08
283	HALF DAY RD	SKOKIE R.	7/14	BLUEGILL	1	52.00	52	52	2.18	2.18	2.18
283	HALF DAY RD	SKOKIE R.	7/14	BLACK CRAPPIE	1	35.00	35	35	0.40	0.40	0.40
283	HALF DAY RD	SKOKIE R.	6/25	NO FISH	0	0.00	0	0	0.00	0.00	0.00
283	HALF DAY RD	SKOKIE R.	6/25	GOLDEN SHINER	1	56.00	56	56	1.80	1.80	1.80

TABLE CONTINUED ON FOLLOWING PAGE.

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 1981

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)
283	HALF DAY RD	SKOKIE R.	7/14	CARP X GOLDFISH	1	286.00	286	286	326.00	326.00	326.00
283	HALF DAY RD	SKOKIE R.	7/14	FATHEAD MINNOW	1	33.00	33	33	0.44	0.44	0.44
283	HALF DAY RD	SKOKIE R.	7/14	GREEN SUNFISH	4	62.00	32	102	9.64	0.78	28.64
51	DUNDEE RD	W.FK.NBCR	7/14	CARP X GOLDFISH	1	305.00	305	305	415.00	415.00	415.00
51	DUNDEE RD	W.FK.NBCR	7/14	GOLDEN SHINER	3	58.33	33	98	6.18	0.40	17.21
51	DUNDEE RD	W.FK.NBCR	7/14	GREEN SUNFISH	5	29.00	16	61	1.30	0.10	5.61
51	DUNDEE RD	W.FK.NBCR	7/14	BLUEGILL	1	35.00	35	35	0.76	0.76	0.76
51	DUNDEE RD	W.FK.NBCR	7/14	LARGEMOUTH BASS	5	38.80	33	47	0.91	0.59	1.66
51	DUNDEE RD	W.FK.NBCR	7/14	CARP	1	102.00	102	102	21.85	21.85	21.85
51	DUNDEE RD	W.FK.NBCR	7/14	GOLDEN SHINER	2	36.00	30	42	0.52	0.25	0.78
51	DUNDEE RD	W.FK.NBCR	7/14	GREEN SUNFISH	8	83.38	53	115	16.05	3.35	39.46
51	DUNDEE RD	W.FK.NBCR	7/14	BLUEGILL	2	38.50	37	40	0.74	0.63	0.85
51	DUNDEE RD	W.FK.NBCR	7/14	LARGEMOUTH BASS	1	41.00	41	41	0.80	0.80	0.80
282	LAKE-COOK RD	M.FK.NBCR	7/23	FATHEAD MINNOW	12	33.75	24	56	0.62	0.16	2.32
282	LAKE-COOK RD	M.FK.NBCR	7/23	GREEN SUNFISH	11	48.27	19	89	5.08	0.08	20.22
282	LAKE-COOK RD	M.FK.NBCR	7/23	PUMPKINSEED	2	58.50	44	73	4.94	1.81	8.06
282	LAKE-COOK RD	M.FK.NBCR	7/23	BLUEGILL	3	59.00	54	64	3.12	2.61	3.59
282	LAKE-COOK RD	M.FK.NBCR	7/23	CARP	1	126.00	126	126	36.04	36.04	36.04
282	LAKE-COOK RD	M.FK.NBCR	7/23	FATHEAD MINNOW	1	56.00	56	56	2.12	2.12	2.12
282	LAKE-COOK RD	M.FK.NBCR	7/23	WHITE SUCKER	5	178.20	150	247	79.05	38.06	205.60
282	LAKE-COOK RD	M.FK.NBCR	7/23	GREEN SUNFISH	2	130.50	100	161	62.67	22.34	103.00
282	LAKE-COOK RD	M.FK.NBCR	7/23	BLUEGILL	3	65.00	52	90	5.52	2.05	11.92
282	LAKE-COOK RD	M.FK.NBCR	7/23	LARGEMOUTH BASS	1	41.00	41	41	0.74	0.74	0.74

TABLE CONTINUED ON FOLLOWING PAGE.

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 1981

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	RESERVOIR	7/23	GREEN SUNFISH	53	61.28	21	125	5.68	0.13	33.00
282	LAKE-COOK RD	RESERVOIR	7/23	GREEN X BLUEGILL	2	63.50	61	66	4.62	3.90	5.33
282	LAKE-COOK RD	RESERVOIR	7/23	BLUEGILL	1	75.00	75	75	6.97	6.97	6.97
282	LAKE-COOK RD	RESERVOIR	7/23	LARGEMOUTH BASS	1	130.00	130	130	20.00	20.00	20.00
284	LAKE-COOK RD	SKOKIE R.	6/30	CARP	3	379.33	353	399	804.33	626.00	1013.00
284	LAKE-COOK RD	SKOKIE R.	6/30	GREEN SUNFISH	3	54.33	42	71	4.08	1.34	8.47
53	W.FRONTAGE RD	SKOKIE R.	7/7	FATHEAD MINNOW	40	28.15	21	37	0.27	0.06	0.62
53	W.FRONTAGE RD	SKOKIE R.	7/7	WHITE SUCKER	1	41.00	41	41	0.89	0.89	0.89
53	W.FRONTAGE RD	SKOKIE R.	7/7	BLACK BULLHEAD	1	119.00	119	119	25.75	25.75	25.75
53	W.FRONTAGE RD	SKOKIE R.	7/7	GREEN SUNFISH	1	77.00	77	77	9.76	9.76	9.76
53	W.FRONTAGE RD	SKOKIE R.	7/7	BLACK BULLHEAD	240	18.10	18	19	0.13	0.10	0.13
53	W.FRONTAGE RD	SKOKIE R.	7/7	GREEN SUNFISH	26	80.27	50	119	14.96	2.69	41.92
53	W.FRONTAGE RD	SKOKIE R.	7/7	GREEN X BLUEGILL	1	142.00	142	142	73.13	73.13	73.13
53	W.FRONTAGE RD	SKOKIE R.	7/7	BLUEGILL	1	70.00	70	70	6.83	6.83	6.83
53	W.FRONTAGE RD	SKOKIE R.	7/7	LARGEMOUTH BASS	2	41.50	39	44	1.21	1.13	1.29
285	GLENVIEW RD	NBCR	7/16	CARP	2	23.50	21	26	0.20	0.14	0.26
285	GLENVIEW RD	NBCR	7/16	FATHEAD MINNOW	8	26.88	23	33	0.25	0.13	0.43
285	GLENVIEW RD	NBCR	7/16	GREEN SUNFISH	13	64.31	20	111	9.37	0.14	37.09
285	GLENVIEW RD	NBCR	7/16	BLUEGILL	1	51.00	51	51	2.99	2.99	2.99
285	GLENVIEW RD	NBCR	7/16	LARGEMOUTH BASS	3	35.00	34	36	0.58	0.52	0.62
285	GLENVIEW RD	NBCR	7/16	BLACK CRAPPIE	1	37.00	37	37	0.76	0.76	0.76
285	GLENVIEW RD	NBCR	7/16	FATHEAD MINNOW	2	30.00	30	30	0.29	0.29	0.29
285	GLENVIEW RD	NBCR	7/16	NO FISH	0	0.00	0	0	0.00	0.00	0.00

TABLE CONTINUED ON FOLLOWING PAGE.

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 1981

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)
286	DEMPSTER ST	NBCR	7/21	FATHEAD MINNOW	2	27.50	22	33	0.28	0.08	0.48
286	DEMPSTER ST	NBCR	7/21	BLACK BULLHEAD	3	22.00	22	22	0.18	0.18	0.18
286	DEMPSTER ST	NBCR	7/21	GREEN SUNFISH	18	45.61	19	86	4.14	0.12	15.36
286	DEMPSTER ST	NBCR	7/21	BLUEGILL	13	24.46	21	27	0.22	0.09	0.34
286	DEMPSTER ST	NBCR	7/21	SUNFISH FRY	22	17.68	14	20	0.07	0.01	0.11
286	DEMPSTER ST	NBCR	7/21	LARGEMOUTH BASS	2	39.50	23	56	1.29	0.15	2.42
286	DEMPSTER ST	NBCR	7/21	BLACK CRAPPIE	1	39.00	39	39	0.90	0.90	0.90
286	DEMPSTER ST	NBCR	7/21	FATHEAD MINNOW	1	45.00	45	45	1.32	1.32	1.32
286	DEMPSTER ST	NBCR	7/21	GREEN SUNFISH	4	58.00	45	69	5.22	2.16	8.15
51	DUNDEE RD	W.FK.NBCR	11/19	GOLDEN SHINER	2	51.50	50	53	1.27	1.13	1.40
51	DUNDEE RD	W.FK.NBCR	11/19	FATHEAD MINNOW	1	40.00	40	40	0.79	0.79	0.79
51	DUNDEE RD	W.FK.NBCR	11/19	GREEN SUNFISH	32	45.94	32	87	2.72	0.64	15.00
282	LAKE-COOK RD	M.FK.NBCR	11/17	GREEN SUNFISH	7	47.86	30	70	2.99	0.55	7.96
282	LAKE-COOK RD	M.FK.NBCR	11/17	GOLDFISH	2	181.50	173	190	102.71	83.52	121.89
282	LAKE-COOK RD	M.FK.NBCR	11/17	FATHEAD MINNOW	1	50.00	50	50	1.35	1.35	1.35
282	LAKE-COOK RD	M.FK.NBCR	11/17	WHITE SUCKER	2	194.50	122	267	143.59	23.78	263.39
282	LAKE-COOK RD	M.FK.NBCR	11/17	GREEN SUNFISH	31	57.10	30	110	5.27	0.52	25.62
282	LAKE-COOK RD	M.FK.NBCR	11/17	PUMPKINSEED	1	72.00	72	72	7.46	7.46	7.46
284	LAKE-COOK RD	SKOKIE R.	11/17	GREEN SUNFISH	4	59.75	45	73	4.46	1.53	7.23
284	LAKE-COOK RD	SKOKIE R.	11/17	ORANGESPOTTED SUNFISH	1	80.00	80	80	9.90	9.90	9.90
284	LAKE-COOK RD	SKOKIE R.	11/17	GREEN SUNFISH	4	57.50	38	74	4.45	0.96	8.06
53	W.FRONTAGE RD	SKOKIE R.	11/19	ORANGESPOTTED SUNFISH	2	59.00	39	79	5.65	0.95	10.35
53	W.FRONTAGE RD	SKOKIE R.	11/19	BLACK BULLHEAD	2	56.50	50	63	2.88	2.08	3.68

TABLE CONTINUED ON FOLLOWING PAGE.

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 1981

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)
53	W.FRONTAGE RD	SKOKIE R.	11/19	GREEN SUNFISH	32	61.56	35	122	7.16	0.90	39.96
53	W.FRONTAGE RD	SKOKIE R.	11/19	PUMPKINSEED	2	41.50	41	42	2.77	2.62	2.92
53	W.FRONTAGE RD	SKOKIE R.	11/19	BLUEGILL	2	39.50	36	43	1.04	0.75	1.33
53	W.FRONTAGE RD	SKOKIE R.	11/19	LARGEMOUTH BASS	3	58.67	55	62	2.76	2.48	3.03
285	GLENVIEW RD	NBCR	11/12	GREEN SUNFISH	15	40.07	30	58	1.28	0.52	3.55
285	GLENVIEW RD	NBCR	11/12	PUMPKINSEED	1	42.00	42	42	1.23	1.23	1.23
285	GLENVIEW RD	NBCR	11/12	GREEN SUNFISH	11	55.55	29	101	4.86	0.43	22.47
286	DEMPSTER ST	NBCR	11/12	GREEN SUNFISH	11	40.91	33	64	1.58	0.75	5.13
286	DEMPSTER ST	NBCR	11/12	GREEN SUNFISH	2	37.00	36	38	1.04	0.93	1.14
287	ALBANY AVE	NBCR	11/12	GREEN SUNFISH	4	42.00	33	47	1.53	0.75	2.08

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

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE AI-3

1981 NORTH BRANCH OF THE CHICAGO RIVER CHEMICAL DATA COLLECTED AT HALF DAY ROAD AND SUTTON PLACE

Parameter	Station and Date				
	Half Day Road West Fork 7/2/81	Sutton Place West Fork 7/2/81	Half Day Road Middle Fork 6/23/81	Half Day Road Skokie River 6/25/81	Half Day Road Skokie River 7/14/81
Fluoride	NA	NA	NA	NA	NA
Phenol (µg/l)	<1.0	1	<1	<1	1
Chloride	142.0	94	100	76	88
Soluble Phosphorus	0.3	0.1	0.1	0.2	0.3
Sulfate	NA	NA	NA	NA	NA
Cyanide	NA	0.006	0.004	0.002	0.004
Fats, Oils & Greases	1	1	2	<1	2
Total Organic Carbon	NA	NA	NA	NA	NA
Turbidity (NTU)	9.2	9.0	13.0	16.0	17.0
Alkalinity	256	188	180	208	196
MBAS	NA	NA	NA	NA	NA
Field Temp. (°C)	24.7	21.8	17.7	19.6	22.9
Field Dissolved Oxygen	4.1	10.4	7.5	5.8	6.2
Zinc	<0.1	0.1	0.1	0.1	<0.1
Cadmium	<0.02	<0.02	<0.02	<0.02	<0.02
Copper	<0.02	<0.02	0.04	0.02	<0.02
Chromium	<0.02	<0.02	0.150	<0.02	<0.02
Iron	1.0	0.7	1.8	1.5	1.4
Nickel	<0.01	0.1	0.1	<0.01	<0.01
Lead	<0.01	<0.01	<0.01	0.03	<0.01
Manganese	NA	NA	NA	NA	NA
Magnesium	38.0	28.0	30.5	23.0	28.5
Calcium	85.0	66.5	74.0	59.0	75.5
Selenium	NA	NA	NA	NA	NA
Arsenic	NA	NA	NA	NA	NA
Hardness	369	281	310	300	306

Table continued on the following page.

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE AI-3 (Continued)

1981 NORTH BRANCH OF THE CHICAGO RIVER CHEMICAL DATA COLLECTED AT HALF DAY ROAD AND SUTTON PLACE

Parameter	Station and Date				
	Half Day Road West Fork 7/2/81	Sutton Place West Fork 7/2/81	Half Day Road Middle Fork 6/23/81	Half Day Road Skokie River 6/25/81	Half Day Road Skokie River 7/14/81
Silver (µg/l)	2.3	0.9	1.0	1.9	2.2
Barium	NA	NA	NA	NA	NA
Mercury (µg/l)	<0.05	<0.05	<0.05	<0.05	<0.05
Total Solids	836	634	851	582	597
Total Volatile Solids	289	253	435	268	236
Total Suspended Solids	53	10	37	41	32
Total Vol. Susp. Solids	13	3	8	9	13
Total Kjeldahl Nitrogen	0.6	0.9	0.9	0.9	0.9
Ammonia-Nitrogen	0.1	0.2	0.2	0.3	0.5
Organic Nitrogen	0.5	0.7	0.7	0.6	0.4
Nitrate + Nitrite	1.0	1.7	3.3	0.7	1.2
COD	32	32	47	15	30
BOD	2	<2	2	3	6
pH (Units)	7.9	7.5	7.1	7.6	7.4
Conductivity (µmhos/cm)	1100	800	925	800	775
Sodium	NA	NA	NA	NA	NA
Potassium	NA	NA	NA	NA	NA
Aluminum	NA	NA	NA	NA	NA
Total Residual Chlorine	0.00	0.00	0.00	NA	0.00

NOTE: All parameters in mg/l unless otherwise noted; NA = No analysis performed; < = below detection limit. All total residual chlorine samples were collected and analyzed on 7/9/81.

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE AI-4

1981 NORTH BRANCH OF THE CHICAGO RIVER CHEMICAL DATA COLLECTED AT DUNDEE ROAD AND LAKE/COOK ROAD

Parameter	Station and Date				
	Dundee Road West Fork 7/14/81	Dundee Road West Fork 11/19/81	Lake/Cook Rd. Middle Fork 7/23/81	Lake/Cook Rd. Middle Fork 11/17/81	Lake/Cook Rd. Middle Fork Reservoir 7/23/81
Fluoride	NA	0.780	NA	0.310	NA
Phenol (µg/l)	<1	3	1	5	<1
Chloride	100.0	168	106	86	158
Soluble Phosphorus	0.7	3.7	0.2	0.1	<0.1
Sulfate	NA	106	NA	89	NA
Cyanide	0.007	0.012	0.003	<0.014	0.004
Fats, Oils & Greases	<1	<1	<1	<1	3
Total Organic Carbon	NA	NA	NA	NA	NA
Turbidity (NTU)	21	9.2	18.0	10.0	27.0
Alkalinity	170	200	252	320	196
MBAS	NA	NA	NA	NA	NA
Field Temp. (°C)	22.4	10.6	19.4	6	22.8
Field Dissolved Oxygen	6.5	7.2	NA	6.5	NA
Zinc	0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	<0.02	<0.02	<0.02	<0.02	<0.02
Copper	<0.02	<0.02	<0.02	<0.02	<0.02
Chromium	<0.02	<0.02	<0.02	<0.02	<0.02
Iron	1.0	0.3	1.3	0.7	2.2
Nickel	<0.01	<0.01	<0.01	<0.01	<0.01
Lead	0.02	<0.01	0.02	<0.01	0.03
Manganese	NA	0.04	NA	0.09	0.05
Magnesium	27.0	32.0	33.5	44.0	34.0
Calcium	62.5	74.0	79.0	105.0	85.0
Selenium	NA	<0.2	NA	<0.2	<0.2
Arsenic	NA	<0.2	NA	<0.2	<0.2
Hardness	267	317	335	450	362

Table continued on the following page.

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE AI-4 (Continued)

1981 NORTH BRANCH OF THE CHICAGO RIVER CHEMICAL DATA COLLECTED AT DUNDEE ROAD AND LAKE/COOK ROAD

Parameter	Station and Date				
	Dundee Road West Fork	Dundee Road West Fork	Lake/Cook Rd. Middle Fork	Lake/Cook Rd. Middle Fork	Lake/Cook Rd. Middle Fork Reservoir
	7/14/81	11/19/81	7/23/81	11/17/81	7/23/81
Silver (µg/l)	2.0	<0.1	1.0	<0.1	1.0
Barium	NA	<0.1	NA	<0.1	<0.1
Mercury (µg/l)	<0.05	0.10	<0.05	<0.05	<0.05
Total Solids	611	750	717	644	818
Total Volatile Solids	282	152	243	143	260
Total Suspended Solids	44	11	64	21	42
Total Vol. Susp. Solids	12	2	20	13	11
Total Kjeldahl Nitrogen	1.2	1.2	1.3	1.2	1.8
Ammonia-Nitrogen	0.5	0.4	0.4	0.2	0.3
Organic Nitrogen	0.6	0.8	0.9	1.0	1.5
Nitrate + Nitrite	3.0	14.7	1.3	1.0	0.5
COD	40	56	34	14	28
BOD	3	3	2	3	<2
pH (Units)	7.2	8.3	7.6	7.8	7.5
Conductivity (µmhos/cm)	775	1200	950	1000	1100
Sodium	NA	120	NA	50.0	NA
Potassium	NA	11.7	NA	2.8	NA
Aluminum	NA	<1	NA	1.0	NA
Total residual chlorine	0.00	NA	0.00	NA	NA

NOTE: All parameters in mg/l unless otherwise noted; NA = No analysis performed; < = below detection limit. All total residual chlorine samples were collected and analyzed on 7/9/81. Total chlorine residual sample for Dundee Road, West Fork was collected 1 mile upstream at Lake/Cook Road.

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE AI-5

1981 NORTH BRANCH OF THE CHICAGO RIVER CHEMICAL DATA COLLECTED AT LAKE/COOK ROAD, FRONTAGE ROAD AND GLENVIEW ROAD

Parameter	Station and Date				
	Lake/Cook Rd. Skokie River 6/30/81	Lake/Cook Rd. Skokie River 11/17/81	Frontage Rd. Skokie River 7/7/81	Frontage Rd. Skokie River 11/17/81	Glenview Rd. North Branch Chicago River 7/16/81
Fluoride	NA	0.670	NA	0.620	NA
Phenol (µg/l)	<1	1	1	2	1
Chloride	70	98	98	118	82
Soluble Phosphorus	1.0	2.9	0.9	1.0	0.8
Sulfate	NA	90	NA	98	NA
Cyanide	0.011	<0.014	0.007	<0.014	0.004
Fats, Oils & Greases	<1	1.0	1.0	1.0	<1
Total Organic Carbon	NA	NA	NA	NA	NA
Turbidity (NTU)	43	3	17	8.3	24
Alkalinity	152	176	170	192	300
MBAS	NA	NA	NA	NA	NA
Field Temp. (°C)	19.8	15.0	25.8	6.9	22.5
Field Dissolved Oxygen	5.4	10.2	8.6	16.5	5.0
Zinc	0.1	<0.1	<0.1	<0.1	0.1
Cadmium	<0.02	<0.02	<0.02	<0.02	<0.02
Copper	0.02	<0.02	<0.02	<0.02	0.02
Chromium	0.03	<0.02	<0.02	<0.02	0.03
Iron	2.9	0.1	1.1	0.2	2.0
Nickel	0.1	<0.01	<0.01	<0.01	<0.01
Lead	0.04	<0.01	0.03	<0.01	0.05
Manganese	NA	0.02	NA	0.02	NA
Magnesium	23.0	30.0	32.0	33.0	23.5
Calcium	59.0	70.0	74.0	75.0	59.0
Selenium	NA	<0.2	NA	<0.2	NA
Arsenic	NA	<0.2	NA	<0.2	NA
Hardness	242	298	316	323	244

Table continued on the following page.

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE AI-5 (Continued)

1981 NORTH BRANCH OF THE CHICAGO RIVER CHEMICAL DATA COLLECTED AT LAKE/COOK ROAD, FRONTAGE ROAD AND GLENVIEW ROAD

Parameter	Station and Date				
	Lake/Cook Rd. Skokie River 6/30/81	Lake/Cook Rd. Skokie River 11/17/81	Frontage Rd. Skokie River 7/7/81	Frontage Rd. Skokie River 11/17/81	Glenview Rd. North Branch Chicago River 7/16/81
Silver (µg/l)	2.5	<0.1	2.4	<0.1	2.1
Barium	NA	<0.1	NA	<0.1	NA
Mercury (µg/l)	<0.05	<0.05	<0.05	<0.05	0.3
Total Solids	571	620	670	667	1864
Total Volatile Solids	219	176	330	191	1515
Total Suspended Solids	92	8	48	23	84
Total Vol. Susp. Solids	28	<1	20	12	14
Total Kjeldahl Nitrogen	1.5	0.9	1.9	1.9	1.7
Ammonia-Nitrogen	0.6	<0.1	<0.1	0.1	0.4
Organic Nitrogen	0.9	0.9	1.9	1.8	1.3
Nitrate + Nitrite	4.1	14.8	2.4	8.1	2.8
COD	46	9	53	28	36
BOD	3	2	7	12	5
pH (Units)	8.2	7.8	8.4	9.0	7.4
Conductivity (µmhos/cm)	700	900	850	1000	725
Sodium	NA	50	NA	80	NA
Potassium	NA	2.8	NA	5.6	NA
Aluminum	NA	<1	NA	<1	NA
Total residual chlorine	0.00	NA	NA	NA	0.00

NOTE: All parameters in mg/l unless otherwise noted; NA = No analysis performed; < = below detection limit. All total residual chlorine samples were collected and analyzed on 7/9/81.

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE AI-6

1981 NORTH BRANCH OF THE CHICAGO RIVER CHEMICAL DATA COLLECTED AT GLENVIEW ROAD, DEMPSTER STREET AND ALBANY AVENUE

Parameter	Station and Date				
	Glenview Rd. North Branch Chicago River 11/12/81	Dempster St. North Branch Chicago River 7/21/81	Dempster St. North Branch Chicago River 11/12/81	Albany Ave. North Branch Chicago River 7/28/81	Albany Ave. North Branch Chicago River 11/12/81
Fluoride	0.510	NA	0.460	NA	0.450
Phenol (µg/l)	4	2	<1	2	<1
Chloride	114	46	118	38	120
Soluble Phosphorus	0.8	0.6	0.7	0.4	0.7
Sulfate	94	NA	92	NA	91
Cyanide	0.007	0.006	0.007	0.006	0.007
Fats, Oils & Greases	3	2	1	3	3
Total Organic Carbon	NA	NA	NA	NA	NA
Turbidity (NTU)	5.5	33	9	23	7.5
Alkalinity	230	88	250	80	260
MBAS	NA	NA	NA	NA	NA
Field Temp. (°C)	8.2	NA	7.3	18.2	6.4
Field Dissolved Oxygen	19.2	NA	13.5	4.9	11.6
Zinc	<0.1	0.1	<0.1	<0.1	<0.1
Cadmium	<0.02	<0.02	<0.02	<0.02	<0.02
Copper	<0.02	0.03	<0.02	<0.02	<0.02
Chromium	<0.02	<0.02	<0.02	<0.02	<0.02
Iron	0.2	2.1	0.5	2.5	0.4
Nickel	<0.01	<0.01	<0.01	<0.01	<0.01
Lead	<0.01	0.05	<0.01	0.04	<0.01
Manganese	0.04	NA	0.05	NA	0.05
Magnesium	34.0	14.0	35.0	12.0	34.0
Calcium	80.0	35.5	85.0	30.5	85.0
Selenium	<0.2	NA	<0.2	NA	<0.2
Arsenic	<0.2	NA	<0.2	NA	<0.2
Hardness	340	146	357	126	359

Table continued on the following page.

THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

TABLE AI-6 (Continued)

1981 NORTH BRANCH OF THE CHICAGO RIVER CHEMICAL DATA COLLECTED AT GLENVIEW ROAD, DEMPSTER STREET AND ALBANY AVENUE

Parameter	Station and Date				
	Glenview Rd. North Branch Chicago River 11/12/81	Dempster St. North Branch Chicago River 7/21/81	Dempster St. North Branch Chicago River 11/12/81	Albany Ave. North Branch Chicago River 7/28/81	Albany Ave. North Branch Chicago River 11/12/81
Silver (µg/l)	<0.1	0.4	<0.1	0.5	<0.1
Barium	<0.1	NA	<0.1	NA	<0.1
Mercury (µg/l)	<0.05	0.2	0.1	<0.05	0.1
Total Solids	642	326	660	351	661
Total Volatile Solids	157	85	157	106	151
Total Suspended Solids	25	92	32	111	19
Total Vol. Susp. Solids	19	29	16	20	13
Total Kjeldahl Nitrogen	2.3	1.6	2.2	1.9	1.7
Ammonia-Nitrogen	<0.1	0.4	0.1	0.5	<0.1
Organic Nitrogen	2.3	1.2	2.1	1.4	1.7
Nitrate + Nitrite	5.7	1.3	4.7	1.8	3.5
COD	57	47	60	51	41
BOD	11	8	8	11	6
pH (Units)	9.1	6.9	8.8	7.3	8.5
Conductivity (µmhos/cm)	1050	450	1100	380	1100
Sodium	80	NA	80	NA	80
Potassium	5.5	NA	5.2	NA	5.6
Aluminum	<1	NA	<1	NA	1.0
Total residual chlorine	NA	0.00	NA	0.00	NA

NOTE: All parameters in mg/l unless otherwise noted; NA = No analysis performed; < = below detection limit. All total residual chlorine samples were collected and analyzed on 7/9/81.