Protecting Our Water Environment

Metropolitan Water Reclamation District of Greater Chicago

MONITORING AND RESEARCH DEPARTMENT

REPORT NO. 17-24

WATER AND SEDIMENT QUALITY ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT LOCK TO THE PEORIA LOCK BETWEEN 1977–2011

AN OVERVIEW

June 2017

Metropolitan Water Reclamation District of Greater Chicago
100 East Erie Street Chicago, Illinois 60611-2803 (312) 751-5600

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By

Thomas A. Minarik, Jr.
Senior Aquatic Biologist

Jennifer L. Wasik
Supervising Aquatic Biologist

Monitoring and Research Department
Edward W. Podczerwinski, Acting Director

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LIST OF ABBREVIATIONS

Abbreviation/Acronym	Definition
Ag	silver
ANOVA	analysis of variance
As	arsenic
BOD_5	five-day biochemical oxygen demand
CAWS	Chicago Area Waterway System
Cd	cadmium
CSO	combined sewer overflow
Cr	chromium
Cu	copper
CWA	Clean Water Act
District	Metropolitan Water Reclamation District of Greater Chicago
DO	dissolved oxygen
E. coli	*Escherichia coli*
FC	fecal coliform
Fe	iron
Hg	mercury
IDNR	Illinois Department of Natural Resources
IEPA	Illinois Environmental Protection Agency
ILWW	Illinois Waterway
INHS	Illinois Natural History Survey
IPCB	Illinois Pollution Control Board
ISWS	Illinois State Water Survey
MGD	million gallons per day
Mn	manganese
NH_3-N	un-ionized ammonia
NH_4-N	ammonia nitrogen
Ni	nickel
NO_2+NO_3-N	nitrite plus nitrate nitrogen
NPDES	National Pollutant Discharge Elimination System
O’Brien	Terrence J. O’Brien
Pb	lead
SEPA	Side-Stream Elevated Pool Aeration
Sol.	soluble
Standard Methods	*Standard Methods for the Examination of Water and Wastewater*
TARP	Tunnel and Reservoir Plan
TCN	total cyanide
TKN	total Kjeldahl Nitrogen
TN	total nitrogen
TP	total phosphorus
TS	total solids

LIST OF ABBREVIATIONS (Continued)

Abbreviation/Acronym	Definition
TSS	total suspended solids
TVS	total volatile solids
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WRP	Water Reclamation Plant
Zn	zinc

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DISCLAIMER

Mention of proprietary equipment and chemicals in this report does not constitute endorsement by the Metropolitan Water Reclamation District of Greater Chicago.

SUMMARY AND CONCLUSIONS

Description of the Program

The Illinois Waterway (ILWW) monitoring program was designed by the Metropolitan Water Reclamation District of Greater Chicago (District) to assess the water quality and sediment chemistry within a 133 river mile reach from Chicago to Peoria, Illinois. Forty-nine monitoring stations were selected within six navigational pools on the ILWW system. Each station was sampled for many water quality parameters once or twice in the spring, summer, and fall for the first time in 1977 and subsequently from 1983 to 2011, except for 1998. Sediment samples were only collected in the fall from selected stations.

Throughout the duration of this program, many process and infrastructure investments were made at the District's water reclamation plants (WRPs) and within its service area to improve water quality. Many of these investments are attributed to requirements under the Clean Water Act (CWA). The goals of the ILWW monitoring program were to generate information that could be used to assess any changes to the water quality downstream of the District's point source discharges and assess the sediment quality. For the duration of this program, this is the most extensive long-term data set on the ILWW collected by any agency.

Significant Findings

All of the water and sediment quality data collected during the ILWW monitoring were placed into a database and assessed for further statistical analysis. The data that qualified were analyzed for spatial and temporal trends.

The trend analysis on the water quality data was conducted for 43 of the water quality constituents measured. The results showed that the trend of yearly means for a majority of the stations was positive for three parameters, negative for eight parameters, and no trend for 32 parameters. A positive temporal trend was observed for dissolved oxygen (DO) that clearly showed more significance for the upper pools of the ILWW as compared to the lower pools. Negative temporal trends were observed for ammonia nitrogen (NH_4-N) and total cyanide (TCN). The upper pools of the ILWW had the biggest reduction in NH_4-N mean concentration compared to the lower pools. Each of these noted water quality improvements corresponded with changes in the District's operations that include upgrades to the treatment processes at the District's WRPs, industrial pretreatment enforcement, the Tunnel and Reservoir Plan (TARP), and the installation of supplemental aeration stations on the Chicago Area Waterway System (CAWS).

The trend analysis on the sediment quality was conducted on 20 of the parameters measured at 14 stations. The temporal trend analysis showed that none of the parameters had the same trend for all of the sample stations. The parameter with the most distinct trend was TCN, where seven of the 14 monitored stations showed a negative trend. This trend follows that of the water chemistry and is most likely attributable to the success of the pretreatment program and enforcement initiatives to limit cyanide discharge from the metal plating industry. Additionally, a review of the sediment quality statistical summaries reveal some spatial differences with many of the sediment chemistry parameters having the highest mean values in the upper pools of the ILWW.

INTRODUCTION

History and Purpose of the Monitoring Program

The ILWW is a water resource for agricultural and urban drainage, commercial and recreational navigation, electric power generation, fishing, industrial and public water supply, and other recreational activities. One of the principal functions of this waterway is for storm water and treated wastewater conveyance. At the upstream end of the ILWW, the District operates three major WRPs in Cook County, Illinois. The treated discharges from these WRPs make up approximately 90 percent of all point source treated wastewater flows entering the ILWW at Lockport (Wasik, 2003). In the years 2002 through 2011, these three WRPs provided wastewater treatment for an average flow of 1,216 million gallons per day (MGD).

The District began monitoring the ILWW in 1977. From 1983 to 2011, except for 1998, the District conducted water quality surveys from the Lockport Lock to the Peoria Lock, a distance of 133 river miles. Data from previous years have been compiled in formal annual reports for 1977, 1983 through 1985, 1989, 1990, 1991, and the individual years of 2002 through 2011.

Forty-nine monitoring stations in six navigational pools were selected for study. Each station was typically sampled six times per year. More frequent monitoring along the ILWW study reach occurred during 1989, 1990, and 1991 as a result of a mandate by the Illinois Pollution Control Board (IPCB) ruling in the Matter of: Amendments to Water Quality and Effluent Standards Applicable to the Chicago River System and Calumet River System (R1987-027).

The primary purpose of the monitoring program was to assess water quality changes downstream of the District's major point source discharges. A secondary objective was to characterize the sediment quality at selected monitoring stations.

This report assesses the data collected through the District's ILWW Monitoring Program and evaluates the following:

1. Changes in water quality throughout the waterway over time.

2. Compare seasonal differences in water quality.

3. Evaluate the relation between nutrients and other water quality parameters.

4. Changes in sediment quality throughout the waterway over time.

Description of the Study Area

Illinois Waterway. The ILWW extends from Grafton, Illinois, located on the Mississippi River upstream of St. Louis, Missouri, to Lake Michigan in Chicago, Illinois. The 327-mile waterway is composed of a series of eight navigational pools (Lockport, Brandon Road, Dresden Island, Marseilles, Starved Rock, Peoria, LaGrange, and Alton) created in the 1930s by lock and dam structures to maintain the water depths required for commercial navigation. The lengths and United States Army Corps of Engineers waterway mile-point designations of these pools are presented in Table 1, and an overview map of the ILWW program area showing the monitoring stations are presented in Figure 1.

The selected study area is a 133-mile reach of the ILWW, extending from the Lockport Lock to the Peoria Lock (Figures 2 and 3).

Monitoring Stations. Forty-nine monitoring stations were selected for the study (Figures 2 and 3; Table 2). Two stations were located on the Chicago Sanitary and Ship Canal, eight on the Des Plaines River, and 39 stations on the Illinois River. During the study period, Stations 1 through 8 were designated as Secondary Contact and Indigenous Aquatic Life Species Waters and the remaining stations were designated as General Use Waters by the IPCB.

TABLE 1: ILLINOIS WATERWAY NAVIGATIONAL POOLS

Navigational Pool	Inclusive Waterway Mile-Points	Length (Miles)
Lockport	327.2–291.0	36.2
Brandon Road	291.0–286.0	5.0
Dresden Island	286.0–271.5	14.5
Marseilles	271.5–244.5	27.0
Starved Rock	244.5–231.0	13.5
Peoria	231.0–157.6	73.4
LaGrange	157.6–80.2	77.4
Alton	80.2–0.0	80.2

FIGURE 1: ILLINOIS WATERWAY

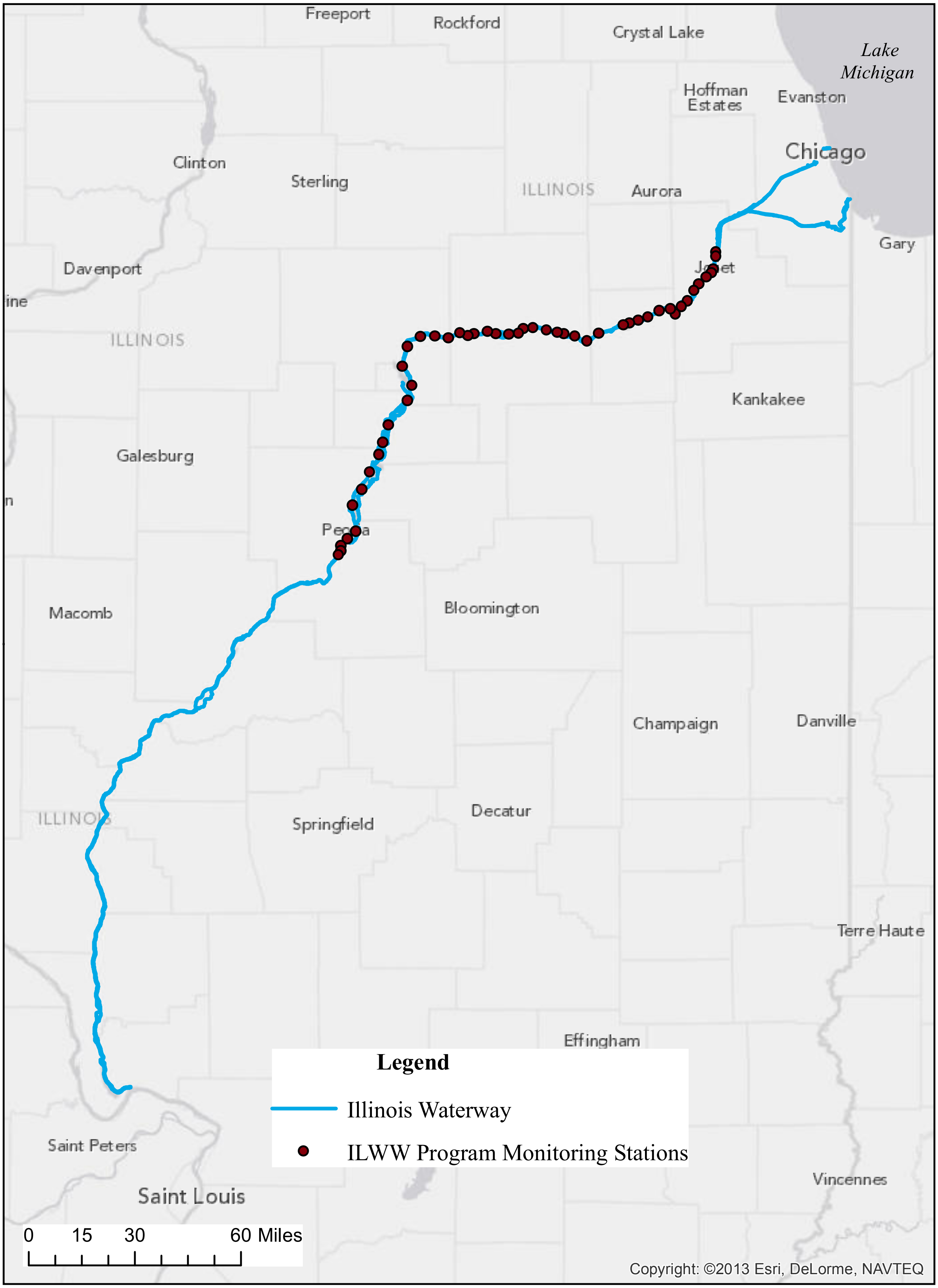

FIGURE 2: MAP OF THE ILLINOIS WATERWAY FROM LOCKPORT TO MARSEILLES SHOWING SAMPLING STATIONS 1 TO 21

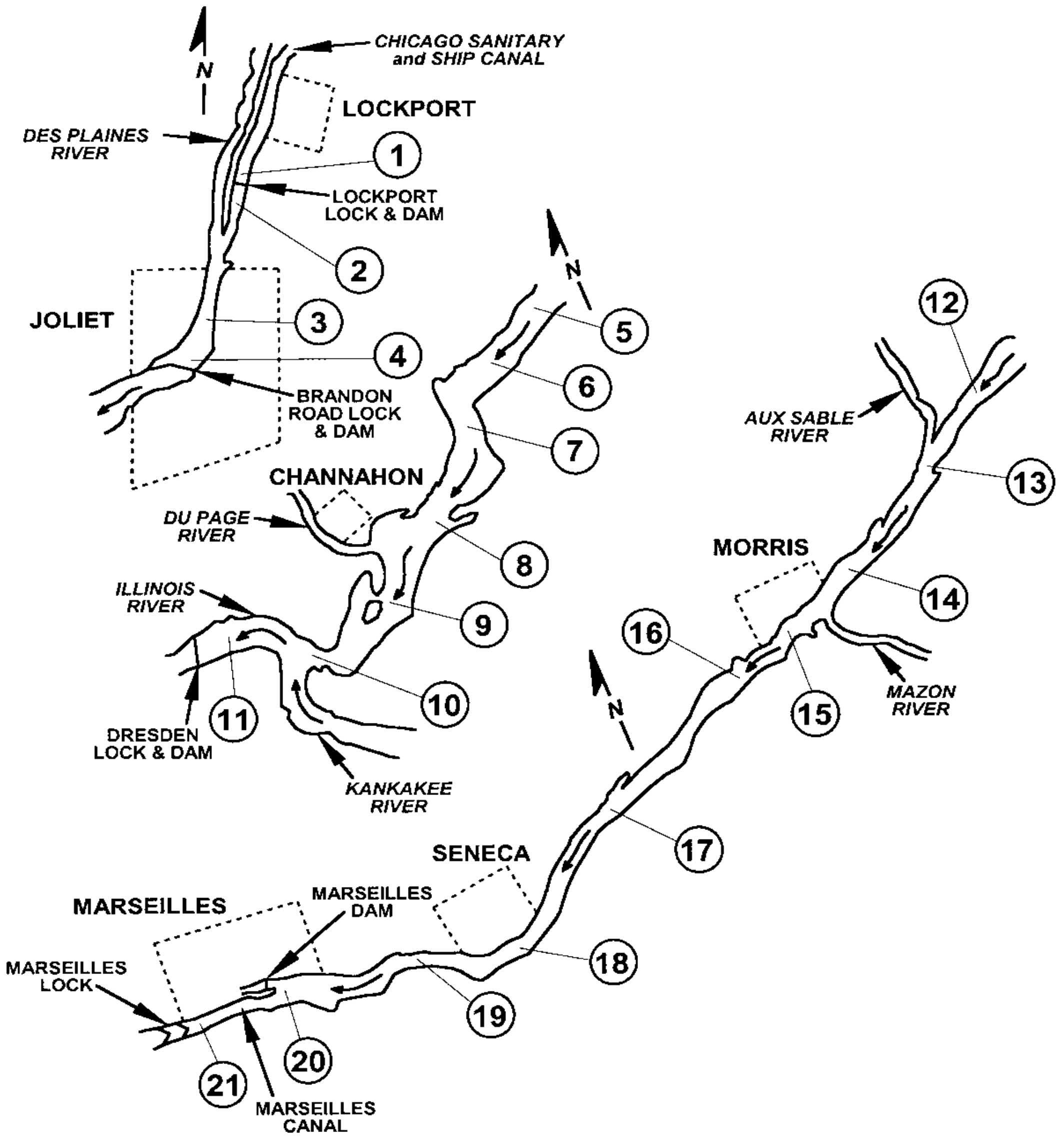

FIGURE 3: MAP OF THE ILLINOIS WATERWAY FROM OTTAWA TO PEORIA SHOWING SAMPLING STATIONS 22 TO 49

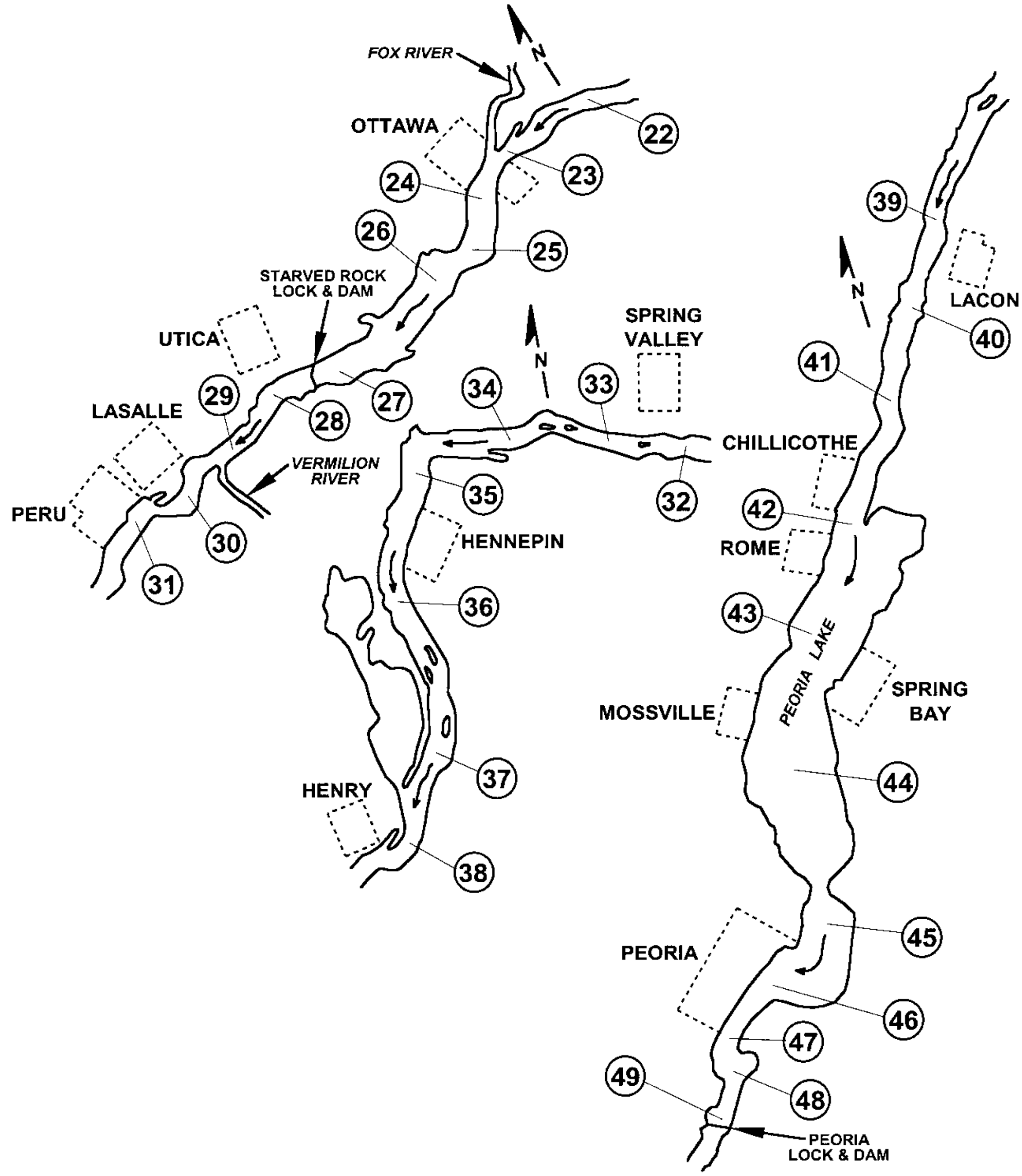

TABLE 2: MONITORING STATIONS ALONG THE ILLINOIS WATERWAY FROM LOCKPORT LOCK TO PEORIA LOCK

Station Number	Waterway	Waterway Mile-Point Location	Navigational Pool
1	Chicago Sanitary and Ship Canal	291.5	Lockport
2	Chicago Sanitary and Ship Canal	290.5	Brandon Road
3	Des Plaines River	287.3	Brandon Road
4	Des Plaines River	286.5	Brandon Road
5	Des Plaines River	285.0	Dresden Island
6	Des Plaines River	282.8	Dresden Island
7	Des Plaines River	280.5	Dresden Island
8	Des Plaines River	278.0	Dresden Island
9	Des Plaines River	276.1	Dresden Island
10	Des Plaines River	274.0	Dresden Island
11	Illinois River	272.4	Dresden Island
12	Illinois River	270.0	Marseilles
13	Illinois River	267.2	Marseilles
14	Illinois River	265.0	Marseilles
15	Illinois River	263.0	Marseilles
16	Illinois River	261.6	Marseilles
17	Illinois River	256.0	Marseilles
18	Illinois River	253.0	Marseilles
19	Illinois River	250.0	Marseilles
20	Illinois River	247.5	Marseilles
21	Illinois River	246.0	Marseilles
22	Illinois River	243.7	Starved Rock
23	Illinois River	240.6	Starved Rock
24	Illinois River	238.5	Starved Rock
25	Illinois River	236.8	Starved Rock
26	Illinois River	234.5	Starved Rock
27	Illinois River	231.7	Starved Rock
28	Illinois River	229.6	Peoria
29	Illinois River	226.9	Peoria
30	Illinois River	224.7	Peoria
31	Illinois River	222.6	Peoria
32	Illinois River	219.8	Peoria
33	Illinois River	217.1	Peoria
34	Illinois River	213.4	Peoria
35	Illinois River	209.4	Peoria
36	Illinois River	205.0	Peoria
37	Illinois River	200.4	Peoria
38	Illinois River	196.9	Peoria

TABLE 2 (Continued): MONITORING STATIONS ALONG THE ILLINOIS WATERWAY FROM LOCKPORT LOCK TO PEORIA LOCK

Station Number	Waterway	Waterway Mile-Point Location	Navigational Pool
39	Illinois River	190.0	Peoria
40	Illinois River	186.4	Peoria
41	Illinois River	183.2	Peoria
42	Illinois River	179.0	Peoria
43	Illinois River	174.9	Peoria
44	Illinois River	170.9	Peoria
45	Illinois River	165.3	Peoria
46	Illinois River	162.8	Peoria
47	Illinois River	160.6	Peoria
48	Illinois River	159.4	Peoria
49	Illinois River	158.2	Peoria

OVERVIEW OF THE REGULATORY CHANGES DURING THE ILLINOIS WATERWAY PROGRAM STUDY PERIOD

The National Pollutant Discharge Elimination System (NPDES) permit and enforcement program was created under the CWA to limit the discharge of certain pollutants from point sources. The District operates three major WRPs that discharge approximately 1,200 MGD into the Lockport Pool. The first NPDES permits were issued to the District in 1974. The NPDES permit for the Calumet, Stickney, and the Terrence J. O'Brien (O'Brien) WRPs were renewed four times during the ILWW program study period. Each renewal involved a review of the current conditions and a change in the effluent limits for certain parameters when needed. There was a major reduction in five-day biochemical oxygen demand (BOD_5), total suspended solids (TSS), and NH_4-N effluent limits at the Stickney and Calumet WRPs after the NPDES permits were renewed in 1979 and 1977, respectively. The Calumet WRP was also subject to a more restrictive TCN effluent limit in 1977 and again in 1988. These reductions in the effluent limits resulted in a significant reduction in loading to the waterways. The DO effluent limits were added to the Calumet and O'Brien WRP permits in 1977 and 1979, respectively, and matched the effluent limit in the Stickney WRP permit to improve DO levels in the waterways. Effluent limits for some of the general chemistry parameters in recent permits of the Calumet, Stickney, and O'Brien WRPs are shown in Tables 3, 4, and 5.

TABLE 3: CALUMET WATER RECLAMATION PLANT NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM GENERAL CHEMISTRY EFFLUENT LIMITS

Selected Parameters	Effective Date of NPDES Permit[1]			
	3/1/2002	7/29/1988	7/31/1977	1/30/1975
DO, mg/L			6.0	
NH_4-N, mg/L	(2.5/4.0) 5.0/8.0 s	(13)	2.5/4.0 s	(25)[38]
$CBOD_5$, mg/L	(10)[20]	(24)[48]		
BOD_5, mg/L			(10)[15]	(50)[60]
SS, mg/L	(15)[25]	(28)[56]	(12)[18]	(30)[45]
CN, mg/L	(0.15) 0.30	0.11	0.025	0.46
FC, cfu/100 mL, geometric mean			400	(200)[400]

[1]Effluent limits not available for NPDES permit modified 10/10/1980.
All values are maximum daily values except those noted below.
( ) = maximum monthly average.
s = seasonal (April–October/November–March for NH_4-N).
[ ] = maximum weekly average.

TABLE 4: STICKNEY WATER RECLAMATION PLANT NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM GENERAL CHEMISTRY EFFLUENT LIMITS

Selected Parameters	Effective Date of NPDES Permit				
	3/1/2002	11/30/1987	6/11/1982	2/26/1979	12/10/1975
DO, mg/L	6.0	6.0	6.0	6.0	6.0
NH_4-N, mg/L	(2.5/4.0) 5.0/8.0 s	(2.5/4.0) s	2.5/4.0 s	2.5/4.0 s	(30)[15]
$CBOD_5$, mg/L	(10)[15]	(10)[20]			
BOD_5 , mg/L			(10)[20]	(10)[15]	(25)[38]
SS, mg/L	(12)[20]	(12)[25]	(12)[25]	(12)[18]	(30)[45]
CN, mg/L				0.025	
FC, cfu/100 mL geometric mean				400	(200)[400]

All values are maximum daily values except those noted below.
( ) = maximum monthly average.
s = seasonal (April - October/November - March for NH_4-N).
[ ] = maximum weekly average.

TABLE 5: TERRENCE J. O'BRIEN WATER RECLAMATION PLANT NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM GENERAL CHEMISTRY EFFLUENT LIMITS

Selected Parameters	Effective Date of NPDES Permit				
	3/1/2002	7/29/1988	9/5/1982	3/7/1979	1/30/1975
DO, mg/L			6.0	6.0	
NH_4-N, mg/L	(2.5/4.0) 5.0/8.0 s	(2.5/4.0) s	(2.5/4.0) s	2.5/4.0 s	(2.5/4.0) s
$CBOD_5$, mg/L	(10)[12]	(12)[24]			
BOD_5, mg/L			(10)[20]	(10)[15]	(10)[15]
SS, mg/L	(12)[18]	(20)[40]	(12)[25]	(12)[18]	(12)[18]
CN, mg/L		0.10		0.025	
FC, cfu/100 ml geometric mean				400	(200)[400]

All values are maximum daily values except those noted below.
( ) = maximum monthly average.
s = seasonal (April–October/November–March for NH_4-N).
[ ] = maximum weekly average.

OVERVIEW OF METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO INFRASTRUCTURE IMPROVEMENTS DURING THE ILLINOIS WATERWAY PROGRAM STUDY PERIOD

The District has made many improvements to its infrastructure and operations during the ILWW Monitoring Program period. Many of these improvements were made in response to new regulations, including new water quality standards and NPDES effluent limits and special conditions. A timeline of these improvements is presented below.

1970s User Charge Ordinance implemented (1979).

In-stream aeration station constructed on the North Shore Channel (1979).

1980s In-stream aeration station constructed on the North Branch of the Chicago River (1980).

The IPCB granted variance to discontinue disinfection of Calumet effluent (1983).

IPCB granted variance to discontinue disinfection of discharges into Secondary Contact Waters (1984).

Discontinued chlorination at the North Side and West-Southwest plants (1984).

Mainstream TARP Tunnel System completed (1985).

Calumet TARP Pump Station and Mainstream TARP pump station on line (1985).

Des Plaines TARP Tunnel System under construction.

Expanded secondary treatment plant capacity at the Calumet WRP with addition of Batteries E1 and E2 (1985).

The United States Environmental Protection Agency (USEPA) approved the District's Pretreatment Program (1985).

Cal-Sag Leg Tunnel System of the Calumet TARP System completed (1986).

Nitrification of Calumet effluent evident (1987).

1990s Design of the Thornton Composite Reservoir and McCook Reservoir underway.

Construction of other portions of the Calumet TARP Tunnel System.

Improved nitrification at the Stickney, Calumet, and North Side WRPs.

SEPA stations along the Cal-Sag Channel (1992 and 1994).

Implementation of the Part 503 biosolids use or disposal regulations (USEPA 1993).

SEPA stations along the Calumet River and Little Calumet River on line (1994).

O'Hare Chicago Underflow Plan Reservoir completed (1998).

Des Plaines TARP Tunnel System completed (1999).

2000s Thornton transitional reservoir online (2003).

Completed Calumet TARP Tunnel System (2006).

Completed Phase I of TARP, pollution control tunnels (2006).

Design and construction of various components of the Master Plans for the three major WRPs.

MATERIALS AND METHODS

Field Monitoring and Laboratory Analysis

The ILWW Monitoring Program was conducted under the guidance of a quality assurance project plan. This plan is available on the District website (www.mwrd.org). Sample collection trips were conducted with the aid of the District's pollution control boat. Samples were collected at each station on the downstream trip from Chicago to Peoria and again on the upstream from Peoria to Chicago. Each sample was collected from the boat in the center of the waterway at a fixed location marked by GPS coordinates according to the project plan. Each one way sample trip typically took four days and the samples were collected from the same locations over the duration of the project.

Water.

Chemical Constituents. Water samples for chemical analyses were collected from the 49 monitoring stations during the first two weeks of May, August, and October of most years. Monitoring was sometimes done in consecutive months. During summer 2009 through 2011, sampling was done only on the downstream trip. The sample dates for all of the events are listed in Table 6. Samples were collected at a depth of three feet below the water surface in the center of the waterway with a submersible drainage pump. Except for fecal coliform (FC) and *Escherichia coli* (*E. coli*), all water samples were transported to the Cecil Lue-Hing Monitoring and Research Department Laboratory by District vehicle in iced, insulated chests within 24 hours of collection. Samples for FC and *E. coli* analysis were transported to a contracted laboratory to meet holding time requirements.

The constituents analyzed in water, sample containers used, and preservation methods are presented in Table 7. Some parameters were not analyzed in all years during the monitoring period. Water temperature, turbidity, conductivity, DO, and pH were measured in the field using a calibrated water quality monitor for the years 2000 to 2011. In prior years, all of these parameters were analyzed in the laboratory except temperature, which was always measured in the field. In the laboratory, all constituents were analyzed using procedures established by the USEPA, except suspended solids, BOD_5, TCN, total metals, and total mercury (Hg), which were analyzed according to *Standard Methods for the Examination of Water and Wastewater* (*Standard Methods*). The concentration of un-ionized ammonia (NH_3-N) was calculated using the equation given by the Illinois Environmental Protection Agency (IEPA) in Section 302.407 of Title 35. During the total of 29 years of monitoring, analytical results that were lower than the detection limits were reported as zero in the earlier years, but in later years they are reported as less than the method detection limit or limit of quantification.

Bacteria. Water samples for FC and *E. coli* analyses were collected from the 49 stations concurrently with samples for chemical analysis. *E. coli* analysis was only conducted for the years 2005 through 2011. Samples were collected with a submersible drainage pump at a depth of three feet below the water surface in the center of the waterway. The sample was poured into a sterile, 175-mL plastic bottle containing 0.3 mL of a 15 percent solution of sodium thiosulfate and 0.1 mL of a 10 percent solution of ethylenediamineteraacetic acid. The samples were kept

TABLE 6: ILLINOIS WATERWAY PROGRAM SAMPLE COLLECTION DATES

Year	Collection Dates
1977	8/23–25, 8/30–9/2, 9/12–15, 9/20–22, 10/3–6, 10/10–11, 10/13–14
1983	9/19–22, 9/26–29, 10/3–6, 10/10–13
1984	5/7–10, 5/15–18, 8/6–9, 8/14–17, 10/1–4, 10/9–12
1985	5/6–9, 5/14–17, 8/5–8, 8/13–16, 10/7–10, 10/15–18
1986	5/5–8, 5/13–16, 8/4–7, 8/12–15, 10/20–23, 10/28–31
1987	5/4–7, 5/12–15, 8/3–6, 8/11–14, 10/4–8, 10/13–16
1988	5/9–12, 5/17–19, 8/1–4, 8/9–12, 10/3–6, 10/11–14
1989	5/8–11, 5/15–18, 6/19–22, 6/26–28, 7/10–12, 7/17–18, 8/7–10, 8/14–17, 9/5–6, 9/11–12, 10/2–5, 10/10–13
1990	4/30–5/1–2, 5/7–10, 5/14–17, 5/21–23, 8/6–8, 8/14–16, 8/20–22, 10/1–4, 10/9–12, 10/15–17
1991	8/5–8, 8/13–16, 8/19–20, 9/3–4, 9/9–10, 9/16–17, 10/7–10, 10/15–18, 10/21–23
1992	5/4–7, 5/12–15, 8/3–6, 8/11–14, 10/5–8, 10/13–16
1993	5/3–6, 5/11–14, 8/2–5, 8/10–13, 10/4–7, 10/12–15
1994	5/2–5, 5/10–13, 8/1–4, 8/9–12, 10/3–6, 10/11–14
1995	5/1–4, 5/9–12, 10/2–5, 10/10–13
1996	8/5–8, 8/13–16, 10/7–10, 10/15–18
1997	8/4–7, 8/12–15
1999	8/2–5, 8/10–13, 10/4–7, 10/12–15
2000	5/1–4, 5/9–12, 8/7–10, 8/15–18, 10/2–5, 10/10–13
2001	5/7–10, 5/15–18, 8/6–9, 8/14–17, 10/1–4, 10/9–12
2002	5/6–9, 5/14–17, 8/5–8, 8/13–16, 10/7–10, 10/15–18
2003	5/5–8, 5/13–16, 8/4–7, 8/12–15, 10/6–9, 10/14–17
2004	5/3–6, 5/11–14, 8/2–5, 8/10–13, 10/4–7, 10/12–15
2005	5/2–5, 5/10–13, 8/1–4, 8/9–12, 10/3–6, 10/11–14
2006	5/1–4, 5/9–12, 8/7–10, 8/15–18, 10/2–5, 10/10–13
2007	5/7–10, 5/15–18, 8/6–9, 8/14–17, 10/1–4, 10/9–12
2008	5/5–8, 5/13–16, 8/4–7, 8/12–15, 10/6–9, 10/14–17
2009	5/4–7, 5/12–15, 8/3–6, 10/5–8
2010	5/3–6, 8/2–5, 10/4–7
2011	5/2–5, 8/1–4, 10/3–6

TABLE 7: CONSTITUENTS ANALYZED, SAMPLE CONTAINERS, AND PRESERVATION METHODS FOR WATER SAMPLES COLLECTED FROM THE ILLINOIS WATERWAY STUDY AREA

Constituent and Abbreviation	Units of Measure	Sample Container	Preservative
Water Temperature (Temp)	°C	NA	Measured in Field
Total Suspended Solids (TSS)	mg/L	Plastic	Cool, 4°C
Total Organic Carbon (TOC)	mg/L	Plastic	Cool, 4°C
Turbidity (Turb)	NTU	NA	Measured in Field
Conductivity (Cond)	µS/cm	NA	Measured in Field
Five-Day Biochemical Oxygen Demand (BOD_5)	mg/L	Plastic	Cool, 4°C
Dissolved Oxygen (DO)	mg/L	NA	Measured in Field
pH	units	NA	Measured in Field
Ammonia Nitrogen (NH_4-N)	mg/L	Plastic	Cool, 4°C, H_2SO_4 to pH < 2
Un-ionized Ammonia (NH_3-N)[1]	mg/L	—	—
Total Kjeldahl Nitrogen (TKN)	mg/L	Plastic	Cool, 4°C, H_2SO_4 to pH < 2
Nitrite plus Nitrate Nitrogen (NO_2+NO_3-N)	mg/L	Plastic	Cool, 4°C, H_2SO_4 to pH < 2

TABLE 7 (Continued): CONSTITUENTS ANALYZED, SAMPLE CONTAINERS, AND PRESERVATION METHODS FOR WATER SAMPLES COLLECTED FROM THE ILLINOIS WATERWAY STUDY AREA

Constituent and Abbreviation	Units of Measure	Sample Container	Preservative
Total Nitrogen (TN)[2]	mg/L	—	—
Total Phosphorus (TP)	mg/L	Plastic	Cool, 4°C
Chlorophyll a (Chlrphl)	μg/L	Plastic, Amber	Cool, 4°C, $MgCO_3$
Total Cyanide (TCN)	mg/L	Plastic	NaOH to pH 12
Phenols (Phenol)	mg/L	Glass	H_2SO_4 to pH <2
Fats, Oils, and Greases (FOG)	mg/L	Glass	Cool, 4°C
Hardness (Hard)[3]	mg/L	—	—
Total and Soluble Metals(Arsenic, Cadmium, Chromium, Copper, Iron, Lead, Manganese, Mercury, Nickel, Silver, and Zinc)	mg/L	Plastic	HNO_3 to pH < 2
Fecal Coliform (FC)	cfu/100 mL	Sterile Plastic	Cool, 4°C, EDTA[4], and Thiosulfate
Escherichia coli (E. coli)	cfu/100 mL	Sterile Plastic	Cool, 4°C, EDTA, and Thiosulfate

[1]Determined by calculation using water temperature, pH and NH_4-N.
[2]Determined by calculation using TKN and NO_2+NO_3-N.
[3]Determined by calculation using Ca and Mg.
[4]Ethylenediaminetetraacetic acid.

cool in iced, insulated chests. The analyses were performed within 24 hours by membrane filter analysis as described in *Standard Methods*.

Chlorophyll a. Beginning in 2002, water samples for chlorophyll *a* analysis were collected at 22 selected monitoring stations (2, 3, 5, 7, 10, 11, 15, 18, 20, 22, 25, 27, 28, 31, 34, 36, 38, 41, 42, 44, 45, and 48) in the same manner as described for chemical constituents. The sample was poured into a 1-liter, wide-mouth, amber plastic bottle containing 1 mg of magnesium carbonate. The water samples were stored in iced, insulated chests. The water samples were analyzed for chlorophyll *a* as described in *Standard Methods*.

Sediment. Sediment samples were collected once per year during surveys between 1983-1996, 1999-2009, and 2011 at 14 of the 49 monitoring stations (1, 2, 5, 8, 12, 18, 23, 28, 32, 35, 38, 41, 44, and 48). During the first week of October, one sediment sample was taken with a six-by-six inch Ponar grab sampler from each of the 14 stations. The sediment sample was transferred to a wide-mouth, quart glass jar and analyzed for total solids (TS), total volatile solids (TVS), chemical oxygen demand, NH4-N, total Kjeldahl nitrogen (TKN), nitrite plus nitrate nitrogen (NO_2+NO_3-N), total phosphorus (TP), TCN, phenols, arsenic, cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead, manganese (Mn), Hg, nickel (Ni), silver (Ag), and zinc (Zn). The constituents analyzed are listed in Table 8. All constituents were analyzed according to USEPA procedures, except TS, TVS, TCN, and total and soluble metals, which were analyzed according to *Standard Methods*.

Statistical Analysis

Water. All of the water quality data collected during the ILWW monitoring program were entered in Microsoft Excel® spreadsheets and compiled in a custom database. The data were reviewed to determine if the number of observations and quality of data for each station and year were adequate for statistical analysis. Before conducting statistical tests, we removed any observation which fell outside the interval of the mean plus or minus five times the standard deviation. We chose this interval because the probability of observing a data point outside this range is less than 1/25 (four percent) according to Chebyshev's Theorem even if the data is not within a normal distribution. If the data is within a normal distribution, this probability is near zero. We also removed all observations of any parameter whose standard deviation is zero or near zero before analysis because no meaningful analysis is possible when the result is nearly always the same. After this initial evaluation of data, four parameters did not qualify for statistical analysis, including *E. coli*, total calcium, total magnesium, and soluble Hg. Additionally, we removed all observations for a parameter if the number of observations was less than five because at least four observations are required to perform correlation analysis. As a result, of the 29 years sampled, a total of 21 years of monitoring data qualified for analysis, including the years 1977, 1984 through 1994, and 2000 through 2008. Of a total of 47 water quality parameters that were reviewed for potential analysis, 43 parameters qualified for statistical analysis. The parameters that qualified for this analysis and the corresponding code number are listed in Table 9.

The water quality data was analyzed to evaluate spatial and temporal relationships and trends. The relationships and trends within the individual ILWW pools were also evaluated.

TABLE 8: CONSTITUENTS ANALYZED IN SEDIMENT SAMPLES COLLECTED FROM THE ILLINOIS WATERWAY STUDY AREA[1]

Constituent and Abbreviation	Units of Measure[2]
Total Solids (TS)	percent
Total Volatile Solids (TVS)	percent
Chemical Oxygen Demand (COD)	mg/kg
Ammonia Nitrogen (NH_4-N)	mg/kg
Total Kjeldahl Nitrogen (TKN)	mg/kg
Nitrite plus Nitrate Nitrogen (NO_2+NO_3-N)	mg/kg
Total Phosphorus (TP)	mg/kg
Total Cyanide (TCN)	mg/kg
Phenols	mg/kg
Total Metals (Arsenic, Cadmium, Chromium, Copper, Iron, Lead, Manganese, Mercury, Nickel, Silver, and Zinc)	mg/kg

[1]All samples stored in glass container and preserved at 4°C.
[2]Expressed on a dry weight basis.

TABLE 9: WATER QUALITY PARAMETERS THAT QUALIFIED FOR STATISTICAL ANALYSIS AND THEIR RESPECTIVE CODES

Constituent	Abbreviation	Units of Measure	Parameter Code
Water Temperature	Temp	°C	1
Dissolved Oxygen	DO	mg/L	2
Five-Day Biochemical Oxygen Demand	BOD_5	mg/L	3
Total Organic Carbon	TOC	mg/L	4
Total Suspend Solids	TSS	mg/L	5
Ammonia Nitrogen	NH_4-N	mg/L	6
Total Kjeldahl Nitrogen	TKN	mg/L	7
Nitrite plus Nitrate Nitrogen	NO_2+NO_3-N	mg/L	8
Total Nitrogen	TN	mg/L	9
Total Phosphorus	TP	mg/L	10
pH	—	mg/L	11
Total Cyanide	TCN	mg/L	12
Phenols	Phenol	mg/L	13
Fats, Oils, and Greases	FOG	mg/L	14
Total Arsenic	As	mg/L	15
Total Cadmium	Cd	mg/L	16
Total Chromium	Cr	mg/L	17
Total Copper	Cu	mg/L	18
Total Iron	Fe	mg/L	19
Total Lead	Pb	mg/L	20
Total Manganese	Mn	mg/L	21
Total Mercury	Hg	mg/L	22
Total Nickel	Ni	mg/L	23
Total Silver	Ag	mg/L	24
Total Zinc	Zn	mg/L	25
Fecal Coliform	FC	cfu/100 mL	26
Nitrite Nitrogen	NO_2	mg/L	28
Nitrate Nitrogen	NO_3	mg/L	29
Hardness	Hard	mg/L	32
Soluble Arsenic	Sol. As	mg/L	33
Soluble Cadmium	Sol. Cd	mg/L	34
Soluble Chromium	Sol. Cr	mg/L	35
Soluble Copper	Sol. Cu	mg/L	36
Soluble Iron	Sol. Fe	mg/L	37
Soluble Lead	Sol. Pb	mg/L	38
Soluble Manganese	Sol. Mn	mg/L	39
Soluble Nickel	Sol. Ni	mg/L	41
Soluble Silver	Sol. Ag	mg/L	42
Soluble Zinc	Sol. Zn	mg/L	43

TABLE 9 (Continued): WATER QUALITY PARAMETERS THAT QUALIFIED FOR STATISTICAL ANALYSIS AND THEIR RESPECTIVE CODES

Constituent	Abbreviation	Units of Measure	Parameter Code
Conductivity	Cond	μS/cm	44
Turbidity	Turb	NTU	45
Chlorophyll *a*	Chlrphl	μg/L	46
Un-ionized Ammonia	NH_3-N	mg/L	47

[1]Abbreviations and parameter codes are used for reference in the tables.

Analysis of variance (ANOVA) was done to evaluate differences in concentration of parameters for each station over the years and between seasons. Seasons were defined as spring - April or May, summer - June through August, and fall - September through November. ANOVA was also done to evaluate differences between waterway pools for each year and each season. Trend analysis was conducted using the Mann-Kendall method to evaluate overall temporal trends in the constituent concentrations for all individual concentrations and yearly mean concentrations at each station.

The relationships between nutrients and other selected water quality parameters were evaluated on data from 2002 through 2011. This analysis was done to determine if the yearly means of selected independent variables were related to selected dependent variables. A simple linear regression analysis was done to evaluate potential relationships between nutrients versus DO, TSS, turbidity, and chlorophyll *a*, and to evaluate the relationships between DO, turbidity, and chlorophyll *a*.

Sediment. The procedures for reviewing the sediment quality data were the same as those described previously for water quality data. As there was only one result per parameter for each sampled station in a year, only limited statistical analyses were recommended. However, since there were 26 total years of sediment quality data available, some qualified analyses were performed and none of the parameters or results were excluded from the statistical analysis. Twenty parameters were analyzed at each of the fourteen sediment monitoring locations. The sediment parameters that were analyzed and the corresponding code number are listed in Table 10.

Temporal analyses using Auto Regressive Integrated Moving Average and the Mann-Kendall non-parametric method were done to evaluate the trends for each chemical parameter at each sample location.

A spatial analysis was done to determine if there was a significant difference in the number of times that a parameter was detected at +1.5 times the standard deviation of the mean or greater between sample locations. The first part involved an overall analysis to test the hypothesis that the variances and means of the ratios are equal for each parameter at all of the stations. The second part of the analysis involved a multiple comparison between the location with the highest ratio and each of the other locations with a ranking based on Tukey's studentized multiple comparison test. If a location had zero detections of a parameter that were +1.5 times the standard deviation of the mean or greater, it was excluded from the analyses.

A regression analysis was used to evaluate relationships between water chemistry and sediment chemistry using the yearly means at stations where parameters were analyzed in both matrices. Sediment chemistry was only collected one time at each station per year.

TABLE 10: SEDIMENT QUALITY PARAMETERS THAT QUALIFIED FOR STATISTICAL ANALYSIS AND THEIR RESPECTIVE CODES

Constituent	Abbreviation	Unit of Measure	Parameter Code
Total Solids	TS	percent	1
Total Volatile Solids	TVS	percent	2
Chemical Oxygen Demand	COD	mg/kg	3
Ammonia Nitrogen	NH_4-N	mg/kg	4
Total Kjeldahl Nitrogen	TKN	mg/kg	5
Nitrite plus Nitrate Nitrogen	NO_2+NO_3-N	mg/kg	6
Total Phosphorus	TP	mg/kg	7
Total Cyanide	TCN	mg/kg	8
Phenols	Phenol	mg/kg	9
Total Arsenic	As	mg/kg	10
Total Cadmium	Cd	mg/kg	11
Total Chromium	Cr	mg/kg	12
Total Copper	Cu	mg/kg	13
Total Iron	Fe	mg/kg	14
Total Lead	Pb	mg/kg	15
Total Manganese	Mn	mg/kg	16
Total Mercury	Hg	mg/kg	17
Total Nickel	Ni	mg/kg	18
Total Silver	Ag	mg/kg	19
Total Zinc	Zn	mg/kg	20

[1]Parameter codes are used for reference in the tables.

RESULTS

Water Quality

Water quality in lotic ecosystems can be evaluated by assessing a combination of biological, chemical, and physical parameters, including bacterial levels, the concentrations of dissolved gases, dissolved and suspended inorganic and organic compounds, nutrients, water temperature, and rate of flow. Methods for measuring the biological and chemical constituents and the physical properties of water are well defined, and they have considerable precision. While sediment quality can reflect long-term effect of conditions over time, water samples are indicative of the water quality only at the time of monitoring.

In order to further assess and describe water quality in the ILWW, the 133-mile study reach was divided by navigational pool:

1. Lockport (Station 1).
2. Brandon Road (Stations 2 through 4).
3. Dresden Island (Stations 5 through 11).
4. Marseilles (Stations 12 through 21).
5. Starved Rock (Stations 22 through 27).
6. Peoria, upper Peoria (Stations 28 through 41), and lower Peoria (Stations 42 through 49).

The Peoria Pool was subdivided based on geo-morphological differences between the upper and lower sub-reaches.

The water quality data for selected general water chemistry parameters are summarized by season for each navigational pool in Appendix Tables A1 through A7 and for trace metals in Appendix Tables A8 through A14. This summary analysis includes all of the available data. The concentrations of trace metals in many samples were below the detection limits and were therefore reported as zero, or less than the detection or reporting limits. To perform statistical analysis, the limit value was used when the reported result was less than the limit and therefore, the mean values calculated are conservatively higher than actual. This practice in handling the "less than" values was used for all analyses conducted for this report. Additional water quality data for the ILWW program and annual summary reports can be found on the District website.

A select number of water quality parameters were further analyzed by evaluating the trends of the annual seasonal means on a timeline for each navigational pool. The parameters were ammonia, TCN, DO, total nitrogen (TN), and TP. The goal was to evaluate the seasonal and spatial variability in levels of the parameters between ILWW pools. The results of this evaluation are presented in Appendix Figures B-1 through B-5. These figures include all of the available data.

The following paragraphs include the results for the analyses that were done on only the 43 water quality parameters that qualified for additional statistical analysis.

The data for each monitoring station over the monitoring period were analyzed using the ANOVA procedure. The results showed that there were significant differences over time for each monitoring station for a range of 18 to 31 of the 43 water quality parameters analyzed (Table 11). Seven of the parameters were found to be significant at all 49 stations, including NH_4-N, TP, pH, phenol, Fe, NO_2-N, and soluble Fe (Sol. Fe). On average, each monitoring station showed a significant annual variation for a majority of the parameters analyzed. The ANOVA procedure was also used to evaluate differences in annual concentrations for each ILWW pool over the monitoring period. The results showed significant annual differences for a range of 10 to 28 of the 43 water quality parameters analyzed for each individual waterway pool (Table 12). Nine of the parameters were found to be significant in all seven pools, including DO, NH_4-N, NO_2+NO_3-N, TP, Phenol, FC, NO_2, NO_3, and Sol. Fe.

The ANOVA procedure was used to evaluate seasonal differences over the monitoring period. The results showed significant seasonal differences for each monitoring station for a range of seven to 16 parameters out of 43 (Table 13). Two of the parameters were found to be significant at all 49 stations, including Temp and NO_2+NO_3-N. The results showed significant seasonal differences for each waterway pool for a range of 15 to 41 parameters out of 43 (Table 14). Twelve of the parameters were found to be significant in all seven pools, including Temp, TOC, TKN, NO_2+NO_3-N, TN, Mn, Ni, Hard, Sol. Cd, Sol. Ni, Sol. Zn, and Cond. The seasonal difference for the parameters in each pool was much lower in the Lockport Pool (pool No. 1) compared to the lower pools of the ILWW.

The trend analysis using the Mann-Kendall method to evaluate overall trends in the constituent concentrations for all of the locations over the years showed varying results (Table 15). An overall negative trend was observed at >50 percent of the stations for 11 parameters, including BOD, NH_4-N, TCN, phenols, fats oils and greases, total Mn, FC, nitrite nitrogen, and soluble Cr, Cu, and Fe. An overall positive trend was observed at >50 percent of the stations for seven parameters, including DO, TP, pH, total iron, total Zn, nitrate nitrogen, and soluble Mn. No trend was observed at >50 percent of the stations for 24 parameters.

The trend analysis using the yearly mean of the constituent concentrations to evaluate trends over the years for each sample station showed varying results (Table 16). An overall negative trend was observed at >50 percent of the stations for eight parameters, including NH_4-N, TCN, phenols, total Cd, total Hg, total Ni, total Ag, and soluble Cr. An overall positive trend was observed at >50 percent of the stations for three parameters, including DO, TP, and pH. No trend was observed at >50 percent of the stations for 32 parameters.

The results of the simple regression analysis showed that both TP and TN were negatively related to DO, TSS, turbidity, and chlorophyll *a* (Table 17), with R^2 ranging from 0.316 to 0.759. The relationship between chlorophyll *a* and both TP and TN had the highest R^2, showing a negative correlation (as TP and TN increased, chlorophyll decreased). The results for DO and turbidity versus chlorophyll *a* showed a weak positive relationship. A test of significance was done to assess the strength of the correlation against the null hypothesis and an alternative hypothesis and the results are shown as a test on R in Table 17.

TABLE 11: LIST OF WATER QUALITY PARAMETERS FOR EACH ILLINOIS WATERWAY STATION SHOWING SIGNIFICANT ANNUAL VARIATION DURING THE MONITORING PERIOD

Location	Significant Parameters		
	List	Number	Percent
1	2, 4, 5, 6, 8, 10, 11, 12, 13, 17, 19, 21, 26, 28, 29, 34, 37, 38, 39	19	44.2
2	2, 6, 7, 8, 10, 11, 12, 13, 14, 17, 18, 19, 20, 21, 26, 28, 29, 34, 37, 39, 41, 47	22	51.2
3	2, 3, 6, 8, 9, 10, 11, 12, 13, 14, 17, 19, 20, 21, 26, 28, 29, 36, 37, 45	20	46.5
4	2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 17, 18, 19, 20, 21, 25, 26, 28, 29, 37, 41	22	51.2
5	1, 2, 3, 5, 6, 7, 8, 10, 11, 12, 13, 14, 17, 18, 19, 20, 21, 22, 26, 28, 29, 34, 36, 37, 41, 45, 47	27	62.8
6	1, 2, 3, 4, 6, 7, 8, 10, 11, 12, 13, 14, 17, 18, 19, 20, 21, 25, 26, 28, 29, 35, 36, 37, 41, 47	26	60.5
7	1, 2, 3, 5, 6, 7, 8, 10, 11, 12, 13, 17, 18, 19, 20, 21, 22, 25, 28, 29, 34, 37, 41, 46, 47	25	58.1
8	1, 2, 3, 5, 6, 7, 8, 10, 11, 12, 13, 17, 18, 19, 20, 21, 25, 26, 28, 29, 32, 34, 36, 37, 38, 41, 47	27	62.8
9	1, 2, 3, 6, 7, 8, 10, 11, 12, 13, 18, 19, 20, 21, 26, 28, 29, 34, 36, 37, 41, 45, 47	23	53.5
10	1, 2, 3, 6, 7, 8, 9, 10, 11, 12, 13, 17, 19, 20, 21, 22, 25, 26, 28, 29, 34, 37, 38, 41, 43	25	58.1
11	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 17, 18, 19, 20, 21, 22, 25, 26, 28, 29, 34, 36, 37, 41, 43	27	62.8
12	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 18, 19, 20, 21, 25, 28, 29, 32, 34, 37, 39, 41, 45, 47	26	60.5
13	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 17, 18, 19, 20, 21, 22, 25, 26, 28, 29, 34, 36, 37, 41, 47	28	65.1
14	1, 2, 3, 4, 6, 8, 10, 11, 12, 13, 17, 18, 19, 20, 21, 25, 26, 28, 29, 34, 37, 39, 41, 45, 47	25	58.1
15	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 17, 18, 19, 20, 21, 25, 26, 28, 29, 34, 35, 37, 41, 45, 47	27	62.8
16	1, 2, 3, 5, 6, 9, 10, 11, 12, 13, 17, 18, 19, 20, 21, 22, 25, 26, 28, 29, 34, 37, 38, 39, 41, 45, 47	27	62.8
17	1, 2, 3, 4, 6, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 25, 26, 28, 29, 36, 37, 38, 45, 47	28	65.1
18	1, 2, 3, 4, 5, 6, 8, 10, 11, 12, 13, 18, 19, 20, 21, 23, 25, 28, 29, 35, 37, 41, 45, 47	24	55.8
19	1, 2, 3, 6, 8, 10, 11, 12, 13, 14, 18, 19, 20, 21, 22, 23, 25, 28, 29, 32, 36, 37, 39, 41, 44, 45, 47	27	62.8

TABLE 11 (Continued): LIST OF WATER QUALITY PARAMETERS FOR EACH ILLINOIS WATERWAY STATION SHOWING SIGNIFICANT ANNUAL VARIATION DURING THE MONITORING PERIOD

Location	Significant Parameters List	Number	Percent
20	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 17, 18, 19, 20, 21, 22, 23, 25, 26, 28, 29, 32, 35, 36, 37, 41, 43, 47	31	72.1
21	1, 2, 3, 5, 6, 7, 8, 10, 11, 12, 13, 17, 18, 19, 21, 23, 25, 28, 29, 37, 38, 39, 41, 43, 44, 45, 47	27	62.8
22	1, 2, 3, 6, 7, 8, 10, 11, 12, 13, 14, 17, 18, 19, 20, 21, 23, 25, 28, 29, 34, 37, 38, 41, 47	25	58.1
23	1, 2, 3, 6, 8, 10, 11, 12, 13, 14, 18, 19, 20, 21, 25, 28, 29, 32, 36, 37, 41, 47	22	51.2
24	1, 2, 3, 4, 6, 8, 10, 11, 12, 13, 17, 18, 19, 20, 21, 23, 26, 28, 29, 34, 37, 38, 39, 43, 47	25	58.1
25	1, 2, 3, 4, 6, 10, 11, 12, 13, 17, 18, 19, 20, 21, 22, 25, 28, 29, 35, 37, 39, 41, 43, 44, 45, 47	26	60.5
26	1, 2, 3, 6, 7, 8, 9, 10, 11, 12, 13, 16, 18, 19, 20, 21, 25, 26, 28, 29, 37, 39, 43, 47	24	55.8
27	1, 2, 3, 6, 8, 10, 11, 12, 13, 17, 18, 19, 21, 25, 28, 29, 34, 35, 37, 39, 41, 47	22	51.2
28	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 13, 18, 19, 21, 23, 28, 29, 35, 37, 39, 41, 44, 47	23	53.5
29	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 18, 19, 20, 21, 25, 26, 28, 29, 34, 35, 36, 37, 38, 41, 44, 45, 47	29	67.4
30	1, 2, 4, 5, 6, 7, 8, 10, 11, 13, 18, 19, 20, 21, 22, 23, 25, 28, 29, 32, 34, 35, 36, 37, 39, 43, 47	27	62.8
31	1, 2, 3, 4, 5, 6, 8, 10, 11, 12, 13, 18, 19, 21, 23, 25, 28, 29, 34, 36, 37, 38, 39, 41, 47	25	58.1
32	1, 2, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 18, 19, 21, 25, 26, 28, 29, 37, 39, 41, 43, 47	24	55.8
33	1, 2, 3, 5, 6, 7, 8, 10, 11, 12, 13, 18, 19, 20, 21, 23, 25, 26, 28, 29, 34, 36, 37, 39, 41, 43, 47	27	62.8
34	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 18, 19, 20, 25, 26, 28, 29, 32, 35, 37, 39, 41, 43, 45, 47	28	65.1
35	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 14, 17, 18, 19, 20, 21, 23, 25, 26, 28, 29, 32, 34, 36, 37, 38, 39, 41, 47	31	72.1
36	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 17, 18, 19, 20, 21, 23, 25, 26, 28, 29, 36, 37, 39, 41, 47	28	65.1
37	1, 2, 4, 6, 8, 10, 11, 12, 13, 18, 19, 20, 21, 23, 25, 26, 28, 29, 32, 34, 36, 37, 39, 41, 43, 44, 47	27	62.8
38	1, 2, 3, 6, 7, 8, 10, 11, 12, 13, 16, 17, 18, 19, 20, 21, 23, 25, 26, 28, 29, 37, 38, 41, 43, 47	26	60.5

TABLE 11 (Continued): LIST OF WATER QUALITY PARAMETERS FOR EACH ILLINOIS WATERWAY STATION SHOWING SIGNIFICANT ANNUAL VARIATION DURING THE MONITORING PERIOD

Location	Significant Parameters List	Number	Percent
39	1, 2, 3, 6, 8, 10, 11, 12, 13, 19, 20, 21, 25, 28, 29, 37, 41, 47	18	41.9
40	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 17, 18, 19, 21, 23, 25, 26, 28, 29, 36, 37, 38, 39, 41, 47	29	67.4
41	1, 5, 6, 7, 9, 10, 11, 12, 13, 14, 18, 19, 20, 21, 23, 25, 26, 28, 29, 37, 41, 44, 46, 47	24	55.8
42	1, 3, 5, 6, 7, 9, 10, 11, 12, 13, 16, 18, 19, 20, 21, 23, 25, 28, 29, 35, 37, 38, 39, 41, 47	25	58.1
43	2, 3, 6, 9, 10, 11, 12, 13, 18, 19, 20, 21, 26, 28, 32, 37, 39, 41, 47	19	44.2
44	3, 5, 6, 9, 10, 11, 12, 13, 18, 19, 20, 21, 25, 28, 37, 38, 41, 45, 47	19	44.2
45	3, 6, 7, 8, 10, 11, 12, 13, 16, 18, 19, 21, 25, 28, 34, 35, 37, 38, 39, 41, 46, 47	22	51.2
46	3, 5, 6, 8, 10, 11, 12, 13, 18, 19, 21, 25, 26, 28, 37, 39, 41, 43, 45, 47	20	46.5
47	2, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 25, 26, 28, 32, 36, 37, 39, 41, 43, 45, 47	29	67.4
48	3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 17, 18, 19, 21, 25, 26, 28, 37, 38, 39, 41, 45, 47	24	55.8
49	3, 4, 6, 7, 8, 10, 11, 12, 13, 14, 18, 19, 20, 21, 22, 23, 25, 26, 28, 32, 34, 36, 37, 43, 45, 47	26	60.5

TABLE 12: LIST OF WATER QUALITY PARAMETERS FOR EACH ILLINOIS WATERWAY POOL SHOWING SIGNIFICANT ANNUAL VARIATION DURING THE MONITORING PERIOD

Pool	List of Water Quality Parameter Codes	Significant Parameters	
		Total	Percent
1	2, 6, 8, 10, 13, 26, 28, 29, 34, 37	10	23.3
2	2, 5, 6, 7, 8, 9, 10, 12, 13, 18, 19, 20, 26, 28, 29, 34, 36, 37	18	41.9
3	1, 2, 6, 8, 9, 10, 11, 12, 13, 16, 18, 20, 21, 26, 28, 29, 37, 38, 45	19	44.2
4	1, 2, 3, 6, 8, 9, 10, 11, 12, 13, 17, 20, 25, 26, 28, 29, 36, 37, 38, 41, 43	21	48.8
5	2, 3, 5, 6, 8, 9, 10, 11, 12, 13, 16, 17, 18, 19, 21, 22, 26, 28, 29, 34, 36, 37, 38, 41, 43, 44, 45, 47	28	65.1
6	2, 3, 4, 6, 7, 8, 10, 11, 12, 13, 17, 18, 19, 21, 26, 28, 29, 37, 38, 41, 47	21	48.8
7	1, 2, 3, 6, 7, 8, 10, 11, 12, 13, 16, 18, 20, 26, 28, 29, 34, 37, 41, 43, 46, 47	22	51.2

TABLE 13: SIGNIFICANT SEASONAL WATER QUALITY PARAMETERS FOR EACH ILLINOIS WATERWAY STATION MONITORED OVER THE YEARS

		Significant Parameters	
Station	List of Water Quality Parameter Codes	Total	Percent
1	1, 6, 7, 8, 9, 32, 34, 39, 41, 42, 43, 44	12	27.9
2	1, 2, 8, 9, 21, 32, 34, 39, 44	9	20.9
3	1, 2, 8, 21, 23, 32, 34, 37, 39, 44, 46	11	25.6
4	1, 2, 3, 8, 9, 10, 21, 32, 34, 39, 44	11	25.6
5	1, 2, 8, 9, 21, 32, 34, 37, 39, 44, 46	11	25.6
6	1, 2, 4, 6, 7, 8, 9, 19, 21, 26, 32, 34, 39, 44	14	32.6
7	1, 2, 5, 6, 7, 8, 9, 21, 32, 39, 44, 46	12	27.9
8	1, 2, 6, 7, 8, 19, 20, 21, 26, 32, 34, 39, 44	13	30.2
9	1, 2, 6, 8, 9, 19, 21, 32, 39, 44, 47	11	25.6
10	1, 2, 4, 6, 7, 8, 9, 10, 21, 32, 34, 39, 44	13	30.2
11	1, 2, 5, 7, 8, 9, 19, 21, 32, 39, 44, 47	12	27.9
12	1, 2, 5, 7, 8, 9, 10, 12, 22, 24, 26, 32, 34, 36, 39, 44	16	37.2
13	1, 2, 5, 7, 8, 9, 10, 21, 29, 32, 34, 39, 44, 47	14	32.6
14	1, 2, 5, 7, 8, 9, 10, 21, 29, 32, 44, 47	12	27.9
15	1, 2, 5, 7, 8, 9, 10, 29, 32, 36, 44, 47	12	27.9
16	1, 2, 5, 7, 8, 9, 10, 21, 29, 32, 44, 47	12	27.9
17	1, 2, 5, 7, 8, 9, 10, 19, 21, 25, 29, 32, 34, 41, 44	15	34.9
18	1, 2, 7, 8, 9, 10, 12, 15, 21, 29, 32, 44	12	27.9
19	1, 2, 8, 9, 10, 29, 32, 44	8	18.6
20	1, 2, 3, 8, 9, 10, 16, 21, 24, 29, 32, 44	12	27.9
21	1, 2, 5, 8, 9, 10, 29, 32, 34, 44	10	23.3
22	1, 2, 7, 8, 9, 10, 20, 29, 32, 39, 43, 44	12	27.9
23	1, 2, 7, 8, 9, 10, 12, 21, 29, 32, 35, 44	12	27.9
24	1, 2, 7, 8, 9, 10, 21, 29, 32, 41, 44, 45	12	27.9
25	1, 2, 8, 9, 10, 29, 32, 34, 44, 45	10	23.3
26	1, 6, 8, 9, 10, 29, 32, 36, 44	6	20.9
27	1, 2, 7, 8, 9, 10, 17, 29, 32, 44	10	23.3
28	1, 2, 5, 7, 8, 9, 10, 12, 29, 32, 44	11	25.6
29	1, 2, 5, 7, 8, 9, 10, 29, 32, 39, 44	11	25.6
30	1, 2, 5, 6, 8, 9, 10, 12, 25, 29, 32, 44	12	27.9
31	1, 2, 5, 7, 8, 9, 10, 17, 29, 32, 34, 36, 41, 44, 45	15	34.9
32	1, 2, 5, 8, 9, 10, 12, 25, 29, 32, 36, 44	12	27.9
33	1, 2, 5, 8, 9, 10, 29, 32, 44	9	20.9
34	1, 2, 5, 7, 8, 9, 10, 12, 17, 29, 32	11	25.6
35	1, 2, 3, 8, 9, 10, 29, 32, 34, 41, 44	11	25.6
36	1, 2, 7, 8, 9, 10, 29, 32, 44	9	20.9
37	1, 2, 3, 7, 8, 9, 10, 17, 29, 32, 44	11	25.6
38	1, 2, 7, 8, 9, 10, 29, 32, 44	9	20.9

TABLE 13 (Continued): SIGNIFICANT SEASONAL WATER QUALITY PARAMETERS FOR EACH ILLINOIS WATERWAY STATION MONITORED OVER THE YEARS

Station	List of Water Quality Parameter Codes	Significant Parameters	
		Total	Percent
39	1, 2, 3, 8, 9, 10, 12, 16, 29, 32, 41, 44	12	27.9
40	1, 2, 8, 9, 10, 12, 16, 21, 29, 32, 41, 44	12	27.9
41	1, 2, 8, 9, 10, 29, 44	7	16.3
42	1, 2, 5, 8, 9, 10, 29, 32, 44	9	20.9
43	1, 2, 8, 9, 10, 12, 29, 32, 44	9	20.9
44	1, 2, 8, 9, 10, 29, 32, 44, 45	9	20.9
45	1, 2, 8, 9, 10, 18, 29, 32, 36, 44, 45, 46	12	27.9
46	1, 2, 7, 8, 9, 10, 21, 29, 32, 44	10	23.3
47	1, 2, 6, 7, 8, 9, 10, 29, 32, 44	10	23.3
48	1, 2, 7, 8, 9, 10, 12, 29, 32, 36, 44	11	25.6
49	1, 2, 6, 7, 8, 9, 10, 21, 29, 32, 44	11	25.6

TABLE 14: SIGNIFICANT SEASONAL WATER QUALITY PARAMETERS FOR EACH ILLINOIS WATERWAY POOL MONITORED OVER THE YEARS

Pool	List of Water Quality Parameter Codes	Significant Parameters	
		Total	Percent
1	1, 4, 7, 8, 9, 21, 23, 32, 34, 35, 37, 39, 41, 43, 44	15	34.9
2	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 21, 23, 24, 26, 28, 29, 32, 34, 35, 37, 39, 41, 43, 44, 46, 47	29	67.4
3	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 18, 19, 20, 21, 23, 24, 26, 28, 29, 32, 34, 36, 37, 38, 39, 41, 43, 44, 45, 46, 47	34	79.1
4	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 19, 20, 21, 22, 23, 24, 26, 28, 29, 32, 34, 35, 36, 37, 38, 39, 41, 42, 43, 44, 45, 46, 47	37	86.0
5	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 19, 20, 21, 22, 23, 24, 26, 28, 29, 32, 34, 35, 36, 37, 38, 39, 41, 42, 43, 44, 45, 47	39	90.7
6	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 19, 20, 21, 22, 23, 24, 25, 26, 28, 29, 32, 34, 35, 36, 37, 38, 39, 41, 42, 43, 44, 45, 46, 47	41	95.3
7	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 15, 16, 17, 18, 20, 21, 22, 23, 24, 25, 26, 28, 29, 32, 34, 35, 36, 38, 41, 43, 44, 45, 46, 47	35	81.4

TABLE 15: OVERALL CONCENTRATION TREND OVER TIME FOR THE WATER QUALITY PARAMETERS MEASURED AT ALL OF THE ILLINOIS WATERWAY MONITORED STATIONS

Code	Parameter Assayed Name	Number of Stations: Concentration Trend[1] Negative	None	Positive	Total Sampled
1	Temp (°C)	0	40	9	49
2	DO (mg/L)	0	10	39	49
3	BOD_5 (mg/L)	25	24	0	49
4	TOC (mg/L)	0	37	12	49
5	TSS (mg/L)	8	34	7	49
6	NH_4-N (mg/L)	39	10	0	49
7	TKN (mg/L)	11	38	0	49
8	NO_2+NO_3-N (mg/L)	0	32	17	49
9	TN (mg/L)	6	43	0	49
10	TP (mg/L)	0	0	49	49
11	pH (mg/L)	0	4	45	49
12	CN (mg/L)	49	0	0	49
13	Phenol (mg/L)	49	0	0	49
14	FOG (mg/L)	33	16	0	49
15	As (mg/L)	0	49	0	49
16	Cd (mg/L)	0	47	2	49
17	Cr (mg/L)	0	45	4	49
18	Cu (mg/L)	0	43	6	49
19	Fe (mg/L)	0	8	41	49
20	Pb (mg/L)	0	42	7	49
21	Mn (mg/L)	32	17	0	49
22	Hg (µg/L)	9	40	0	49
23	Ni (mg/L)	0	47	2	49
24	Ag (mg/L)	1	48	0	49
25	Zn (mg/L)	0	14	35	49
26	FC (cfu/100mL)	39	10	0	49
28	NO_2 (mg/L)	45	4	0	49
29	NO_3 (mg/L)	0	6	43	49
32	Hard (mg/L)	0	49	0	49
33	Sol. As (mg/L)	0	49	0	49
34	Sol. Cd (mg/L)	1	48	0	49
35	Sol. Cr (mg/L)	41	8	0	49
36	Sol. Cu (mg/L)	32	17	0	49
37	Sol. Fe (mg/L)	48	1	0	49
38	Sol. Pb (mg/L)	0	49	0	49
39	Sol. Mn (mg/L)	0	19	30	49
41	Sol. Ni (mg/L)	15	34	0	49

TABLE 15 (Continued): OVERALL CONCENTRATION TREND OVER TIME FOR THE WATER QUALITY PARAMETERS MEASURED AT ALL OF THE ILLINOIS WATERWAY MONITORED STATIONS

Parameter Assayed		Number of Stations			
		Concentration Trend[1]			Total
Code	Name	Negative	None	Positive	Sampled
42	Sol. Ag (mg/L)	2	47	0	49
43	Sol. Zn (mg/L)	0	38	11	49
44	Cond (μS/cm)	0	49	0	49
45	Turb (NTU)	9	40	0	49
46	Chlrphl (μg/L)	7	15	0	22
47	NH_3-N (mg/L)	9	16	24	49

[1]Determined by the Mann-Kendall method.

TABLE 16: MEAN CONCENTRATION TREND OVER TIME FOR THE WATER QUALITY PARAMETERS MEASURED AT ALL OF THE ILLINOIS WATERWAY MONITORED STATIONS

Parameter Assayed		Number of Stations			
		Concentration Trend[1]			Total
Code	Name	Negative	None	Positive	Sampled
1	Temp (°C)	0	39	10	49
2	DO (mg/L)	0	14	35	49
3	BOD_5 (mg/L)	12	37	0	49
4	TOC (mg/L)	0	48	1	49
5	TSS (mg/L)	0	46	3	49
6	NH_4-N (mg/L)	35	14	0	49
7	TKN (mg/L)	0	49	0	49
8	NO_2+NO_3-N (mg/L)	0	36	13	49
9	TN (mg/L)	1	48	0	49
10	TP (mg/L)	0	13	36	49
11	pH (mg/L)	0	4	45	49
12	CN (mg/L)	49	0	0	49
13	Phenol (mg/L)	46	3	0	49
14	FOG (mg/L)	8	41	0	49
15	As (mg/L)	11	38	0	49
16	Cd (mg/L)	34	15	0	49
17	Cr (mg/L)	1	48	0	49
18	Cu (mg/L)	0	49	0	49
19	Fe (mg/L)	0	27	22	49
20	Pb (mg/L)	0	49	0	49
21	Mn (mg/L)	7	41	1	49
22	Hg (µg/L)	27	22	0	49
23	Ni (mg/L)	45	4	0	49
24	Ag (mg/L)	41	8	0	49
25	Zn (mg/L)	0	49	0	49
26	FC (cfu/100mL)	24	25	0	49
28	NO_2 (mg/L)	0	49	0	49
29	NO_3 (mg/L)	0	40	9	49
32	Hard (mg/L)	0	49	0	49
33	Sol. As (mg/L)	0	49	0	49
34	Sol Cd (mg/L)	0	49	0	49
35	Sol. Cr (mg/L)	39	10	0	49
36	Sol. Cu (mg/L)	9	40	0	49
37	Sol. Fe (mg/L)	10	39	0	49
38	Sol. Pb (mg/L)	0	49	0	49
39	Sol. Mn (mg/L)	0	48	1	49
41	Sol. Ni (mg/L)	0	49	0	49

TABLE 16 (Continued): MEAN CONCENTRATION TREND OVER TIME FOR THE WATER QUALITY PARAMETERS MEASURED AT ALL OF THE ILLINOIS WATERWAY MONITORED STATIONS

Parameter Assayed		Number of Stations			
		Concentration Trend[1]			Total
Code	Name	Negative	None	Positive	Sampled
42	Sol. Ag (mg/L)	0	49	0	49
43	Sol. Zn (mg/L)	0	46	3	49
44	Cond (μS/cm)	0	49	0	49
45	Turb (NTU)	2	47	0	49
46	Chlrphl (μg/L)	0	22	0	22
47	NH_3-N (mg/L)	10	34	5	49

[1]Determined by the Mann-Kendall method.

TABLE 17: SIMPLE LINEAR REGRESSION BETWEEN SELECTED PARAMETERS ASSAYED IN THE ILLINOIS WATERWAY[1]

Variable		Regression Result				Test on *R*	
Dependent (y)	Independent (x)	b_0	b_1	R^2	R	P_{01}	P_{02}
Dissolved Oxygen	TN[2]	14.93	-1.21	0.515	0.717	0.000	0.632
Total Suspended Solids	TN	120.36	-15.72	0.450	0.671	0.000	0.276
Turbidity	TN	151.34	-19.68	0.454	0.674	0.000	0.292
Chlorophyll *a*	TN	165.28	-24.68	0.759	0.871	0.000	0.112
Dissolved Oxygen	TP[3]	11.95	-4.95	0.682	0.826	0.000	0.170
Total Suspended Solids	TP	70.16	-46.68	0.316	0.562	0.000	0.022
Turbidity	TP	88.44	-58.35	0.318	0.564	0.000	0.023
Chlorophyll *a*	TP	91.21	-81.09	0.714	0.845	0.000	0.247
Dissolved Oxygen	Chlorophyll *a*	-58.49	11.06	0.430	0.655	0.001	0.412
Turbidity	Chlorophyll *a*	6.43	0.60	0.467	0.684	0.000	0.551

[1]Analysis performed on data collected from 2002–2011.
[2]Total nitrogen.
[3]Total phosphorus.
$R = \sqrt{R^2}$ in one predictor regression.
b_0 = Intercept of the regression model.
b_1 = Slope of the regression model.
R^2 = Fit criterion of the regression model.
P_{01} = Significance probability for testing $R = 0$. Alternative is $|R| > 0$.
P_{02} = Significance probability for testing $R = 0.75$. Alternative is $|R| \neq 0.75$.

Sediment Quality

Sediment quality can impact overlying water quality, benthic community structure, food chain dynamics, and other elements of freshwater ecosystems. Since sediment acts as a reservoir for persistent or bioaccumulative contaminants, sediment quality reflects the potential water quality in the long term. A statistical summary of the general sediment chemistry found at the ILWW sediment monitoring stations is presented in Appendix Table C-1 and the metals data in Appendix Table C-2. The majority of the general chemistry and metal constituents that were analyzed had the highest mean values in the upper reaches of the ILWW.

The temporal trend analysis showed no overall consistent trend for any parameter. The trend analysis results also showed mostly no trend or the trend was equal to the mean (Table 18). There were occurrences of 18 positive trends and 23 negative trends at different stations for different parameters. TCN showed negative trends at the most locations (seven of the 14 sample locations). All of the other parameters that showed a trend were at three sample locations or less.

A spatial analysis was performed to evaluate differences between stations for each parameter. Sediments may have concentrated pockets of a certain parameter that could be considered a hot spot, or the station could have new deposition of sediment compared to the last sample collection. The ratio of parameter detections that were greater than 1.5 times the standard deviation from the mean to the total number of detections was calculated for each parameter at each location. Statistical comparisons were performed to determine if there were significant differences in the ratios between sample locations. The multi-comparison results showed that there were no significant differences between locations (Table 19). The table shows that the variance and mean of the ratios are statistically equal for each parameter at all of the stations and the ranking for each location compared to the location with the highest ratio were all the same.

Since sediment and water samples were collected simultaneously at some locations, a simple regression analysis was done to evaluate the relationship between sediment and water quality (Table 20). The best fit found from the regression analysis suggested a non-linear relationship between sediment and water chemistry showing a high R^2 at many locations. The non-linear equations in the table could be used to predict results. The results for the linear regression analysis showed some r values greater than 0.3 which could be considered a good linear correlation between water and sediment chemistry. However, after evaluating the significance of r, the results show that there is a strong chance of a type II error and just a few instances that suggest a linear relationship where the potential of a type II error is low.

TABLE 18: OVERALL TRENDS OVER TIME FOR THE SEDIMENT CHEMISTRY PARAMETERS MEASURED AT ALL OF THE MONITORED ILLINOIS WATERWAY STATIONS

Parameter Name	Loc. ID	ARIMA[1] Model Determination			Overall Trend[3]
		Type	Equation	Log[2]	
TS	1	MA(1,1)[a]	$(1-B)Y_t = (1-0.632B)E_t$	0	0
TS	2		$Y_t = 52.673$	0	2
TS	5	MA(1,1)[a]	$(1-B)Y_t = (1-0.972B)E_t$	0	0
TS	8		$Y_t = 53.742$	0	2
TS	12		$Y_t = 73.556$	0	2
TS	18		$Y_t = 73.477$	0	2
TS	23		$Y_t = 79.727$	0	2
TS	28		$Y_t = 73.596$	0	2
TS	32		$Y_t = 75.919$	0	2
TS	35		$Y_t = 69.662$	0	2
TS	38	MA(1,1)[a]	$(1-B)Y_t = (1-0.883B)E_t$	1	0
TS	41	MA(1,1)[a]	$(1-B)(Y_t-\mu) = (1-0.773B)E_t$	1	0
TS	44		$Y_t = 42.127$	0	2
TS	48		$Y_t = 61.304$	0	2
TVS	1	MA(1,1)[a]	$(1-B)Y_t = (1-0.619B)E_t$	1	0
TVS	2		$Y_t = 11.936$	0	2
TVS	5		$Y_t = 5.084$	0	2
TVS	8		$Y_t = 8.808$	0	2
TVS	12		$Y_t = 2.096$	0	2
TVS	18	MA(1,1)[a]	$(1-B)Y_t = (1-0.438B)E_t$	1	1
TVS	23		$Y_t = 1.427$	0	2
TVS	28		$Y_t = 1.736$	0	2
TVS	32		$Y_t = 2.073$	0	2
TVS	35		$Y_t = 2.777$	0	2
TVS	38	AR(1,1)[a]	$(1-0.012B)(1-B)Y_t = (1-0.821B)E_t$	0	0
TVS	41	MA(1,1)[a]	$(1-B)Y_t = (1-0.627B)E_t$	0	0
TVS	44	MA(1,1)[a]	$(1-B)Y_t = (1-0.946B)E_t$	1	0
TVS	48		$Y_t = 4.204$	0	2
COD	1	MA(1,1)[a]	$(1-B)Y_t = (1-0.754B)E_t$	0	0
COD	2		$Y_t = 101950.25$	0	2
COD	5		$Y_t = 34831.455$	0	2
COD	8		$Y_t = 99792.417$	0	2
COD	12		$Y_t = 12581.091$	0	2
COD	18	MA(1,1)[a]	$(1-B)Y_t = (1-0.204B)E_t$	1	0
COD	23		$Y_t = 4413.455$	0	2

TABLE 18 (Continued): OVERALL TRENDS OVER TIME FOR THE SEDIMENT CHEMISTRY PARAMETERS MEASURED AT ALL OF THE MONITORED ILLINOIS WATERWAY STATIONS

Parameter Name	Loc. ID	ARIMA[1] Model Determination: Type	Equation	Log[2]	Overall Trend[3]
COD	28		$Y_t = 12645.417$	0	2
COD	32		$Y_t = 6599.167$	0	2
COD	35	MA(1,1)[a]	$(1-B)Y_t = (1-0.604B)E_t$	1	0
COD	38		$Y_t = 47047.25$	0	2
COD	41	MA(1,1)[a]	$(1-B)Y_t = (1-0.783B)E_t$	1	0
COD	44		$Y_t = 89601.333$	0	2
COD	48		$Y_t = 53566.417$	0	2
TKN	1	MA(1,1)[a]	$(1-B)Y_t = (1-0.629B)E_t$	1	0
TKN	2	AR(1,1)[a]	$(1-0.619B)(1-B)Y_t = (1-0.966B)E_t$	1	0
TKN	5		$Y_t = 1241.45$	0	2
TKN	8	AR(1,1)[a]	$(1-0.201B)(1-B)Y_t = (1-0.956B)E_t$	1	0
TKN	12	MA(1,1)[a]	$(1-B)Y_t = (1-0.875B)E_t$	1	0
TKN	18	AR(1,1)[a]	$(1-0.422B)(1-B)Y_t = (1-0.873B)E_t$	1	1
TKN	23	MA(1,1)[a]	$(1-B)Y_t = (1-0.487B)E_t$	1	0
TKN	28	MA(1,2)[a]	$(1-B)Y_t = (1-0.43B-0.554B2)E_t$	1	0
TKN	32		$Y_t = 262.84$	0	2
TKN	35	MA(1,1)[a]	$(1-B)Y_t = (1-0.915B)E_t$	1	0
TKN	38		$Y_t = 1517.24$	0	2
TKN	41		$Y_t = 2032.25$	0	2
TKN	44	MA(1,1)[a]	$(1-B)Y_t = (1-0.383B)E_t$	0	0
TKN	48		$Y_t = 1464.72$	0	2
NH_4-N	1	MA(1,1)[a]	$(1-B)Y_t = (1-0.632B)E_t$	1	0
NH_4-N	2		$Y_t = 136.667$	0	2
NH_4-N	5	MA(1,1)[a]	$(1-B)Y_t = (1-0.88B)E_t$	1	0
NH_4-N	8	MA(1,1)[a]	$(1-B)Y_t = (1-0.804B)E_t$	1	0
NH_4-N	12		$Y_t = 5.05$	0	2
NH_4-N	18	MA(1,1)[a]	$(1-B)(Y_t - \mu) = (1-0.327B)E_t$	1	1
NH_4-N	23		$Y_t = 4.5$	0	2
NH_4-N	28	MA(1,1)[a]	$(1-B)Y_t = (1-0.945B)E_t$	1	1
NH_4-N	32		$Y_t = 6.25$	0	2
NH_4-N	35		$Y_t = 26$	0	2
NH_4-N	38		$Y_t = 75.476$	0	2
NH_4-N	41		$Y_t = 83.9$	0	2

TABLE 18 (Continued): OVERALL TRENDS OVER TIME FOR THE SEDIMENT CHEMISTRY PARAMETERS MEASURED AT ALL OF THE MONITORED ILLINOIS WATERWAY STATIONS

Parameter Name	Loc. ID	ARIMA[1] Model Determination: Type	Equation	Log[2]	Overall Trend[3]
NH_4-N	44		$Y_t = 98.667$	0	2
NH_4-N	48	MA(1,1)[a]	$(1-B)Y_t = (1-0.635B)E_t$	1	0
TP	1	MA(1,1)[a]	$(1-B)Y_t = (1-0.789B)E_t$	1	0
TP	2		$Y_t = 3423.214$	0	2
TP	5		$Y_t = 1701$	0	2
TP	8		$Y_t = 3248.071$	0	2
TP	12	MA(1,1)[a]	$(1-B)Y_t = (1-0.99B)E_t$	1	0
TP	18	MA(1,2)[a]	$(1-B)Y_t = (1-0.434B2)E_t$	1	0
TP	23		$Y_t = 279.214$	0	2
TP	28	AR(1,1)[a]	$(1-0.465B)(1-B)Y_t = (1-0.909B)E_t$	1	0
TP	32	MA(1,1)[a]	$(1-B)Y_t = (1-0.893B)E_t$	1	0
TP	35	MA(1,1)[a]	$(1-B)Y_t = (1-0.973B)E_t$	1	0
TP	38		$Y_t = 1248.714$	0	2
TP	41		$Y_t = 2073.615$	0	2
TP	44		$Y_t = 1712.929$	0	2
TP	48	MA(1,1)[a]	$(1-\mathrm{B})Y_t = (1-0.69\mathrm{B})E_t$	1	0
CN	1		$Y_t = 3.111$	0	2
CN	2		$Y_t = 2.171$	0	2
CN	5	MA(1,1)[a]	$(1-\mathrm{B})Y_t = (1-0.914\mathrm{B})E_t$	1	0
CN	8		$Y_t = 1.376$	0	2
CN	12	MA(1,1)[a]	$(1-\mathrm{B})Y_t = (1-0.525\mathrm{B})E_t$	1	-1
CN	18	MA(1,1)[a]	$(1-\mathrm{B})Y_t = (1-0.606\mathrm{B})E_t$	1	-1
CN	23	MA(1,1)[a]	$(1-\mathrm{B})Y_t = (1-0.934\mathrm{B})E_t$	1	-1
CN	28		$Y_t = 0.139$	0	2
CN	32	MA(1,1)[a]	$(1-\mathrm{B})Y_t = (1-0.936\mathrm{B})E_t$	1	-1
CN	35		$Y_t = 0.242$	0	2
CN	38	MA(1,1)[a]	$(1-\mathrm{B})(Y_t-\mu) = (1-0.485\mathrm{B})E_t$	1	-1
CN	41	MA(1,1)[a]	$(1-\mathrm{B})Y_t = (1-0.753\mathrm{B})E_t$	1	-1
CN	44		$Y_t = 0.304$	0	2
CN	48	MA(1,1)[a]	$(1-\mathrm{B})Y_t = (1-0.913\mathrm{B})E_t$	1	-1
Phenol	1		$Y_t = 2.904$	0	2
Phenol	2		$Y_t = 1.471$	0	2
Phenol	5		$Y_t = 0.289$	0	2
Phenol	8		$Y_t = 0.287$	0	2

TABLE 18 (Continued): OVERALL TRENDS OVER TIME FOR THE SEDIMENT CHEMISTRY PARAMETERS MEASURED AT ALL OF THE MONITORED ILLINOIS WATERWAY STATIONS

Parameter Name	Loc. ID	ARIMA[1] Model Determination: Type	Equation	Log[2]	Overall Trend[3]
Phenol	12	MA(1,1)[a]	$(1-B)Y_t = (1-0.715B)E_t$	1	0
Phenol	18		$Y_t = 0.2$	0	2
Phenol	23	MA(1,1)[a]	$(1-B)Y_t = (1-0.935B)E_t$	1	-1
Phenol	28	AR(1,1)[a]	$(1-0.82B)(1-B)Y_t = (1-1.816B)E_t$	1	0
Phenol	32		$Y_t = 0.155$	0	2
Phenol	35	AR(1,1)[a]	$(1-0.383B)(1-B)Y_t = (1-0.964B)E_t$	1	-1
Phenol	38		$Y_t = 0.233$	0	2
Phenol	41	MA(1,1)[a]	$(1-B)Y_t = (1-0.774B)E_t$	1	0
Phenol	44	MA(1,1)[a]	$(1-B)Y_t = (1-0.94B)E_t$	1	-1
Phenol	48	MA(1,1)[a]	$(1-B)Y_t = (1-0.646B)E_t$	1	0
NO_2+NO_3	1		$Y_t = 13.8$	0	2
NO_2+NO_3	2		$Y_t = 8.4$	0	2
NO_2+NO_3	5	MA(1,1)[a]	$(1-B)Y_t = (1-0.776B)E_t$	0	0
NO_2+NO_3	8		$Y_t = 8.4$	0	2
NO_2+NO_3	12		$Y_t = 2.9$	0	2
NO_2+NO_3	18	MA(1,1)[a]	$(1-B)Y_t = (1-0.378B)E_t$	1	1
NO_2+NO_3	23		$Y_t = 2.4$	0	2
NO_2+NO_3	28		$Y_t = 2.556$	0	2
NO_2+NO_3	32	MA(1,1)[a]	$(1-B)Y_t = (1-0.925B)E_t$	1	0
NO_2+NO_3	35		$Y_t = 4.2$	0	2
NO_2+NO_3	38		$Y_t = 4.4$	0	2
NO_2+NO_3	41		$Y_t = 5.1$	0	2
NO_2+NO_3	44		$Y_t = 14.222$	0	2
NO_2+NO_3	48		$Y_t = 5.5$	0	2
As	1		$Y_t = 4.385$	0	2
As	2		$Y_t = 5$	0	2
As	5		$Y_t = 3.714$	0	2
As	8	MA(1,1)[a]	$(1-B)Y_t = (1-0.225B)E_t$	1	1
As	12	MA(1,1)[a]	$(1-B)Y_t = (1-0.705B)E_t$	1	0
As	18	MA(1,1)[a]	$(1-B)Y_t = (1-0.295B)E_t$	1	0
As	23		$Y_t = 3.87$	0	2
As	28		$Y_t = 3.905$	0	2
As	32	AR(1,1)[a]	$(1-0.429B)(1-B)Y_t = E_t$	1	1
As	35	MA(1,1)[a]	$(1-B)(Y_t-\mu) = (1-0.773B)E_t$	1	1
As	38		$Y_t = 3.696$	0	2

TABLE 18 (Continued): OVERALL TRENDS OVER TIME FOR THE SEDIMENT CHEMISTRY PARAMETERS MEASURED AT ALL OF THE MONITORED ILLINOIS WATERWAY STATIONS

Parameter Name	Loc. ID	ARIMA[1] Model Determination Type	Equation	Log[2]	Overall Trend[3]
As	41		$Y_t = 4.417$	0	2
As	44		$Y_t = 5.522$	0	2
As	48		$Y_t = 4.292$	0	2
Cd	1	MA(1,1)[a]	$(1-B)Y_t = (1-0.543B)E_t$	1	-1
Cd	2	MA(1,1)[a]	$(1-B)Y_t = (1-0.711B)E_t$	1	0
Cd	5		$Y_t = 3.875$	0	2
Cd	8		$Y_t = 7.231$	0	2
Cd	12	MA(1,1)[a]	$(1-B)Y_t = (1-0.327B)E_t$	1	0
Cd	18	MA(1,1)[a]	$(1-B)Y_t = (1-0.12B)E_t$	1	-1
Cd	23		$Y_t = 1.109$	0	2
Cd	28	MA(1,1)[a]	$(1-B)Y_t = (1-0.97B)E_t$	1	-1
Cd	32		$Y_t = 1.236$	0	2
Cd	35	MA(1,1)[a]	$(1-B)Y_t = (1-0.555B)E_t$	1	0
Cd	38		$Y_t = 2.167$	0	2
Cd	41		$Y_t = 1.96$	0	2
Cd	44		$Y_t = 3.269$	0	2
Cd	48		$Y_t = 1.462$	0	2
Cr	1		$Y_t = 220.231$	0	2
Cr	2	MA(1,1)[a]	$(1-B)Y_t = (1-0.798B)E_t$	1	0
Cr	5		$Y_t = 68.25$	0	2
Cr	8		$Y_t = 69.346$	0	2
Cr	12	MA(1,1)[a]	$(1-B)Y_t = (1-0.779B)E_t$	1	0
Cr	18	MA(1,1)[a]	$(1-B)Y_t = (1-0.56B)E_t$	1	0
Cr	23		$Y_t = 13.16$	0	2
Cr	28		$Y_t = 12.423$	0	2
Cr	32	MA(1,1)[a]	$(1-B)(Y_t - \mu) = (1-0.723B)E_t$	1	0
Cr	35		$Y_t = 20.269$	0	2
Cr	38		$Y_t = 24.615$	0	2
Cr	41		$Y_t = 27.231$	0	2
Cr	44	AR(1,1)[a]	$(1-0.4B)(1-B)Y_t = (1-0.889B)E_t$	1	0
Cr	48	MA(1,1)[a]	$(1-B)Y_t = (1-0.649B)E_t$	1	0
Cu	1	MA(1,1)[a]	$(1-B)Y_t = (1-0.859B)E_t$	1	-1
Cu	2	MA(1,1)[a]	$(1-B)Y_t = (1-0.742B)E_t$	1	0
Cu	5		$Y_t = 49.292$	0	2

TABLE 18 (Continued): OVERALL TRENDS OVER TIME FOR THE SEDIMENT CHEMISTRY PARAMETERS MEASURED AT ALL OF THE MONITORED ILLINOIS WATERWAY STATIONS

Parameter Name	Loc. ID	ARIMA[1] Model Determination			Overall Trend[3]
		Type	Equation	Log[2]	
Cu	8		$Y_t = 94.346$	0	2
Cu	12	MA(1,1)[a]	$(1-B)Y_t = (1-0.897B)E_t$	1	0
Cu	18		$Y_t = 12.72$	0	2
Cu	23		$Y_t = 4.538$	0	2
Cu	28	MA(1,1)[a]	$(1-B)(Y_t-\mu) = (1-0.748B)E_t$	1	0
Cu	32	MA(1,1)[a]	$(1-B)Y_t = (1-0.932B)E_t$	1	0
Cu	35	MA(1,1)[a]	$(1-B)Y_t = (1-0.937B)E_t$	1	0
Cu	38		$Y_t = 21.154$	0	2
Cu	41		$Y_t = 22.44$	0	2
Cu	44		$Y_t = 40.308$	0	2
Cu	48		$Y_t = 17.846$	0	2
Fe	1		$Y_t = 24682.769$	0	2
Fe	2	MA(1,1)[a]	$(1-B)(Y_t-\mu) = (1-0.607B)E_t$	0	1
Fe	5		$Y_t = 13152.13$	0	2
Fe	8	MA(1,1)[a]	$(1-B)(Y_t-\mu) = (1-0.765B)E_t$	0	1
Fe	12		$Y_t = 8126.24$	0	2
Fe	18	MA(1,1)[a]	$(1-B)(Y_t-\mu) = (1-0.712B)E_t$	1	1
Fe	23	MA(1,1)[a]	$(1-B)Y_t = (1-0.701B)E_t$	0	1
Fe	28		$Y_t = 5774.154$	0	2
Fe	32		$Y_t = 9375.192$	0	2
Fe	35	MA(1,1)[a]	$(1-B)Y_t = (1-0.498B)E_t$	1	0
Fe	38	MA(1,1)[a]	$(1-B)Y_t = (1-0.685B)E_t$	0	0
Fe	41	MA(1,1)[a]	$(1-B)Y_t = (1-0.644B)E_t$	0	1
Fe	44	MA(1,1)[a]	$(1-B)Y_t = (1-0.361B)E_t$	0	0
Fe	48	MA(1,1)[a]	$(1-B)Y_t = (1-0.653B)E_t$	0	1
Pb	1		$Y_t = 242.423$	0	2
Pb	2		$Y_t = 230.545$	0	2
Pb	5	MA(1,1)[a]	$(1-B)Y_t = (1-0.901B)E_t$	0	0
Pb	8		$Y_t = 94.962$	0	2
Pb	12		$Y_t = 19.75$	0	2
Pb	18	AR(1,1)[a]	$(1-0.136B)(1-B)Y_t = (1-0.525B)E_t$	1	1
Pb	23	MA(1,1)[a]	$(1-B)Y_t = (1-0.585B)E_t$	1	1
Pb	28	MA(1,1)[a]	$(1-B)Y_t = (1-0.93B)E_t$	1	0
Pb	32	MA(1,1)	$(Y_t-\mu) = (1-0.947B)E_t$	1	0
Pb	35	MA(1,1)[a]	$(1-B)Y_t = (1-0.775B)E_t$	1	0

TABLE 18 (Continued): OVERALL TRENDS OVER TIME FOR THE SEDIMENT CHEMISTRY PARAMETERS MEASURED AT ALL OF THE MONITORED ILLINOIS WATERWAY STATIONS

Parameter Name	Loc. ID	ARIMA[1] Model Determination Type	Equation	Log[2]	Overall Trend[3]
Pb	38		$Y_t = 26.6$	0	2
Pb	41	MA(1,1)[a]	$(1-B)Y_t = (1-0.663B)E_t$	1	0
Pb	44		$Y_t = 37.923$	0	2
Pb	48		$Y_t = 22.2$	0	2
Mn	1	AR(1,1)[a]	$(1-0.671B)(1-B)Y_t = (1-1.631B)E_t$	1	1
Mn	2	MA(1,1)[a]	$(1-B)Y_t = (1-0.707B)E_t$	1	1
Mn	5		$Y_t = 284.25$	0	2
Mn	8		$Y_t = 370.846$	0	2
Mn	12		$Y_t = 262.12$	0	2
Mn	18		$Y_t = 206.077$	0	2
Mn	23		$Y_t = 181.731$	0	2
Mn	28		$Y_t = 202.385$	0	2
Mn	32		$Y_t = 375.615$	0	2
Mn	35		$Y_t = 270.731$	0	2
Mn	38	MA(1,1)[a]	$(1-B)Y_t = (1-0.869B)E_t$	1	-1
Mn	41	MA(1,1)[a]	$(1-B)Y_t = (1-0.767B)E_t$	1	0
Mn	44	MA(1,1)[a]	$(1-B)Y_t = (1-0.353B)E_t$	1	-1
Mn	48	MA(1,1)[a]	$(1-B)Y_t = (1-0.67B)E_t$	1	0
Hg	1		$Y_t = 1.302$	0	2
Hg	2	MA(1,1)[a]	$(1-B)Y_t = (1-0.551B)E_t$	1	0
Hg	5	MA(1,1)[a]	$(1-B)Y_t = (1-0.819B)E_t$	1	0
Hg	8	MA(1,1)[a]	$(1-B)Y_t = (1-0.746B)E_t$	1	0
Hg	12		$Y_t = 0.175$	0	2
Hg	18	AR(1,1)[a]	$(1-0.99B)(1-B)Y_t = E_t$	1	0
Hg	23	MA(1,1)[a]	$(1-B)Y_t = (1-0.744B)E_t$	0	0
Hg	28	MA(1,1)[a]	$(1-B)Y_t = (1-0.693B)E_t$	1	0
Hg	32	MA(1,1)[a]	$(1-B)Y_t = (1-0.849B)E_t$	1	0
Hg	35		$Y_t = 0.233$	0	2
Hg	38	MA(1,1)[a]	$(1-B)Y_t = (1-0.674B)E_t$	1	0
Hg	41		$Y_t = 0.298$	0	2
Hg	44		$Y_t = 0.448$	0	2
Hg	48	MA(1,1)[a]	$(1-B)Y_t = (1-1.198B)E_t$	1	0
Ni	1		$Y_t = 86.269$	0	2
Ni	2		$Y_t = 54.909$	0	2

TABLE 18 (Continued): OVERALL TRENDS OVER TIME FOR THE SEDIMENT CHEMISTRY PARAMETERS MEASURED AT ALL OF THE MONITORED ILLINOIS WATERWAY STATIONS

Parameter Name	Loc. ID	ARIMA[1] Model Determination Type	Equation	Log[2]	Overall Trend[3]
Ni	5		$Y_t = 38.792$	0	2
Ni	8		$Y_t = 44.154$	0	2
Ni	12	MA(1,1)[a]	$(1-B)Y_t = (1-0.953B)E_t$	1	-1
Ni	18	MA(1,1)[a]	$(1-B)Y_t = (1-0.717B)E_t$	1	0
Ni	23		$Y_t = 10.346$	0	2
Ni	28		$Y_t = 9.68$	0	2
Ni	32	MA(1,1)[a]	$(1-B)Y_t = (1-0.97B)E_t$	1	0
Ni	35	MA(1,1)[a]	$(1-B)Y_t = (1-1.081B)E_t$	1	0
Ni	38	MA(1,1)[a]	$(1-B)Y_t = (1-0.834B)E_t$	1	-1
Ni	41		$Y_t = 20.615$	0	2
Ni	44		$Y_t = 34.115$	0	2
Ni	48	MA(1,1)[a]	$(1-B)Y_t = (1-0.873B)E_t$	0	0
Ag	1		$Y_t = 5.058$	0	2
Ag	2		$Y_t = 2.514$	0	2
Ag	5		$Y_t = 2.105$	0	2
Ag	8	MA(1,1)[a]	$(1-B)Y_t = (1-0.345B)E_t$	1	0
Ag	12		$Y_t = 1.84$	0	2
Ag	18		$Y_t = 1.386$	0	2
Ag	23		$Y_t = 1.445$	0	2
Ag	28		$Y_t = 1.673$	0	2
Ag	32		$Y_t = 1.419$	0	2
Ag	35	AR(1,1)	$(1-0.377B)Y_t = E_t$	1	-1
Ag	38		$Y_t = 1.4$	0	2
Ag	41		$Y_t = 1.719$	0	2
Ag	44	AR(1,1)	$(1-0.293B)Y_t = E_t$	1	-1
Ag	48	MA(1,1)[a]	$(1-B)Y_t = (1-0.669B)E_t$	1	-1
Zn	1	MA(1,1)[a]	$(1-B)Y_t = (1-0.813B)E_t$	1	-1
Zn	2	MA(1,1)[a]	$(1-B)Y_t = (1-0.516B)E_t$	1	0
Zn	5		$Y_t = 234.125$	0	2
Zn	8	MA(1,1)[a]	$(1-B)Y_t = (1-0.666B)E_t$	1	0
Zn	12		$Y_t = 77.88$	0	2
Zn	18		$Y_t = 62.538$	0	2
Zn	23		$Y_t = 37.5$	0	2
Zn	28		$Y_t = 41.423$	0	2
Zn	32	AR(1,1)[a]	$(1-0.154B)(1-B)Y_t = (1-0.878B)E_t$	1	0

TABLE 18 (Continued): OVERALL TRENDS OVER TIME FOR THE SEDIMENT CHEMISTRY PARAMETERS MEASURED AT ALL OF THE MONITORED ILLINOIS WATERWAY STATIONS

Parameter Name	Loc. ID	ARIMA[1] Model Determination: Type	Equation	Log[2]	Overall Trend[3]
Zn	35		$Y_t = 82.538$	0	2
Zn	38	MA(1,1)[a]	$(1-B)Y_t = (1-0.557B)E_t$	1	-1
Zn	41		$Y_t = 135.654$	0	2
Zn	44		$Y_t = 215$	0	2
Zn	48		$Y_t = 94.769$	0	2

[1]Auto-Regressive Moving Average.
[2]Indicated by 1 if log transformation is taken in ARIMA.
[3]Trend = -1 (negative trend), = 0 (no trend), = 1 (positive trend), = 2 (mean is trend). Trends are determined by Mann-Kendall non-parametric method.
[a]Model evaluated at lag 1 (after first difference).
MA = moving average, AR = autoregressive, Y_t = time series, B = backshift notation, E_t = random error

TABLE 19: ANALYSIS OF THE NUMBER OF SEDIMENT CHEMISTRY PARAMETERS THAT FALL OUTSIDE THE INTERVAL OF 1.5 TIMES THE STANDARD DEVIATION FROM THE MEAN FOR ALL MONITORED ILLINOIS WATERWAY STATIONS

Parameter Name	Code	Location Name	Sig. Prob. for Equal σ	Sig. Prob. for Equal μ	Multiple Comparison[1] 1st Location r_1	n_1	μ_1	2nd Location r_2	n_2	μ_2	Compared[2] Locations	Rank
TS	1	Sanitary Ship Canal	0.694	0.994	2	26	0.077	2	26	0.077	(1, 1)	A
TS	23	Illinois River	—	—	2	26	0.077	2	26	0.077	(23, 1)	A
TS	38	Illinois River	—	—	2	26	0.077	2	26	0.077	(38, 1)	A
TS	41	Illinois River	—	—	2	26	0.077	2	26	0.077	(41, 1)	A
TS	44	Illinois River	—	—	2	26	0.077	2	26	0.077	(44, 1)	A
TS	12	Illinois River	—	—	2	26	0.077	1	25	0.040	(12, 1)	A
TS	28	Illinois River	—	—	2	26	0.077	1	26	0.038	(28, 1)	A
TS	32	Illinois River	—	—	2	26	0.077	1	26	0.038	(32, 1)	A
TS	48	Illinois River	—	—	2	26	0.077	1	26	0.038	(48, 1)	A
TVS	18	Illinois River	0.672	0.919	4	26	0.154	4	26	0.154	(18, 18)	A
TVS	8	Des Plaines River	—	—	4	26	0.154	3	26	0.115	(8, 18)	A
TVS	2	Sanitary Ship Canal	—	—	4	26	0.154	2	22	0.091	(2, 18)	A
TVS	5	Des Plaines River	—	—	4	26	0.154	2	25	0.080	(5, 18)	A
TVS	1	Sanitary Ship Canal	—	—	4	26	0.154	2	26	0.077	(1, 18)	A
TVS	32	Illinois River	—	—	4	26	0.154	2	26	0.077	(32, 18)	A
TVS	48	Illinois River	—	—	4	26	0.154	2	26	0.077	(48, 18)	A
TVS	12	Illinois River	—	—	4	26	0.154	1	25	0.040	(12, 18)	A
TVS	28	Illinois River	—	—	4	26	0.154	1	25	0.040	(28, 18)	A
TVS	23	Illinois River	—	—	4	26	0.154	1	26	0.038	(23, 18)	A
TVS	35	Illinois River	—	—	4	26	0.154	1	26	0.038	(35, 18)	A
TVS	38	Illinois River	—	—	4	26	0.154	1	26	0.038	(38, 18)	A
TVS	41	Illinois River	—	—	4	26	0.154	1	26	0.038	(41, 18)	A
TVS	44	Illinois River	—	—	4	26	0.154	1	26	0.038	(44, 18)	A
COD	32	Illinois River	1.000	1.000	2	12	0.167	2	12	0.167	(32, 32)	A
COD	35	Illinois River	—	—	2	12	0.167	2	12	0.167	(35, 32)	A
COD	2	Sanitary Ship Canal	—	—	2	12	0.167	1	8	0.125	(2, 32)	A
COD	5	Des Plaines River	—	—	2	12	0.167	1	11	0.091	(5, 32)	A
COD	12	Illinois River	—	—	2	12	0.167	1	11	0.091	(12, 32)	A
COD	23	Illinois River	—	—	2	12	0.167	1	11	0.091	(23, 32)	A
COD	1	Sanitary Ship Canal	—	—	2	12	0.167	1	12	0.083	(1, 32)	A
COD	8	Des Plaines River	—	—	2	12	0.167	1	12	0.083	(8, 32)	A
COD	18	Illinois River	—	—	2	12	0.167	1	12	0.083	(18, 32)	A
COD	28	Illinois River	—	—	2	12	0.167	1	12	0.083	(28, 32)	A
COD	38	Illinois River	—	—	2	12	0.167	1	12	0.083	(38, 32)	A
COD	41	Illinois River	—	—	2	12	0.167	1	12	0.083	(41, 32)	A
COD	44	Illinois River	—	—	2	12	0.167	1	12	0.083	(44, 32)	A
COD	48	Illinois River	—	—	2	12	0.167	1	12	0.083	(48, 32)	A

TABLE 19 (Continued): ANALYSIS OF THE NUMBER OF SEDIMENT CHEMISTRY PARAMETERS THAT FALL OUTSIDE THE INTERVAL OF 1.5 TIMES THE STANDARD DEVIATION FROM THE MEAN FOR ALL MONITORED ILLINOIS WATERWAY STATIONS

Parameter Name	Code	Location Name	Sig. Prob. for Equal σ	Sig. Prob. for Equal μ	Multiple Comparison[1] 1st Location r_1	n_1	μ_1	2nd Location r_2	n_2	μ_2	Compared[2] Locations	Rank
TKN	12	Illinois River	0.899	0.976	3	24	0.125	3	24	0.125	(12, 12)	A
TKN	1	Sanitary Ship Canal	—	—	3	24	0.125	3	25	0.120	(1, 12)	A
TKN	8	Des Plaines River	—	—	3	24	0.125	3	25	0.120	(8, 12)	A
TKN	38	Illinois River	—	—	3	24	0.125	3	25	0.120	(38, 12)	A
TKN	18	Illinois River	—	—	3	24	0.125	2	25	0.080	(18, 12)	A
TKN	28	Illinois River	—	—	3	24	0.125	2	25	0.080	(28, 12)	A
TKN	32	Illinois River	—	—	3	24	0.125	2	25	0.080	(32, 12)	A
TKN	44	Illinois River	—	—	3	24	0.125	2	25	0.080	(44, 12)	A
TKN	2	Sanitary Ship Canal	—	—	3	24	0.125	1	19	0.053	(2, 12)	A
TKN	5	Des Plaines River	—	—	3	24	0.125	1	20	0.050	(5, 12)	A
TKN	23	Illinois River	—	—	3	24	0.125	1	25	0.040	(23, 12)	A
TKN	35	Illinois River	—	—	3	24	0.125	1	25	0.040	(35, 12)	A
TKN	41	Illinois River	—	—	3	24	0.125	1	25	0.040	(41, 12)	A
TKN	48	Illinois River	—	—	3	24	0.125	1	25	0.040	(48, 12)	A
NH_4-N	44	Illinois River	0.989	0.993	3	21	0.143	3	21	0.143	(44, 44)	A
NH_4-N	18	Illinois River	—	—	3	21	0.143	2	21	0.095	(18, 44)	A
NH_4-N	38	Illinois River	—	—	3	21	0.143	2	21	0.095	(38, 44)	A
NH_4-N	48	Illinois River	—	—	3	21	0.143	2	21	0.095	(48, 44)	A
NH_4-N	2	Sanitary Ship Canal	—	—	3	21	0.143	1	19	0.053	(2, 44)	A
NH_4-N	5	Des Plaines River	—	—	3	21	0.143	1	19	0.053	(5, 44)	A
NH_4-N	1	Sanitary Ship Canal	—	—	3	21	0.143	1	20	0.050	(1, 44)	A
NH_4-N	8	Des Plaines River	—	—	3	21	0.143	1	21	0.048	(8, 44)	A
NH_4-N	12	Illinois River	—	—	3	21	0.143	1	21	0.048	(12, 44)	A
NH_4-N	23	Illinois River	—	—	3	21	0.143	1	21	0.048	(23, 44)	A
NH_4-N	28	Illinois River	—	—	3	21	0.143	1	21	0.048	(28, 44)	A
NH_4-N	32	Illinois River	—	—	3	21	0.143	1	21	0.048	(32, 44)	A
NH_4-N	35	Illinois River	—	—	3	21	0.143	1	21	0.048	(35, 44)	A
NH_4-N	41	Illinois River	—	—	3	21	0.143	1	21	0.048	(41, 44)	A
TP	2	Sanitary Ship Canal	1.000	0.999	2	14	0.143	2	14	0.143	(2, 2)	A
TP	8	Des Plaines River	—	—	2	14	0.143	2	14	0.143	(8, 2)	A
TP	12	Illinois River	—	—	2	14	0.143	2	14	0.143	(12, 2)	A
TP	38	Illinois River	—	—	2	14	0.143	2	14	0.143	(38, 2)	A
TP	5	Des Plaines River	—	—	2	14	0.143	1	13	0.077	(5, 2)	A
TP	1	Sanitary Ship Canal	—	—	2	14	0.143	1	14	0.071	(1, 2)	A
TP	18	Illinois River	—	—	2	14	0.143	1	14	0.071	(18, 2)	A
TP	23	Illinois River	—	—	2	14	0.143	1	14	0.071	(23, 2)	A
TP	28	Illinois River	—	—	2	14	0.143	1	14	0.071	(28, 2)	A
TP	32	Illinois River	—	—	2	14	0.143	1	14	0.071	(32, 2)	A

TABLE 19 (Continued): ANALYSIS OF THE NUMBER OF SEDIMENT CHEMISTRY PARAMETERS THAT FALL OUTSIDE THE INTERVAL OF 1.5 TIMES THE STANDARD DEVIATION FROM THE MEAN FOR ALL MONITORED ILLINOIS WATERWAY STATIONS

Parameter Name	Code	Location Name	Sig. Prob. for Equal σ	Sig. Prob. for Equal μ	Multiple Comparison[1] 1st Location r_1	n_1	μ_1	2nd Location r_2	n_2	μ_2	Compared[2] Locations	Rank
TP	35	Illinois River	—	—	2	14	0.143	1	14	0.071	(35, 2)	A
TP	41	Illinois River	—	—	2	14	0.143	1	14	0.071	(41, 2)	A
TP	44	Illinois River	—	—	2	14	0.143	1	14	0.071	(44, 2)	A
TP	48	Illinois River	—	—	2	14	0.143	1	14	0.071	(48, 2)	A
CN	2	Sanitary Ship Canal	0.959	0.999	2	21	0.095	2	21	0.095	(2, 2)	A
CN	12	Illinois River	—	—	2	21	0.095	2	24	0.083	(12, 2)	A
CN	41	Illinois River	—	—	2	21	0.095	2	24	0.083	(41, 2)	A
CN	44	Illinois River	—	—	2	21	0.095	2	24	0.083	(44, 2)	A
CN	5	Des Plaines River	—	—	2	21	0.095	2	25	0.080	(5, 2)	A
CN	8	Des Plaines River	—	—	2	21	0.095	2	25	0.080	(8, 2)	A
CN	32	Illinois River	—	—	2	21	0.095	2	25	0.080	(32, 2)	A
CN	35	Illinois River	—	—	2	21	0.095	2	25	0.080	(35, 2)	A
CN	38	Illinois River	—	—	2	21	0.095	1	24	0.042	(38, 2)	A
CN	48	Illinois River	—	—	2	21	0.095	1	24	0.042	(48, 2)	A
CN	1	Sanitary Ship Canal	—	—	2	21	0.095	1	25	0.040	(1, 2)	A
CN	18	Illinois River	—	—	2	21	0.095	1	25	0.040	(18, 2)	A
CN	23	Illinois River	—	—	2	21	0.095	1	25	0.040	(23, 2)	A
CN	28	Illinois River	—	—	2	21	0.095	1	25	0.040	(28, 2)	A
Phenol	28	Illinois River	0.935	0.993	3	24	0.125	3	24	0.125	(28, 28)	A
Phenol	1	Sanitary Ship Canal	—	—	3	24	0.125	3	25	0.120	(1, 28)	A
Phenol	2	Sanitary Ship Canal	—	—	3	24	0.125	2	21	0.095	(2, 28)	A
Phenol	5	Des Plaines River	—	—	3	24	0.125	2	24	0.083	(5, 28)	A
Phenol	38	Illinois River	—	—	3	24	0.125	2	24	0.083	(38, 28)	A
Phenol	8	Des Plaines River	—	—	3	24	0.125	2	25	0.080	(8, 28)	A
Phenol	32	Illinois River	—	—	3	24	0.125	2	25	0.080	(32, 28)	A
Phenol	35	Illinois River	—	—	3	24	0.125	2	25	0.080	(35, 28)	A
Phenol	41	Illinois River	—	—	3	24	0.125	2	25	0.080	(41, 28)	A
Phenol	44	Illinois River	—	—	3	24	0.125	1	23	0.043	(44, 28)	A
Phenol	12	Illinois River	—	—	3	24	0.125	1	24	0.042	(12, 28)	A
Phenol	48	Illinois River	—	—	3	24	0.125	1	24	0.042	(48, 28)	A
Phenol	18	Illinois River	—	—	3	24	0.125	1	25	0.040	(18, 28)	A
Phenol	23	Illinois River	—	—	3	24	0.125	1	25	0.040	(23, 28)	A
NO_2+NO_3-N	28	Illinois River	1.000	0.999	2	10	0.200	2	10	0.200	(28, 28)	A
NO_2+NO_3-N	32	Illinois River	—	—	2	10	0.200	2	10	0.200	(32, 28)	A
NO_2+NO_3-N	44	Illinois River	—	—	2	10	0.200	2	10	0.200	(44, 28)	A
NO_2+NO_3-N	5	Des Plaines River	—	—	2	10	0.200	1	9	0.111	(5, 28)	A
NO_2+NO_3-N	1	Sanitary Ship Canal	—	—	2	10	0.200	1	10	0.100	(1, 28)	A

TABLE 19 (Continued): ANALYSIS OF THE NUMBER OF SEDIMENT CHEMISTRY PARAMETERS THAT FALL OUTSIDE THE INTERVAL OF 1.5 TIMES THE STANDARD DEVIATION FROM THE MEAN FOR ALL MONITORED ILLINOIS WATERWAY STATIONS

Parameter Name	Code	Location Name	Sig. Prob. for Equal σ	Sig. Prob. for Equal μ	Multiple Comparison[1] 1st Location r_1	n_1	μ_1	2nd Location r_2	n_2	μ_2	Compared[2] Locations	Rank
NO_2+NO_3-N	2	Sanitary Ship Canal	—	—	2	10	0.200	1	10	0.100	(2, 28)	A
NO_2+NO_3-N	8	Des Plaines River	—	—	2	10	0.200	1	10	0.100	(8, 28)	A
NO_2+NO_3-N	12	Illinois River	—	—	2	10	0.200	1	10	0.100	(12, 28)	A
NO_2+NO_3-N	18	Illinois River	—	—	2	10	0.200	1	10	0.100	(18, 28)	A
NO_2+NO_3-N	23	Illinois River	—	—	2	10	0.200	1	10	0.100	(23, 28)	A
NO_2+NO_3-N	41	Illinois River	—	—	2	10	0.200	1	10	0.100	(41, 28)	A
NO_2+NO_3-N	48	Illinois River	—	—	2	10	0.200	1	10	0.100	(48, 28)	A
As	44	Illinois River	0.944	0.998	3	26	0.115	3	26	0.115	(44, 44)	A
As	2	Sanitary Ship Canal	—	—	3	26	0.115	2	22	0.091	(2, 44)	A
As	1	Sanitary Ship Canal	—	—	3	26	0.115	2	26	0.077	(1, 44)	A
As	8	Des Plaines River	—	—	3	26	0.115	2	26	0.077	(8, 44)	A
As	32	Illinois River	—	—	3	26	0.115	2	26	0.077	(32, 44)	A
As	35	Illinois River	—	—	3	26	0.115	2	26	0.077	(35, 44)	A
As	38	Illinois River	—	—	3	26	0.115	2	26	0.077	(38, 44)	A
As	41	Illinois River	—	—	3	26	0.115	2	26	0.077	(41, 44)	A
As	48	Illinois River	—	—	3	26	0.115	2	26	0.077	(48, 44)	A
As	5	Des Plaines River	—	—	3	26	0.115	1	25	0.040	(5, 44)	A
As	12	Illinois River	—	—	3	26	0.115	1	25	0.040	(12, 44)	A
As	18	Illinois River	—	—	3	26	0.115	1	26	0.038	(18, 44)	A
As	23	Illinois River	—	—	3	26	0.115	1	26	0.038	(23, 44)	A
As	28	Illinois River	—	—	3	26	0.115	1	26	0.038	(28, 44)	A
Cd	1	Sanitary Ship Canal	0.734	0.929	4	26	0.154	4	26	0.154	(1, 1)	A
Cd	28	Illinois River	—	—	4	26	0.154	4	26	0.154	(28, 1)	A
Cd	23	Illinois River	—	—	4	26	0.154	3	26	0.115	(23, 1)	A
Cd	44	Illinois River	—	—	4	26	0.154	3	26	0.115	(44, 1)	A
Cd	2	Sanitary Ship Canal	—	—	4	26	0.154	2	22	0.091	(2, 1)	A
Cd	12	Illinois River	—	—	4	26	0.154	2	25	0.080	(12, 1)	A
Cd	8	Des Plaines River	—	—	4	26	0.154	2	26	0.077	(8, 1)	A
Cd	18	Illinois River	—	—	4	26	0.154	2	26	0.077	(18, 1)	A
Cd	41	Illinois River	—	—	4	26	0.154	2	26	0.077	(41, 1)	A
Cd	48	Illinois River	—	—	4	26	0.154	2	26	0.077	(48, 1)	A
Cd	5	Des Plaines River	—	—	4	26	0.154	1	25	0.040	(5, 1)	A
Cd	35	Illinois River	—	—	4	26	0.154	1	26	0.038	(35, 1)	A
Cd	38	Illinois River	—	—	4	26	0.154	1	26	0.038	(38, 1)	A
Cr	2	Sanitary Ship Canal	0.969	0.997	3	22	0.136	3	22	0.136	(2, 2)	A
Cr	1	Sanitary Ship Canal	—	—	3	22	0.136	3	26	0.115	(1, 2)	A
Cr	28	Illinois River	—	—	3	22	0.136	3	26	0.115	(28, 2)	A

TABLE 19 (Continued): ANALYSIS OF THE NUMBER OF SEDIMENT CHEMISTRY PARAMETERS THAT FALL OUTSIDE THE INTERVAL OF 1.5 TIMES THE STANDARD DEVIATION FROM THE MEAN FOR ALL MONITORED ILLINOIS WATERWAY STATIONS

Parameter		Location	Sig. Prob. for Equal		Multiple Comparison[1]							
					1st Location			2nd Location			Compared[2]	
Name	Code	Name	σ	μ	r_1	n_1	μ_1	r_2	n_2	μ_2	Locations	Rank
Cr	38	Illinois River	—	—	3	22	0.136	3	26	0.115	(38, 2)	A
Cr	5	Des Plaines River	—	—	3	22	0.136	2	24	0.083	(5, 2)	A
Cr	12	Illinois River	—	—	3	22	0.136	2	25	0.080	(12, 2)	A
Cr	8	Des Plaines River	—	—	3	22	0.136	2	26	0.077	(8, 2)	A
Cr	18	Illinois River	—	—	3	22	0.136	2	26	0.077	(18, 2)	A
Cr	32	Illinois River	—	—	3	22	0.136	2	26	0.077	(32, 2)	A
Cr	35	Illinois River	—	—	3	22	0.136	2	26	0.077	(35, 2)	A
Cr	41	Illinois River	—	—	3	22	0.136	2	26	0.077	(41, 2)	A
Cr	48	Illinois River	—	—	3	22	0.136	2	26	0.077	(48, 2)	A
Cr	23	Illinois River	—	—	3	22	0.136	1	25	0.040	(23, 2)	A
Cr	44	Illinois River	—	—	3	22	0.136	1	26	0.038	(44, 2)	A
Cu	32	Illinois River	0.760	0.921	4	26	0.154	4	26	0.154	(32, 32)	A
Cu	1	Sanitary Ship Canal	—	—	4	26	0.154	3	26	0.115	(1, 32)	A
Cu	18	Illinois River	—	—	4	26	0.154	3	26	0.115	(18, 32)	A
Cu	48	Illinois River	—	—	4	26	0.154	3	26	0.115	(48, 32)	A
Cu	8	Des Plaines River	—	—	4	26	0.154	2	26	0.077	(8, 32)	A
Cu	23	Illinois River	—	—	4	26	0.154	2	26	0.077	(23, 32)	A
Cu	41	Illinois River	—	—	4	26	0.154	2	26	0.077	(41, 32)	A
Cu	44	Illinois River	—	—	4	26	0.154	2	26	0.077	(44, 32)	A
Cu	2	Sanitary Ship Canal	—	—	4	26	0.154	1	22	0.045	(2, 32)	A
Cu	5	Des Plaines River	—	—	4	26	0.154	1	22	0.045	(5, 32)	A
Cu	12	Illinois River	—	—	4	26	0.154	1	25	0.040	(12, 32)	A
Cu	28	Illinois River	—	—	4	26	0.154	1	26	0.038	(28, 32)	A
Cu	35	Illinois River	—	—	4	26	0.154	1	26	0.038	(35, 32)	A
Cu	38	Illinois River	—	—	4	26	0.154	1	26	0.038	(38, 32)	A
Fe	18	Illinois River	0.856	0.986	3	26	0.115	3	26	0.115	(18, 18)	A
Fe	48	Illinois River	—	—	3	26	0.115	3	26	0.115	(48, 18)	A
Fe	12	Illinois River	—	—	3	26	0.115	2	25	0.080	(12, 18)	A
Fe	23	Illinois River	—	—	3	26	0.115	2	26	0.077	(23, 18)	A
Fe	28	Illinois River	—	—	3	26	0.115	2	26	0.077	(28, 18)	A
Fe	32	Illinois River	—	—	3	26	0.115	2	26	0.077	(32, 18)	A
Fe	35	Illinois River	—	—	3	26	0.115	2	26	0.077	(35, 18)	A
Fe	2	Sanitary Ship Canal	—	—	3	26	0.115	1	22	0.045	(2, 18)	A
Fe	5	Des Plaines River	—	—	3	26	0.115	1	23	0.043	(5, 18)	A
Fe	8	Des Plaines River	—	—	3	26	0.115	1	26	0.038	(8, 18)	A
Fe	38	Illinois River	—	—	3	26	0.115	1	26	0.038	(38, 18)	A

TABLE 19 (Continued): ANALYSIS OF THE NUMBER OF SEDIMENT CHEMISTRY PARAMETERS THAT FALL OUTSIDE THE INTERVAL OF 1.5 TIMES THE STANDARD DEVIATION FROM THE MEAN FOR ALL MONITORED ILLINOIS WATERWAY STATIONS

Parameter Name	Code	Location Name	Sig. Prob. for Equal σ	Sig. Prob. for Equal μ	Multiple Comparison[1] 1st Location r_1	n_1	μ_1	2nd Location r_2	n_2	μ_2	Compared[2] Locations	Rank
Fe	41	Illinois River	—	—	3	26	0.115	1	26	0.038	(41, 18)	A
Fe	44	Illinois River	—	—	3	26	0.115	1	26	0.038	(44, 18)	A
Pb	8	Des Plaines River	0.768	0.925	4	26	0.154	4	26	0.154	(8, 8)	A
Pb	48	Illinois River	—	—	4	26	0.154	4	26	0.154	(48, 8)	A
Pb	1	Sanitary Ship Canal	—	—	4	26	0.154	3	26	0.115	(1, 8)	A
Pb	2	Sanitary Ship Canal	—	—	4	26	0.154	2	22	0.091	(2, 8)	A
Pb	5	Des Plaines River	—	—	4	26	0.154	2	24	0.083	(5, 8)	A
Pb	18	Illinois River	—	—	4	26	0.154	2	26	0.077	(18, 8)	A
Pb	23	Illinois River	—	—	4	26	0.154	2	26	0.077	(23, 8)	A
Pb	28	Illinois River	—	—	4	26	0.154	2	26	0.077	(28, 8)	A
Pb	32	Illinois River	—	—	4	26	0.154	2	26	0.077	(32, 8)	A
Pb	44	Illinois River	—	—	4	26	0.154	2	26	0.077	(44, 8)	A
Pb	12	Illinois River	—	—	4	26	0.154	1	25	0.040	(12, 8)	A
Pb	35	Illinois River	—	—	4	26	0.154	1	26	0.038	(35, 8)	A
Pb	38	Illinois River	—	—	4	26	0.154	1	26	0.038	(38, 8)	A
Pb	41	Illinois River	—	—	4	26	0.154	1	26	0.038	(41, 8)	A
Mn	35	Illinois River	0.792	0.962	4	26	0.154	4	26	0.154	(35, 35)	A
Mn	2	Sanitary Ship Canal	—	—	4	26	0.154	3	22	0.136	(2, 35)	A
Mn	5	Des Plaines River	—	—	4	26	0.154	3	24	0.125	(5, 35)	A
Mn	38	Illinois River	—	—	4	26	0.154	3	26	0.115	(38, 35)	A
Mn	48	Illinois River	—	—	4	26	0.154	3	26	0.115	(48, 35)	A
Mn	12	Illinois River	—	—	4	26	0.154	2	25	0.080	(12, 35)	A
Mn	18	Illinois River	—	—	4	26	0.154	2	26	0.077	(18, 35)	A
Mn	23	Illinois River	—	—	4	26	0.154	2	26	0.077	(23, 35)	A
Mn	32	Illinois River	—	—	4	26	0.154	2	26	0.077	(32, 35)	A
Mn	41	Illinois River	—	—	4	26	0.154	2	26	0.077	(41, 35)	A
Mn	44	Illinois River	—	—	4	26	0.154	2	26	0.077	(44, 35)	A
Mn	1	Sanitary Ship Canal	—	—	4	26	0.154	1	26	0.038	(1, 35)	A
Mn	8	Des Plaines River	—	—	4	26	0.154	1	26	0.038	(8, 35)	A
Mn	28	Illinois River	—	—	4	26	0.154	1	26	0.038	(28, 35)	A
Hg	18	Illinois River	0.882	0.983	3	26	0.115	3	26	0.115	(18, 18)	A
Hg	41	Illinois River	—	—	3	26	0.115	3	26	0.115	(41, 18)	A
Hg	44	Illinois River	—	—	3	26	0.115	3	26	0.115	(44, 18)	A
Hg	1	Sanitary Ship Canal	—	—	3	26	0.115	2	26	0.077	(1, 18)	A
Hg	8	Des Plaines River	—	—	3	26	0.115	2	26	0.077	(8, 18)	A
Hg	32	Illinois River	—	—	3	26	0.115	2	26	0.077	(32, 18)	A
Hg	35	Illinois River	—	—	3	26	0.115	2	26	0.077	(35, 18)	A

TABLE 19 (Continued): ANALYSIS OF THE NUMBER OF SEDIMENT CHEMISTRY PARAMETERS THAT FALL OUTSIDE THE INTERVAL OF 1.5 TIMES THE STANDARD DEVIATION FROM THE MEAN FOR ALL MONITORED ILLINOIS WATERWAY STATIONS

Parameter Name	Code	Location Name	Sig. Prob. for Equal σ	Sig. Prob. for Equal μ	Multiple Comparison[1] 1st Location r_1	n_1	μ_1	2nd Location r_2	n_2	μ_2	Compared[2] Locations	Rank
Hg	48	Illinois River	—	—	3	26	0.115	2	26	0.077	(48, 18)	A
Hg	2	Sanitary Ship Canal	—	—	3	26	0.115	1	22	0.045	(2, 18)	A
Hg	5	Des Plaines River	—	—	3	26	0.115	1	25	0.040	(5, 18)	A
Hg	12	Illinois River	—	—	3	26	0.115	1	25	0.040	(12, 18)	A
Hg	23	Illinois River	—	—	3	26	0.115	1	26	0.038	(23, 18)	A
Hg	28	Illinois River	—	—	3	26	0.115	1	26	0.038	(28, 18)	A
Hg	38	Illinois River	—	—	3	26	0.115	1	26	0.038	(38, 18)	A
Ni	32	Illinois River	0.706	0.878	4	26	0.154	4	26	0.154	(32, 32)	A
Ni	35	Illinois River	—	—	4	26	0.154	4	26	0.154	(35, 32)	A
Ni	12	Illinois River	—	—	4	26	0.154	3	25	0.120	(12, 32)	A
Ni	23	Illinois River	—	—	4	26	0.154	3	26	0.115	(23, 32)	A
Ni	44	Illinois River	—	—	4	26	0.154	3	26	0.115	(44, 32)	A
Ni	8	Des Plaines River	—	—	4	26	0.154	2	26	0.077	(8, 32)	A
Ni	28	Illinois River	—	—	4	26	0.154	2	26	0.077	(28, 32)	A
Ni	38	Illinois River	—	—	4	26	0.154	2	26	0.077	(38, 32)	A
Ni	41	Illinois River	—	—	4	26	0.154	2	26	0.077	(41, 32)	A
Ni	2	Sanitary Ship Canal	—	—	4	26	0.154	1	22	0.045	(2, 32)	A
Ni	5	Des Plaines River	—	—	4	26	0.154	1	24	0.042	(5, 32)	A
Ni	1	Sanitary Ship Canal	—	—	4	26	0.154	1	26	0.038	(1, 32)	A
Ni	18	Illinois River	—	—	4	26	0.154	1	26	0.038	(18, 32)	A
Ni	48	Illinois River	—	—	4	26	0.154	1	26	0.038	(48, 32)	A
Ag	5	Des Plaines River	1.000	0.999	4	25	0.160	4	25	0.160	(5, 5)	A
Ag	8	Des Plaines River	—	—	4	25	0.160	4	26	0.154	(8, 5)	A
Ag	32	Illinois River	—	—	4	25	0.160	4	26	0.154	(32, 5)	A
Ag	35	Illinois River	—	—	4	25	0.160	4	26	0.154	(35, 5)	A
Ag	1	Sanitary Ship Canal	—	—	4	25	0.160	3	26	0.115	(1, 5)	A
Ag	23	Illinois River	—	—	4	25	0.160	3	26	0.115	(23, 5)	A
Ag	28	Illinois River	—	—	4	25	0.160	3	26	0.115	(28, 5)	A
Ag	38	Illinois River	—	—	4	25	0.160	3	26	0.115	(38, 5)	A
Ag	44	Illinois River	—	—	4	25	0.160	3	26	0.115	(44, 5)	A
Ag	48	Illinois River	—	—	4	25	0.160	3	26	0.115	(48, 5)	A
Ag	2	Sanitary Ship Canal	—	—	4	25	0.160	2	22	0.091	(2, 5)	A
Ag	12	Illinois River	—	—	4	25	0.160	2	25	0.080	(12, 5)	A
Ag	18	Illinois River	—	—	4	25	0.160	2	26	0.077	(18, 5)	A
Ag	41	Illinois River	—	—	4	25	0.160	2	26	0.077	(41, 5)	A
Zn	1	Sanitary Ship Canal	0.961	0.999	3	26	0.115	3	26	0.115	(1, 1)	A
Zn	2	Sanitary Ship Canal	—	—	3	26	0.115	2	22	0.091	(2, 1)	A

TABLE 19 (Continued): ANALYSIS OF THE NUMBER OF SEDIMENT CHEMISTRY PARAMETERS THAT FALL OUTSIDE THE INTERVAL OF 1.5 TIMES THE STANDARD DEVIATION FROM THE MEAN FOR ALL MONITORED ILLINOIS WATERWAY STATIONS

Parameter Name	Code	Location Name	Sig. Prob. for Equal		Multiple Comparison[1]							
					1st Location			2nd Location			Compared[2]	
			σ	μ	r_1	n_1	μ_1	r_2	n_2	μ_2	Locations	Rank
Zn	5	Des Plaines River	—	—	3	26	0.115	2	24	0.083	(5, 1)	A
Zn	8	Des Plaines River	—	—	3	26	0.115	2	26	0.077	(8, 1)	A
Zn	18	Illinois River	—	—	3	26	0.115	2	26	0.077	(18, 1)	A
Zn	23	Illinois River	—	—	3	26	0.115	2	26	0.077	(23, 1)	A
Zn	28	Illinois River	—	—	3	26	0.115	2	26	0.077	(28, 1)	A
Zn	32	Illinois River	—	—	3	26	0.115	2	26	0.077	(32, 1)	A
Zn	41	Illinois River	—	—	3	26	0.115	2	26	0.077	(41, 1)	A
Zn	48	Illinois River	—	—	3	26	0.115	2	26	0.077	(48, 1)	A
Zn	12	Illinois River	—	—	3	26	0.115	1	25	0.040	(12, 1)	A
Zn	35	Illinois River	—	—	3	26	0.115	1	26	0.038	(35, 1)	A
Zn	38	Illinois River	—	—	3	26	0.115	1	26	0.038	(38, 1)	A
Zn	44	Illinois River	—	—	3	26	0.115	1	26	0.038	(44, 1)	A

[1]Comparing mean of each location against the mean of location with highest mean. r = number outside range, n = total observations, and μ = mean of observations outside range for first and second location with subscript 1 and 2, respectively.
[2]Rank is established by Tukey, Scheffe, and Least Significant Difference (LSD) methods.

TABLE 20: ANALYSIS OF THE RELATIONSHIP BETWEEN WATER CHEMISTRY AND SEDIMENT CHEMISTRY AT SAME MONITORED STATION ON THE ILLINOIS WATERWAY

Parameter Name	Loc ID	Equation	R^2 of Fit	Linear Corr (r)	α^1 H_0: $\lvert\rho\rvert \geq 0.3$	β^2 $\lvert\rho\rvert \leq 0.225$
TKN	1	$\log(y) = 32.586[\log(x)] - 29.927[\log(x)]^2$	0.942	-0.006	0.122	0.894
TKN	2	$\log(y) = 37.827[\log(x)] - 49.078[\log(x)]^2$	0.877	-0.064	0.220	0.872
TKN	5	$\log(y) = 29.434[\log(x)] - 33.094[\log(x)]^2$	0.784	-0.337	0.837	0.632
TKN	8	$\log(y) = 36.007[\log(x)] - 38.215[\log(x)]^2$	0.741	-0.28	0.911	0.664
TKN	12	$\log(y) = -3.27[\log(x)] + 66.823[\log(x)]^2$	0.542	-0.371	0.683	0.548
TKN	18	$\log(y) = -9.867[\log(x)] + 69.294[\log(x)]^2$	0.322	-0.171	0.485	0.778
TKN	23	$\log(y) = -0.744[\log(x)] + 115.773[\log(x)]^2$	0.619	0.294	0.973	0.946
TKN	28	$\log(y) = 11.013[\log(x)] + 5.916[\log(x)]^2$	0.620	-0.689	0.800	0.107
TKN	32	$\log(y) = 25.977[\log(x)] - 34.529[\log(x)]^2$	0.755	-0.12	0.335	0.821
TKN	35	$\log(y) = 35.061[\log(x)] - 52.287[\log(x)]^2$	0.744	-0.577	0.800	0.247
TKN	38	$\log(y) = 32.289[\log(x)] - 40.736[\log(x)]^2$	0.766	-0.23	0.701	0.721
TKN	41	$\log(y) = 40.873[\log(x)] - 59.655[\log(x)]^2$	0.880	-0.443	0.405	0.495
TKN	44	$\log(y) = 36.093[\log(x)] - 42.337[\log(x)]^2$	0.957	0.063	0.209	0.923
TKN	48	$\log(y) = 30.677[\log(x)] - 34.248[\log(x)]^2$	0.879	0.115	0.323	0.938
NH_4-N	1	$\log(y) = -2.216[\log(x)] + 3.79[\log(x)]^2$	0.441	-0.04	0.140	0.839
NH_4-N	2	$\log(y) = -3.073[\log(x)] + 0.346[\log(x)]^2$	0.353	-0.185	0.517	0.722
NH_4-N	5	$\log(y) = -6.78[\log(x)] - 3.481[\log(x)]^2$	0.734	-0.086	0.229	0.808
NH_4-N	8	$\log(y) = -9.541[\log(x)] - 5.147[\log(x)]^2$	0.765	0.215	0.612	0.950
NH_4-N	12	$\log(y) = -1.271[\log(x)] - 0.37[\log(x)]^2$	0.638	0.421	0.445	0.877
NH_4-N	18	$\log(y) = -0.163[\log(x)] + 0.187[\log(x)]^2$	0.601	-0.257	0.798	0.577
NH_4-N	23	$\log(y) = 0.594[\log(x)] + 0.388[\log(x)]^2$	0.539	-0.37	0.666	0.398
NH_4-N	28	$\log(y) = -0.988[\log(x)] - 0.224[\log(x)]^2$	0.514	0.266	0.840	0.948
NH_4-N	32	$\log(y) = -1.231[\log(x)] - 0.286[\log(x)]^2$	0.653	0.657	0.800	0.484
NH_4-N	35	$\log(y) = -1.873[\log(x)] - 0.411[\log(x)]^2$	0.643	0.668	0.800	0.491
NH_4-N	38	$\log(y) = -2.364[\log(x)] - 0.467[\log(x)]^2$	0.800	0.469	0.267	0.820
NH_4-N	41	$\log(y) = -3.395[\log(x)] - 0.961[\log(x)]^2$	0.767	0.285	0.928	0.945
NH_4-N	44	$\log(y) = -3.774[\log(x)] - 0.947[\log(x)]^2$	0.913	0.238	0.710	0.950
NH_4-N	48	$\log(y) = -2.608[\log(x)] - 0.557[\log(x)]^2$	0.817	0.330	0.855	0.931
CN	1	$\log(y) = -0.357[\log(x)] - 0.043[\log(x)]^2$	0.298	0.098	0.225	0.919
CN	2	$\log(y) = -0.455[\log(x)] - 0.084[\log(x)]^2$	0.054	-0.037	0.136	0.841
CN	5	$\log(y) = 0.673[\log(x)] + 0.084[\log(x)]^2$	0.488	-0.027	0.099	0.817
CN	8	$\log(y) = 0.195[\log(x)] + 0.018[\log(x)]^2$	0.161	0.306	0.970	0.936
CN	12	$\log(y) = 0.431[\log(x)] + 0.015[\log(x)]^2$	0.932	0.484	0.247	0.835
CN	18	$\log(y) = 1.507[\log(x)] + 0.217[\log(x)]^2$	0.801	-0.182	0.522	0.768
CN	23	$\log(y) = 0.394[\log(x)] + 0.002[\log(x)]^2$	0.979	0.748	0.800	0.410
CN	28	$\log(y) = 0.715[\log(x)] + 0.06[\log(x)]^2$	0.961	0.293	0.968	0.944
CN	32	$\log(y) = 0.308[\log(x)] - 0.009[\log(x)]^2$	0.919	0.441	0.394	0.882
CN	35	$\log(y) = 0.289[\log(x)] - 0.001[\log(x)]^2$	0.836	0.441	0.386	0.874
CN	38	$\log(y) = 0.157[\log(x)] - 0.014[\log(x)]^2$	0.737	0.080	0.209	0.918
CN	41	$\log(y) = 0.201[\log(x)] - 0.011[\log(x)]^2$	0.769	0.306	0.972	0.940

TABLE 20 (Continued): ANALYSIS OF THE RELATIONSHIP BETWEEN WATER CHEMISTRY AND SEDIMENT CHEMISTRY AT SAME MONITORED STATION ON THE ILLINOIS WATERWAY

Parameter Name	Loc ID	Equation	R^2 of Fit	Linear Corr (r)	α^1 H_0: $\lvert\rho\rvert \geq 0.3$	β^2 $\lvert\rho\rvert \leq 0.225$
CN	44	$\log(y) = 0.1[\log(x)] - 0.023[\log(x)]^2$	0.773	0.127	0.304	0.933
CN	48	$\log(y) = 0.308[\log(x)] + 0.003[\log(x)]^2$	0.830	0.165	0.433	0.945
Phenol	1	$\log(y) = -0.222[\log(x)] - 0.053[\log(x)]^2$	0.047	-0.118	0.280	0.732
Phenol	2	$\log(y) = 0.218[\log(x)] + 0.002[\log(x)]^2$	0.311	-0.016	0.108	0.859
Phenol	5	$\log(y) = 0.544[\log(x)] + 0.05[\log(x)]^2$	0.712	-0.075	0.215	0.830
Phenol	8	$\log(y) = 0.628[\log(x)] + 0.057[\log(x)]^2$	0.678	-0.159	0.399	0.676
Phenol	12	$\log(y) = 0.531[\log(x)] + 0.044[\log(x)]^2$	0.782	-0.158	0.419	0.733
Phenol	18	$\log(y) = 0.771[\log(x)] + 0.075[\log(x)]^2$	0.896	0.105	0.280	0.932
Phenol	23	$\log(y) = 0.707[\log(x)] + 0.056[\log(x)]^2$	0.950	0.237	0.719	0.951
Phenol	28	$\log(y) = 0.847[\log(x)] + 0.077[\log(x)]^2$	0.985	0.496	0.207	0.809
Phenol	32	$\log(y) = 0.521[\log(x)] + 0.027[\log(x)]^2$	0.934	0.296	0.981	0.942
Phenol	35	$\log(y) = 0.553[\log(x)] + 0.038[\log(x)]^2$	0.855	0.081	0.219	0.921
Phenol	38	$\log(y) = 0.646[\log(x)] + 0.059[\log(x)]^2$	0.791	-0.165	0.441	0.725
Phenol	41	$\log(y) = 0.418[\log(x)] + 0.031[\log(x)]^2$	0.450	-0.158	0.411	0.714
Phenol	44	$\log(y) = 0.042[\log(x)] - 0.03[\log(x)]^2$	0.400	-0.001	0.103	0.883
Phenol	48	$\log(y) = 0.264[\log(x)] + 0.001[\log(x)]^2$	0.499	-0.108	0.287	0.801
NO_2+NO_3-N	1	$\log(y) = -2.435[\log(x)] + 2.181[\log(x)]^2$	0.883	0.553	0.133	0.848
NO_2+NO_3-N	2	$\log(y) = -3.76[\log(x)] + 2.796[\log(x)]^2$	0.888	0.814	0.800	0.417
NO_2+NO_3-N	5	$\log(y) = 0.733[\log(x)] + 0.063[\log(x)]^2$	0.950	0.342	0.822	0.943
NO_2+NO_3-N	8	$\log(y) = 2.775[\log(x)] - 1.165[\log(x)]^2$	0.693	-0.052	0.217	0.900
NO_2+NO_3-N	12	$\log(y) = 3.537[\log(x)] - 2.162[\log(x)]^2$	0.787	-0.637	0.800	0.342
NO_2+NO_3-N	18	$\log(y) = 2.7[\log(x)] - 1.541[\log(x)]^2$	0.701	-0.391	0.620	0.663
NO_2+NO_3-N	23	$\log(y) = 1.374[\log(x)] - 0.792[\log(x)]^2$	0.503	-0.313	0.945	0.738
NO_2+NO_3-N	28	$\log(y) = 3.668[\log(x)] - 2.513[\log(x)]^2$	0.834	-0.625	0.800	0.445
NO_2+NO_3-N	32	$\log(y) = 3.85[\log(x)] - 2.548[\log(x)]^2$	0.781	-0.597	0.800	0.401
NO_2+NO_3-N	35	$\log(y) = 5.236[\log(x)] - 3.486[\log(x)]^2$	0.805	-0.59	0.800	0.412
NO_2+NO_3-N	38	$\log(y) = 2.666[\log(x)] - 1.315[\log(x)]^2$	0.942	-0.305	0.979	0.745
NO_2+NO_3-N	41	$\log(y) = 3.092[\log(x)] - 1.911[\log(x)]^2$	0.728	-0.316	0.932	0.735
NO_2+NO_3-N	44	$\log(y) = 5.989[\log(x)] - 4.169[\log(x)]^2$	0.702	-0.431	0.477	0.680
NO_2+NO_3-N	48	$\log(y) = 4.63[\log(x)] - 3.554[\log(x)]^2$	0.780	-0.599	0.800	0.398
Cd	1	$\log(y) = -1.155[\log(x)] - 0.107[\log(x)]^2$	0.943	0.500	0.221	0.844
Cd	2	$\log(y) = -0.522[\log(x)] - 0.037[\log(x)]^2$	0.727	-0.305	0.978	0.707
Cd	5	$\log(y) = -0.73[\log(x)] - 0.083[\log(x)]^2$	0.597	0.912	0.800	0.046
Cd	8	$\log(y) = -0.708[\log(x)] - 0.073[\log(x)]^2$	0.654	0.063	0.200	0.920
Cd	12	—	—	—	—	—
Cd	18	$\log(y) = -0.01[\log(x)] - 0.004[\log(x)]^2$	0.216	0.442	0.449	0.933
Cd	23	$\log(y) = -0.022[\log(x)] - 0.004[\log(x)]^2$	0.013	0.286	0.939	0.948
Cd	28	$\log(y) = -0.073[\log(x)] - 0.008[\log(x)]^2$	0.204	0.608	0.800	—
Cd	32	$\log(y) = 0.125[\log(x)] + 0.021[\log(x)]^2$	0.547	-0.036	0.180	0.897

TABLE 20 (Continued): ANALYSIS OF THE RELATIONSHIP BETWEEN WATER CHEMISTRY AND SEDIMENT CHEMISTRY AT SAME MONITORED STATION ON THE ILLINOIS WATERWAY

Parameter Name	Loc ID	Equation	R^2 of Fit	Linear Corr (r)	α^1 H_0: $\lvert\rho\rvert \geq 0.3$	β^2 $\lvert\rho\rvert \leq 0.225$
Cd	35	$\log(y) = 0.131[\log(x)] + 0.02[\log(x)]^2$	0.823	0.030	0.190	0.934
Cd	38	$\log(y) = -0.51[\log(x)] - 0.061[\log(x)]^2$	0.666	0.439	0.419	0.898
Cd	41	$\log(y) = -0.478[\log(x)] - 0.054[\log(x)]^2$	0.720	0.696	0.800	0.584
Cd	44	$\log(y) = -0.621[\log(x)] - 0.07[\log(x)]^2$	0.794	0.550	0.109	0.771
Cd	48	$\log(y) = -0.151[\log(x)] - 0.016[\log(x)]^2$	0.349	0.294	0.973	0.945
Cr	1	$\log(y) = -1.806[\log(x)] - 0.147[\log(x)]^2$	0.991	-0.166	0.429	0.685
Cr	2	$\log(y) = -1.632[\log(x)] - 0.15[\log(x)]^2$	0.947	0.379	0.630	0.911
Cr	5	$\log(y) = -0.998[\log(x)] - 0.06[\log(x)]^2$	0.886	-0.037	0.123	0.824
Cr	8	$\log(y) = -1.1[\log(x)] - 0.068[\log(x)]^2$	0.966	-0.35	0.756	0.398
Cr	12	$\log(y) = -0.868[\log(x)] - 0.063[\log(x)]^2$	0.946	-0.16	0.410	0.693
Cr	18	$\log(y) = -0.817[\log(x)] - 0.071[\log(x)]^2$	0.768	-0.146	0.382	0.746
Cr	23	$\log(y) = -0.438[\log(x)] - 0.001[\log(x)]^2$	0.875	-0.311	0.948	0.525
Cr	28	$\log(y) = -0.721[\log(x)] - 0.062[\log(x)]^2$	0.822	-0.147	0.402	0.781
Cr	32	$\log(y) = -1.004[\log(x)] - 0.101[\log(x)]^2$	0.864	-0.021	0.127	0.871
Cr	35	$\log(y) = -0.403[\log(x)] + 0.005[\log(x)]^2$	0.891	-0.228	0.682	0.670
Cr	38	$\log(y) = -1.393[\log(x)] - 0.143[\log(x)]^2$	0.978	-0.007	0.103	0.872
Cr	41	$\log(y) = -1.233[\log(x)] - 0.117[\log(x)]^2$	0.948	0.557	0.800	0.701
Cr	44	$\log(y) = -1.443[\log(x)] - 0.135[\log(x)]^2$	0.994	0.166	0.429	0.945
Cr	48	$\log(y) = -1.275[\log(x)] - 0.124[\log(x)]^2$	0.944	0.068	0.179	0.909
Cu	1	$\log(y) = -2.338[\log(x)] - 0.239[\log(x)]^2$	0.982	0.054	0.136	0.889
Cu	2	$\log(y) = -2.276[\log(x)] - 0.261[\log(x)]^2$	0.967	0.401	0.528	0.892
Cu	5	$\log(y) = -1.777[\log(x)] - 0.204[\log(x)]^2$	0.946	0.710	0.800	0.229
Cu	8	$\log(y) = -1.499[\log(x)] - 0.129[\log(x)]^2$	0.958	-0.219	0.612	0.540
Cu	12	$\log(y) = -0.478[\log(x)] - 0.01[\log(x)]^2$	0.885	-0.398	0.515	0.236
Cu	18	$\log(y) = -0.558[\log(x)] - 0.045[\log(x)]^2$	0.634	-0.124	0.281	0.693
Cu	23	$\log(y) = -0.75[\log(x)] - 0.095[\log(x)]^2$	0.807	-0.056	0.134	0.774
Cu	28	$\log(y) = -0.452[\log(x)] - 0.025[\log(x)]^2$	0.820	-0.19	0.501	0.609
Cu	32	$\log(y) = -0.688[\log(x)] - 0.07[\log(x)]^2$	0.746	-0.108	0.241	0.717
Cu	35	$\log(y) = -0.698[\log(x)] - 0.06[\log(x)]^2$	0.799	-0.047	0.126	0.795
Cu	38	$\log(y) = -1.132[\log(x)] - 0.103[\log(x)]^2$	0.969	-0.083	0.181	0.738
Cu	41	$\log(y) = -1.207[\log(x)] - 0.116[\log(x)]^2$	0.958	0.066	0.169	0.904
Cu	44	$\log(y) = -1.596[\log(x)] - 0.164[\log(x)]^2$	0.997	0.236	0.683	0.950
Cu	48	$\log(y) = -0.918[\log(x)] - 0.073[\log(x)]^2$	0.932	-0.296	0.980	0.432
Fe	1	$\log(y) = -4.859[\log(x)] + 1.313[\log(x)]^2$	0.600	0.292	0.959	0.940
Fe	2	$\log(y) = -3.321[\log(x)] + 3.615[\log(x)]^2$	0.650	0.342	0.794	0.925
Fe	5	$\log(y) = -3.02[\log(x)] + 6.156[\log(x)]^2$	0.635	0.320	0.897	0.930
Fe	8	$\log(y) = -5.794[\log(x)] + 3.022[\log(x)]^2$	0.688	-0.094	0.203	0.724
Fe	12	$\log(y) = -6.23[\log(x)] + 6.226[\log(x)]^2$	0.691	-0.106	0.229	0.706
Fe	18	$\log(y) = -4.349[\log(x)] + 4.773[\log(x)]^2$	0.654	-0.054	0.131	0.776

TABLE 20 (Continued): ANALYSIS OF THE RELATIONSHIP BETWEEN WATER CHEMISTRY AND SEDIMENT CHEMISTRY AT SAME MONITORED STATION ON THE ILLINOIS WATERWAY

Parameter Name	Loc ID	Equation	R^2 of Fit	Linear Corr (r)	α^1 H_0: $\lvert\rho\rvert \geq 0.3$	β^2 $\lvert\rho\rvert \leq 0.225$
Fe	23	$\log(y) = -3.271[\log(x)] + 3.284[\log(x)]^2$	0.482	-0.07	0.157	0.756
Fe	28	$\log(y) = -7.011[\log(x)] + 4.821[\log(x)]^2$	0.658	-0.095	0.205	0.721
Fe	32	$\log(y) = -6.814[\log(x)] + 4.823[\log(x)]^2$	0.547	-0.114	0.249	0.694
Fe	35	$\log(y) = -5.78[\log(x)] + 4.139[\log(x)]^2$	0.474	-0.057	0.135	0.773
Fe	38	$\log(y) = -7.579[\log(x)] + 5.88[\log(x)]^2$	0.461	0.679	0.800	0.287
Fe	41	$\log(y) = -6.572[\log(x)] + 5.026[\log(x)]^2$	0.302	0.247	0.735	0.949
Fe	44	$\log(y) = -0.158[\log(x)] + 4.912[\log(x)]^2$	0.244	0.310	0.948	0.933
Fe	48	$\log(y) = 0.006[\log(x)] + 2.926[\log(x)]^2$	0.128	0.073	0.162	0.899
Pb	1	$\log(y) = -2.283[\log(x)] - 0.226[\log(x)]^2$	0.975	0.530	0.138	0.781
Pb	2	$\log(y) = -2.018[\log(x)] - 0.182[\log(x)]^2$	0.982	-0.093	0.270	0.841
Pb	5	$\log(y) = -2.018[\log(x)] - 0.228[\log(x)]^2$	0.980	0.042	0.150	0.902
Pb	8	$\log(y) = -1.661[\log(x)] - 0.163[\log(x)]^2$	0.962	-0.265	0.835	0.564
Pb	12	$\log(y) = -0.981[\log(x)] - 0.084[\log(x)]^2$	0.986	-0.145	0.404	0.801
Pb	18	$\log(y) = -1.226[\log(x)] - 0.163[\log(x)]^2$	0.781	0.062	0.183	0.912
Pb	23	$\log(y) = -0.662[\log(x)] - 0.059[\log(x)]^2$	0.821	-0.024	0.131	0.869
Pb	28	$\log(y) = -0.863[\log(x)] - 0.088[\log(x)]^2$	0.851	-0.069	0.212	0.847
Pb	32	$\log(y) = -1.078[\log(x)] - 0.122[\log(x)]^2$	0.956	0.196	0.564	0.950
Pb	35	$\log(y) = -0.958[\log(x)] - 0.097[\log(x)]^2$	0.844	-0.001	0.109	0.890
Pb	38	$\log(y) = -1.574[\log(x)] - 0.182[\log(x)]^2$	0.977	0.278	0.899	0.947
Pb	41	$\log(y) = -1.018[\log(x)] - 0.086[\log(x)]^2$	0.916	0.086	0.246	0.928
Pb	44	$\log(y) = -1.376[\log(x)] - 0.132[\log(x)]^2$	0.979	0.176	0.471	0.947
Pb	48	$\log(y) = -1.004[\log(x)] - 0.074[\log(x)]^2$	0.968	-0.143	0.381	0.768
Mn	1	$\log(y) = -3.938[\log(x)] - 0.627[\log(x)]^2$	0.998	-0.249	0.748	0.489
Mn	2	$\log(y) = -4.129[\log(x)] - 0.704[\log(x)]^2$	0.991	0.033	0.124	0.888
Mn	5	$\log(y) = -4.685[\log(x)] - 0.916[\log(x)]^2$	0.994	0.307	0.964	0.935
Mn	8	$\log(y) = -3.591[\log(x)] - 0.55[\log(x)]^2$	0.994	-0.27	0.847	0.429
Mn	12	$\log(y) = -4.33[\log(x)] - 0.828[\log(x)]^2$	0.992	-0.237	0.688	0.487
Mn	18	$\log(y) = -3.931[\log(x)] - 0.735[\log(x)]^2$	0.982	-0.138	0.313	0.656
Mn	23	$\log(y) = -3.972[\log(x)] - 0.748[\log(x)]^2$	0.986	-0.199	0.524	0.555
Mn	28	$\log(y) = -5.819[\log(x)] - 1.403[\log(x)]^2$	0.981	-0.071	0.158	0.754
Mn	32	$\log(y) = -5.112[\log(x)] - 1.096[\log(x)]^2$	0.971	-0.134	0.301	0.663
Mn	35	$\log(y) = -5.678[\log(x)] - 1.317[\log(x)]^2$	0.982	-0.121	0.266	0.683
Mn	38	$\log(y) = -7.327[\log(x)] - 1.868[\log(x)]^2$	0.995	-0.007	0.073	0.831
Mn	41	$\log(y) = -6.569[\log(x)] - 1.582[\log(x)]^2$	0.990	0.112	0.244	0.922
Mn	44	$\log(y) = -6.165[\log(x)] - 1.419[\log(x)]^2$	0.995	-0.019	0.086	0.818
Mn	48	$\log(y) = -5.34[\log(x)] - 1.147[\log(x)]^2$	0.990	-0.226	0.638	0.507
Hg	1	$\log(y) = -0.019[\log(x)] - 0.019[\log(x)]^2$	0.038	-0.078	0.229	0.839
Hg	2	$\log(y) = -0.05[\log(x)] - 0.077[\log(x)]^2$	0.366	-0.112	0.306	0.812
Hg	5	$\log(y) = 0.106[\log(x)] - 0.055[\log(x)]^2$	0.455	-0.117	0.293	0.763

TABLE 20 (Continued): ANALYSIS OF THE RELATIONSHIP BETWEEN WATER CHEMISTRY AND SEDIMENT CHEMISTRY AT SAME MONITORED STATION ON THE ILLINOIS WATERWAY

Parameter Name	Loc ID	Equation	R^2 of Fit	Linear Corr (r)	α^1 H_0: $\lvert\rho\rvert \geq 0.3$	β^2 $\lvert\rho\rvert \leq 0.225$
Hg	8	$\log(y) = 0.827[\log(x)] + 0.154[\log(x)]^2$	0.345	-0.172	0.472	0.737
Hg	12	$\log(y) = 1.551[\log(x)] + 0.238[\log(x)]^2$	0.987	0.422	0.482	0.907
Hg	18	$\log(y) = -0.05[\log(x)] - 0.13[\log(x)]^2$	0.642	-0.095	0.304	0.882
Hg	23	$\log(y) = 0.15[\log(x)] - 0.121[\log(x)]^2$	0.497	0.019	0.146	0.912
Hg	28	$\log(y) = 1.727[\log(x)] + 0.307[\log(x)]^2$	0.968	-0.007	0.109	0.879
Hg	32	$\log(y) = 0.157[\log(x)] - 0.159[\log(x)]^2$	0.657	-0.014	0.140	0.898
Hg	35	$\log(y) = 0.063[\log(x)] - 0.146[\log(x)]^2$	0.666	-0.086	0.237	0.821
Hg	38	$\log(y) = 0.071[\log(x)] - 0.124[\log(x)]^2$	0.610	-0.186	0.528	0.743
Hg	41	$\log(y) = 0.04[\log(x)] - 0.094[\log(x)]^2$	0.512	-0.123	0.334	0.803
Hg	44	$\log(y) = 0.036[\log(x)] - 0.096[\log(x)]^2$	0.637	-0.119	0.315	0.792
Hg	48	$\log(y) = 0.167[\log(x)] - 0.133[\log(x)]^2$	0.701	-0.104	0.286	0.820
Ni	1	$\log(y) = -2.11[\log(x)] - 0.237[\log(x)]^2$	0.975	0.467	0.298	0.852
Ni	2	$\log(y) = -1.826[\log(x)] - 0.197[\log(x)]^2$	0.983	0.265	0.846	0.950
Ni	5	$\log(y) = -1.815[\log(x)] - 0.207[\log(x)]^2$	0.966	0.495	0.217	0.823
Ni	8	$\log(y) = -1.83[\log(x)] - 0.211[\log(x)]^2$	0.977	0.783	0.800	0.192
Ni	12	$\log(y) = -0.945[\log(x)] - 0.092[\log(x)]^2$	0.903	-0.311	0.950	0.592
Ni	18	$\log(y) = -0.96[\log(x)] - 0.09[\log(x)]^2$	0.805	0.237	0.724	0.951
Ni	23	$\log(y) = -1.054[\log(x)] - 0.123[\log(x)]^2$	0.809	0.386	0.619	0.919
Ni	28	$\log(y) = -0.877[\log(x)] - 0.098[\log(x)]^2$	0.620	0.742	0.800	0.425
Ni	32	$\log(y) = -1.124[\log(x)] - 0.12[\log(x)]^2$	0.928	0.000	0.101	0.884
Ni	35	$\log(y) = -0.753[\log(x)] - 0.065[\log(x)]^2$	0.719	0.475	0.265	0.834
Ni	38	$\log(y) = -1.601[\log(x)] - 0.191[\log(x)]^2$	0.943	0.721	0.800	0.393
Ni	41	$\log(y) = -1.502[\log(x)] - 0.183[\log(x)]^2$	0.907	0.348	0.777	0.928
Ni	44	$\log(y) = -1.703[\log(x)] - 0.192[\log(x)]^2$	0.989	0.685	0.800	0.484
Ni	48	$\log(y) = -1.425[\log(x)] - 0.16[\log(x)]^2$	0.976	-0.143	0.381	0.767
Ag	1	$\log(y) = -0.294[\log(x)] - 0.028[\log(x)]^2$	0.204	-0.301	0.996	0.748
Ag	2	$\log(y) = -0.377[\log(x)] - 0.041[\log(x)]^2$	0.324	-0.165	0.493	0.845
Ag	5	$\log(y) = -0.54[\log(x)] - 0.08[\log(x)]^2$	0.760	0.435	0.463	0.925
Ag	8	$\log(y) = -0.684[\log(x)] - 0.077[\log(x)]^2$	0.732	0.429	0.527	—
Ag	12	$\log(y) = -0.911[\log(x)] - 0.114[\log(x)]^2$	0.957	0.304	0.985	—
Ag	18	$\log(y) = -0.572[\log(x)] - 0.072[\log(x)]^2$	0.832	0.213	0.677	—
Ag	23	$\log(y) = -0.111[\log(x)] - 0.02[\log(x)]^2$	0.597	0.263	0.850	0.954
Ag	28	$\log(y) = -0.473[\log(x)] - 0.062[\log(x)]^2$	0.544	0.209	0.648	0.955
Ag	32	$\log(y) = -0.452[\log(x)] - 0.066[\log(x)]^2$	0.733	0.327	0.896	—
Ag	35	$\log(y) = -0.786[\log(x)] - 0.088[\log(x)]^2$	0.852	0.535	0.210	—
Ag	38	$\log(y) = -0.72[\log(x)] - 0.091[\log(x)]^2$	0.792	0.026	0.217	—
Ag	41	—	—	—	—	—
Ag	44	$\log(y) = -0.697[\log(x)] - 0.098[\log(x)]^2$	0.430	0.233	0.741	0.959
Ag	48	—	—	—	—	—

TABLE 20 (Continued): ANALYSIS OF THE RELATIONSHIP BETWEEN WATER CHEMISTRY AND SEDIMENT CHEMISTRY AT SAME MONITORED STATION ON THE ILLINOIS WATERWAY

Parameter Name	Loc ID	Equation	R^2 of Fit	Linear Corr (r)	α^1 H_0: $\lvert\rho\rvert \geq 0.3$	β^2 $\lvert\rho\rvert \leq 0.225$
Zn	1	$\log(y) = -5.143[\log(x)] - 0.901[\log(x)]^2$	0.978	-0.182	0.464	0.603
Zn	2	$\log(y) = -4.878[\log(x)] - 0.916[\log(x)]^2$	0.980	0.181	0.481	0.947
Zn	5	$\log(y) = -4.267[\log(x)] - 0.82[\log(x)]^2$	0.986	0.183	0.468	0.947
Zn	8	$\log(y) = -3.565[\log(x)] - 0.524[\log(x)]^2$	0.986	-0.246	0.730	0.470
Zn	12	$\log(y) = -2.223[\log(x)] - 0.276[\log(x)]^2$	0.980	-0.183	0.462	0.583
Zn	18	$\log(y) = -1.665[\log(x)] - 0.177[\log(x)]^2$	0.974	-0.254	0.778	0.529
Zn	23	$\log(y) = -2.256[\log(x)] - 0.337[\log(x)]^2$	0.992	0.029	0.107	0.875
Zn	28	$\log(y) = -2.025[\log(x)] - 0.278[\log(x)]^2$	0.970	0.029	0.107	0.875
Zn	32	$\log(y) = -2.882[\log(x)] - 0.464[\log(x)]^2$	0.984	0.492	0.181	0.755
Zn	35	$\log(y) = -2.615[\log(x)] - 0.384[\log(x)]^2$	0.983	-0.116	0.260	0.705
Zn	38	$\log(y) = -2.941[\log(x)] - 0.419[\log(x)]^2$	0.987	0.081	0.196	0.913
Zn	41	$\log(y) = -2.832[\log(x)] - 0.408[\log(x)]^2$	0.968	0.283	0.916	0.944
Zn	44	$\log(y) = -3.104[\log(x)] - 0.433[\log(x)]^2$	0.991	0.523	0.125	0.728
Zn	48	$\log(y) = -2.85[\log(x)] - 0.431[\log(x)]^2$	0.975	0.104	0.246	0.924

—: No relation can be established or sample size is not large enough to test. Also, R^2 of regression fit and linear correlation does not exist.

[1]The highest significant probability (p-value).

[2]Probability of making Type 2 Error (β).

DISCUSSION

The CWA has been instrumental in reducing pollution of the Nation's waters. Through water quality criteria, pretreatment programs, and discharge permits, water quality in the ILWW has improved significantly. McClelland et al. (2012) documented trends in the fish species richness and relative abundance for a long-term data set collected on the ILWW from 1957 through 2009. The trend analysis found increases in the overall and native fish species richness throughout the Illinois River as well as temporal changes in the relative abundance of overall and native fishes. A shift in the Illinois River fish community occurred in the late 1970s and was likely the result of improvements to water quality.

Ammonia is one of several forms of nitrogen that exists in aquatic environments that has a direct toxic effect on aquatic life. Sources of ammonia include municipal wastewater effluents, animal waste, runoff from agricultural lands, nitrogen fixation, and air deposition (USEPA 2013a). The USEPA first published ammonia criteria for the protection of aquatic life in 1976. The criteria were then updated in 1985, 1999, and 2013. The IPCB adopted NH_4-N and un-ionized ammonia water quality standards in 1982 that were later updated in 1988 and 2002. The results of the temporal trend analysis in Table 15 and 16 show negative trends for individual concentrations and the yearly mean concentrations of NH_4-N. Appendix Figure B-1 shows NH_4-N over time for three seasons for each ILWW pool. The upper pools clearly show greater reduction in NH_4-N compared to the lower pools. The reduction in the upper pools is most likely attributed to the tighter regulations, lower effluent limits in the NPDES permits, subsequent improvements to WRPs, and the effectiveness of the TARP system intercepting pollutants to the waterways via CSO reduction.

The most common source of cyanide pollution is the electroplating and metal treatment industries and it has a direct toxic effect on aquatic life. The USEPA first published cyanide criteria in 1976, with updates in 1980 and 1985. The IPCB adopted water quality standards for cyanide in 1978 that were most recently updated in 2013. For the duration of the ILWW monitoring program, TCN was measured. The results of the trend analysis in Tables 15 and 16 show negative temporal trends for individual concentrations and the yearly mean concentrations of TCN for all monitoring stations. Appendix Figure B-2 shows TCN over time for three seasons for each pool. The upper pools show greater reduction over time compared to the lower pools. The reductions in TCN are most likely due to the enforcement of the User Charge Ordinance in 1979 and the pre-treatment program in the early to mid-1980s.

DO is necessary for all stages of aquatic life, and low DO levels are often an indicator of water pollution. The USEPA first published DO criteria in 1976 and updated them in 1986. The IPCB adopted water quality standards for DO in 1977, 1988 and 2008. Since the start of the ILWW monitoring program, DO levels have increased greatly in the upper pools of the ILWW system. This trend is shown in Appendix Figure B-3. The results of the trend analysis in Tables 15 and 16 also show a positive trend for DO at most of the monitoring stations. The lower pools showed less significant improvements, as seen in Appendix Figure B-3. The reduction of CSOs due to implementation of TARP and the installation of supplemental aeration stations, as well as improvements in the quality of treated wastewater discharging to the waterways, likely contributed to the DO improvements in the Lockport and Brandon Road Pools.

Nutrient pollution is a national concern for rivers and streams. In a recent national study, the USEPA found both phosphorus and nitrogen to be the greatest chemical stressors on river and stream water quality (USEPA, 2013b). TN was measured for the sampling trips in 1992 and 1994 through 2011. The results of the trend analysis in Tables 15 and 16 found there was no trend in TN over time. This is also shown in Appendix Figure B-4. TP was measured throughout the program. Although the results of the trend analysis in Tables 15 and 16 indicated a positive trend for overall concentrations at each station and yearly mean concentrations of TP at 36 out of 49 stations, the graphical plot for TP versus time for three seasons for each pool did not visually show such a trend (Appendix Figure B-5).

There are point and nonpoint sources of nutrients to the ILWW. As the ILWW has many tributaries that contribute agricultural runoff, it becomes a challenge to establish relationships between point source activities and water quality in the ILWW. Nutrients from point sources can be diluted and assimilated as they move downstream and nutrient concentrations in streams can increase at times during heavy periods of runoff from nonpoint sources. One study conducted by the Illinois State Geological Survey evaluated the sources and fate of nitrate in the Illinois River basin (Panno, 2008). This study analyzed isotopic compositions of nitrate and found that the samples from the Illinois River had a signature of treated wastewater during the low flow periods. During the high flow periods, the nitrate signature resembled those of agricultural tile drains. This finding can probably explain why the spring concentrations of TN are higher than in other seasons, especially in the lower pools which have more tributary input from agricultural lands (Appendix Figure B-4). The study also reported that in-stream denitrification occurs in the lower pools especially during summer and periods of low flow.

Another nitrogen isotope study focusing on the Illinois River and its tributaries was done by the University of Illinois at Chicago, in collaboration with the District (Sturchio, 2009). The study found that high flows during the spring created a pulse of nitrate into the Illinois River that was strongly reflected in the waters of the tributaries.

The statistical summary for the sediment quality in Appendix C shows that there are spatial differences where the upper pools of the ILWW show higher mean values for many of the parameters. These upper pools of the ILWW were likely impacted by the vast urbanization and industrialization that occurred in the northeast Illinois region.

End Users of Data

The water quality data collected from this program have been periodically reported in District reports, which are available on the District’s website. The District receives requests for this data from other entities such as the Illinois Department of Natural Resources, the Illinois State Water Survey (ISWS), the Illinois Natural History Survey (INHS), IEPA, the United States Geological Survey (USGS), University of Illinois Urbana-Champaign, the United States Army Corps of Engineers, and various consultants. The District compiled the ILWW water quality data and submitted it biannually to the IEPA for use in the agency’s 305(b) Reports.

Other Entities that Monitor the Illinois Waterway

- The IEPA monitors water quality at a total of six locations in the District's ILWW program monitoring reach once every six weeks (nine times/year) as part of its Ambient Water Quality Monitoring network. Four of these stations are located on the Illinois River, and two are on the Lower Des Plaines River. The agency also conducts intensive basin surveys once every five years which include biological monitoring. The programs are designed to collect water quality data in compliance with the requirements of the CWA. Information on the programs is available at <http://www.epa.state.il.us/water/surface-water/river-stream-mon.html>.

- The ISWS conducts special studies on the ILWW, but currently does not perform any regular water quality monitoring. A long-term monitoring station was maintained at Peoria from 1965 through 1999 and the data are available at <http://ilrdss.isws.illinois.edu/WQ>.

- The USGS currently has six monitoring locations on the ILWW, but the available data is limited. The data are available at <http://waterwatch.usgs.gov/wqwatch/faq?faq_id=1>. The USGS has also conducted studies of the ILWW under the national Water Quality Assessment Program unit investigations for the upper and lower Illinois River. The investigations are done on a nine year cycle. The data are available at <http://il.water.usgs.gov/proj/lirb/pubs/factsheet.html>.

- The INHS conducts a Long Term Resource Monitoring Program which includes some monitoring locations on the lower end of the ILWW. These locations are downstream of the District's ILWW monitoring program reach and the data is limited. The data are available at <http://www.umesc.usgs.gov/data_library/water_quality/water_quality_page.html>.

Data Comparison

The ISWS conducted a study of the physical and chemical water quality characteristics within the ILWW from river mile 3.6 to 270.6 during 1978 and 1979 (Kothandaraman, 1981). The Marseilles, Starved Rock, and Peoria Pools were sampled during this study and the results were comparable to those described in the District's ILWW program.

In another study, the ISWS evaluated water quality trends in the ILWW from Peoria to Chicago for the years 1965 through 1995 (Larson, 2001). The evaluation included District data for locations within the CAWS, data from the USGS for one station in the Marseilles Pool, and data from the ISWS for one station in the Peoria Pool. The results of the trend analysis over time showed a positive trend for DO in the Peoria Pool and a negative trend for NH_4-N for both pools, which is similar to the findings in this report.

Project Cost

The estimated cost for the most recent sampling trips in 2011 was $31,804 per trip or $95,412 for the three one-way sampling trips conducted annually. In the years prior to 2009, there was also sampling on the return trip, so the cost was higher. The cost estimate to conduct the ILWW Monitoring Program includes labor, fuel, hotel fees, docking fees, analyses, and sample containers. This cost estimate did not include the sampling equipment since it is used for other monitoring programs and activities.

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APPENDIX A

WATER QUALITY SUMMARY FOR THE ILLINOIS WATERWAY MONITORING PROGRAM

TABLE A-1: SUMMARY OF WATER QUALITY IN THE LOCKPORT POOL ON THE CHICAGO SANITARY AND SHIP CANAL FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Water Temperature (°C)[3]	Mean	18.0	26.4	19.7
	Min.	12.2	21.0	12.6
	Max.	27.2	33.1	27.6
	Std. Dev.	3.2	2.9	3.4
	No. of Samples	46	59	53
Total Suspended Solids	Mean	31	17	13
	Min.	6	3	6
	Max.	760	262	40
	Std. Dev.	110	34	6
	No. of Samples	46	58	53
Total Organic Carbon[4]	Mean	11	7	10
	Min.	6	5	6
	Max.	25	11	45
	Std. Dev.	4	2	7
	No. of Samples	24	33	28
Turbidity (NTU)[5]	Mean	38	16	28
	Min.	1	3	6
	Max.	447	40	240
	Std. Dev.	92	11	50
	No. of Samples	22	21	21
Conductivity (µS/cm)[5]	Mean	1,090	723	758
	Min.	882	594	552
	Max.	1,276	885	879
	Std. Dev.	111	67	94
	No. of Samples	22	21	21
Five-Day BOD	Mean	3	3	3
	Min.	0	0	0
	Max.	10	18	16
	Std. Dev.	2	4	3
	No. of Samples	38	57	47

TABLE A-1 (Continued): SUMMARY OF WATER QUALITY IN THE LOCKPORT POOL ON THE CHICAGO SANITARY AND SHIP CANAL FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Dissolved Oxygen[6]	Mean	4.2	3.5	4.6
	Min.	0.6	0.0	1.0
	Max.	7.7	5.9	7.4
	Std. Dev.	1.6	1.2	1.4
	No. of Samples	46	64	54
pH (units)	Mean	6.9	7.1	7.1
	Min.	5.1	6.1	6.1
	Max.	7.9	8.6	8.8
	Std. Dev.	0.4	0.4	0.5
	No. of Samples	46	62	55
Ammonia Nitrogen	Mean	1.60	0.98	1.05
	Min.	0.22	0.07	0.06
	Max.	6.80	4.30	3.70
	Std. Dev.	1.64	0.77	0.95
	No. of Samples	46	64	55
Un-ionized Ammonia	Mean	0.009	0.013	0.007
	Min.	0.000	0.001	0.000
	Max.	0.174	0.169	0.068
	Std. Dev.	0.026	0.027	0.011
	No. of Samples	45	57	52
Total Kjeldahl Nitrogen[7]	Mean	1.81	1.34	1.43
	Min.	0.66	0.51	0.61
	Max.	4.98	2.60	2.97
	Std. Dev.	0.77	0.40	0.64
	No. of Samples	28	31	31
Nitrite plus Nitrate Nitrogen[8]	Mean	4.37	3.21	4.24
	Min.	0.62	0.97	1.50
	Max.	8.85	5.50	7.37
	Std. Dev.	1.94	1.06	1.55
	No. of Samples	46	58	52

TABLE A-1 (Continued): SUMMARY OF WATER QUALITY IN THE LOCKPORT POOL ON THE CHICAGO SANITARY AND SHIP CANAL FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Nitrogen[9]	Mean	7.06	5.28	6.52
	Min.	2.84	3.06	4.91
	Max.	11.02	6.82	8.45
	Std. Dev.	1.89	0.81	1.01
	No. of Samples	28	31	31
Total Phosphorus	Mean	0.87	0.73	0.96
	Min.	0.30	0.04	0.17
	Max.	4.45	2.13	2.22
	Std. Dev.	0.63	0.37	0.45
	No. of Samples	46	64	55
Chlorophyll *a* (µg/L)[10]	Mean	NA	NA	NA
	Min.	NA	NA	NA
	Max.	NA	NA	NA
	Std. Dev.	NA	NA	NA
	No. of Samples	NA	NA	NA
Total Cyanide	Mean	0.007	0.007	0.007
	Min.	0.000	0.000	0.002
	Max.	0.021	0.030	0.027
	Std. Dev.	0.004	0.005	0.005
	No. of Samples	44	58	51
Phenols	Mean	0.015	0.025	0.014
	Min.	<0.002	0.000	0.000
	Max.	0.050	0.140	0.050
	Std. Dev.	0.013	0.032	0.013
	No. of Samples	46	59	53
Fats, Oils, and Grease[11]	Mean	7	6	5
	Min.	0	0	0
	Max.	34	33	18
	Std. Dev.	8	8	6
	No. of Samples	24	33	28

TABLE A-1 (Continued): SUMMARY OF WATER QUALITY IN THE LOCKPORT POOL ON THE CHICAGO SANITARY AND SHIP CANAL FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Hardness[12]	Mean	263	194	207
	Min.	187	172	152
	Max.	327	236	271
	Std. Dev.	38	15	26
	No. of Samples	21	24	24
Fecal Coliform (cfu/100 mL)	Mean	4,539	7,652	3,062
	Min.	10	10	20
	Max.	120,000	190,000	49,000
	Std. Dev.	18,619	28,158	7,419
	No. of Samples	45	61	54
E. coli (cfu/100 mL)[13]	Mean	58	423	90
	Min.	<10	10	<10
	Max.	140	1,400	200
	Std. Dev.	62	526	76
	No. of Samples	6	7	7

[1]Water quality sampling did not occur in the years 1978–82 and 1998.
[2]Expressed in mg/L, except where noted.
[3]Field measurement. No data available for 1977.
[4]Total organic carbon data available only for 1983 and 1985–94.
[5]Field measurement taken with a water quality monitor. Data only available for years 2000–11.
[6]Dissolved oxygen was measured in the field with a water quality monitor for years 2000–11; previous years included a fixed DO sample.
[7]TKN was not analyzed for the years 1977, 1983–91, and 1993.
[8]Nitrite plus nitrate nitrogen was not analyzed for 1991.
[9]Total nitrogen data available only for 1992, 1994–97, and 1999–2011.
[10]Chlorophyll *a* data available only for 2002–2011.
[11]Fats, oils, and grease not analyzed after 1995.
[12]Hardness data available only for 1994–97, 1999–2002, and 2005–10.
[13]*E. coli* data available only during 2005–2011 Chicago to Peoria monitoring trips.

TABLE A-2: SUMMARY OF WATER QUALITY IN THE BRANDON ROAD POOL ON THE CHICAGO SANITARY AND SHIP CANAL AND DES PLAINES RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Water Temperature (°C)[3]	Mean	17.4	26.3	19.1
	Min.	12.0	21.0	12.0
	Max.	25.5	32.1	28.4
	Std. Dev.	2.8	2.7	3.0
	No. of Samples	138	178	159
Total Suspended Solids	Mean	21	21	19
	Min.	8	2	5
	Max.	66	182	59
	Std. Dev.	11	22	9
	No. of Samples	138	180	159
Total Organic Carbon[4]	Mean	10	9	10
	Min.	6	3	4
	Max.	18	41	48
	Std. Dev.	2	5	8
	No. of Samples	72	99	84
Turbidity (NTU)[5]	Mean	27	20	37
	Min.	3	5	5
	Max.	123	44	272
	Std. Dev.	19	10	57
	No. of Samples	66	63	63
Conductivity (µS/cm)[5]	Mean	1,108	738	779
	Min.	900	582	564
	Max.	1,285	918	922
	Std. Dev.	111	71	88
	No. of Samples	66	63	63
Five-Day BOD	Mean	4	3	3
	Min.	0	0	0
	Max.	10	25	10
	Std. Dev.	2	3	2
	No. of Samples	116	177	144

TABLE A-2 (Continued): SUMMARY OF WATER QUALITY IN THE BRANDON ROAD POOL ON THE CHICAGO SANITARY AND SHIP CANAL AND DES PLAINES RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Dissolved Oxygen[6]	Mean	5.3	4.2	5.4
	Min.	0.7	1.3	1.2
	Max.	8.7	8.4	8.5
	Std. Dev.	1.7	1.3	1.4
	No. of Samples	138	192	165
pH (units)	Mean	7.1	7.2	7.2
	Min.	5.8	6.3	5.8
	Max.	7.7	8.6	9.6
	Std. Dev.	0.4	0.4	0.4
	No. of Samples	138	190	165
Ammonia Nitrogen	Mean	1.35	0.90	0.92
	Min.	0.16	0.22	0.00
	Max.	7.00	4.20	3.70
	Std. Dev.	1.49	0.72	0.86
	No. of Samples	138	192	165
Un-ionized Ammonia	Mean	0.008	0.010	0.007
	Min.	0.000	0.000	0.000
	Max.	0.098	0.218	0.085
	Std. Dev.	0.015	0.020	0.011
	No. of Samples	135	183	156
Total Kjeldahl Nitrogen[7]	Mean	1.56	1.28	1.31
	Min.	0.58	0.61	0.60
	Max.	2.83	4.11	3.41
	Std. Dev.	0.45	0.44	0.55
	No. of Samples	84	93	93
Nitrite plus Nitrate Nitrogen[8]	Mean	4.18	3.21	4.31
	Min.	0.40	1.10	1.81
	Max.	9.73	5.52	7.31
	Std. Dev.	1.76	1.08	1.45
	No. of Samples	138	162	150

TABLE A-2 (Continued): SUMMARY OF WATER QUALITY IN THE BRANDON ROAD POOL ON THE CHICAGO SANITARY AND SHIP CANAL AND DES PLAINES RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Nitrogen[9]	Mean	6.43	5.32	6.38
	Min.	2.90	3.02	4.27
	Max.	11.65	9.07	8.64
	Std. Dev.	1.76	0.94	1.08
	No. of Samples	84	81	87
Total Phosphorus	Mean	0.75	0.72	0.95
	Min.	0.22	0.02	0.15
	Max.	1.83	1.55	2.37
	Std. Dev.	0.34	0.33	0.40
	No. of Samples	138	192	165
Chlorophyll *a* (µg/L)[10]	Mean	12	10	4
	Min.	2	3	2
	Max.	41	28	7
	Std. Dev.	9	6	1
	No. of Samples	32	32	32
Total Cyanide	Mean	0.007	0.006	0.007
	Min.	0.001	0.000	0.002
	Max.	0.070	0.011	0.025
	Std. Dev.	0.007	0.003	0.004
	No. of Samples	132	174	153
Phenols	Mean	0.015	0.022	0.013
	Min.	0.000	0.000	0.000
	Max.	0.058	0.100	0.050
	Std. Dev.	0.014	0.028	0.012
	No. of Samples	138	178	159
Fats, Oils, and Grease[11]	Mean	6	5	5
	Min.	0	0	0
	Max.	29	30	37
	Std. Dev.	6	6	7
	No. of Samples	70	97	84

TABLE A-2 (Continued): SUMMARY OF WATER QUALITY IN THE BRANDON ROAD POOL ON THE CHICAGO SANITARY AND SHIP CANAL AND DES PLAINES RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Hardness[12]	Mean	271	199	214
	Min.	191	169	162
	Max.	355	248	301
	Std. Dev.	38	18	30
	No. of Samples	63	72	72
Fecal Coliform (cfu/100 mL)	Mean	3,536	3,876	2,166
	Min.	<10	<10	10
	Max.	180,000	90,000	27,000
	Std. Dev.	21,155	10,906	3,828
	No. of Samples	135	186	162
E. coli (cfu/100 mL)[13]	Mean	43	450	282
	Min.	<10	10	<10
	Max.	160	1,400	1,100
	Std. Dev.	49	440	269
	No. of Samples	18	21	21

[1]Water quality sampling did not occur in the years 1978–82 and 1998.
[2]Expressed in mg/L, except where noted.
[3]Field measurement. No data available for 1977.
[4]Total organic carbon data available only for 1983 and 1985–94.
[5]Field measurement taken with a water quality monitor. Data only available for years 2000–11.
[6]Dissolved oxygen was measured in the field with a water quality monitor for years 2000–11; previous years included a fixed DO sample.
[7]TKN was not analyzed for the years 1977, 1983–91, and 1993.
[8]Nitrite plus nitrate nitrogen was not analyzed for 1991.
[9]Total nitrogen data available only for 1992, 1994–97, and 1999–2011.
[10]Chlorophyll *a* data available only for 2002–2011.
[11]Fats, oils, and grease not analyzed after 1995.
[12]Hardness data available only for 1994–97, 1999–2002, and 2005–10.
[13]*E. coli* data available only during 2005–2011 Chicago to Peoria monitoring trips.

TABLE A-3: SUMMARY OF WATER QUALITY IN THE DRESDEN ISLAND POOL ON THE DES PLAINES AND ILLINOIS RIVERS FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Water Temperature (°C)[3]	Mean	17.8	27.2	19.2
	Min.	11.0	21.0	12.8
	Max.	26.2	34.1	28.5
	Std. Dev.	2.9	2.9	3.3
	No. of Samples	322	434	371
Total Suspended Solids	Mean	30	22	23
	Min.	5	0	3
	Max.	280	172	320
	Std. Dev.	28	17	23
	No. of Samples	321	432	371
Total Organic Carbon[4]	Mean	11	8	10
	Min.	6	4	3
	Max.	21	25	63
	Std. Dev.	3	3	8
	No. of Samples	167	245	196
Turbidity (NTU)[5]	Mean	39	25	41
	Min.	8	6	4
	Max.	488	160	864
	Std. Dev.	49	18	83
	No. of Samples	154	147	147
Conductivity (µS/cm)[5]	Mean	1,091	762	822
	Min.	464	597	582
	Max.	1,325	938	1,003
	Std. Dev.	146	64	81
	No. of Samples	154	147	147
Five-Day BOD	Mean	5	4	4
	Min.	0	0	0
	Max.	15	20	12
	Std. Dev.	3	3	3
	No. of Samples	272	432	336

TABLE A-3 (Continued): SUMMARY OF WATER QUALITY IN THE DRESDEN ISLAND POOL ON THE DES PLAINES AND ILLINOIS RIVERS FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Dissolved Oxygen[6]	Mean	7.9	6.6	7.6
	Min.	1.3	3.2	1.4
	Max.	11.5	11.5	11.0
	Std. Dev.	1.6	1.2	1.2
	No. of Samples	322	462	383
pH (units)	Mean	7.3	7.4	7.4
	Min.	5.8	6.1	4.9
	Max.	8.2	9.0	9.8
	Std. Dev.	0.4	0.4	0.5
	No. of Samples	322	462	384
Ammonia Nitrogen	Mean	1.01	0.64	0.66
	Min.	0.05	0.00	0.00
	Max.	4.90	3.00	4.00
	Std. Dev.	1.21	0.62	0.72
	No. of Samples	322	462	384
Un-ionized Ammonia	Mean	0.008	0.011	0.006
	Min.	0.000	0.000	0.000
	Max.	0.178	0.197	0.051
	Std. Dev.	0.017	0.018	0.008
	No. of Samples	315	427	364
Total Kjeldahl Nitrogen[7]	Mean	1.48	1.19	1.15
	Min.	0.55	0.69	0.30
	Max.	2.95	2.69	3.07
	Std. Dev.	0.45	0.31	0.45
	No. of Samples	195	217	217
Nitrite plus Nitrate Nitrogen[8]	Mean	4.20	3.36	4.38
	Min.	1.23	1.48	1.78
	Max.	9.62	6.24	7.51
	Std. Dev.	1.49	0.91	1.29
	No. of Samples	322	420	364

TABLE A-3 (Continued): SUMMARY OF WATER QUALITY IN THE DRESDEN ISLAND POOL ON THE DES PLAINES AND ILLINOIS RIVERS FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Nitrogen[9]	Mean	6.13	5.09	6.18
	Min.	3.25	3.01	3.05
	Max.	9.72	7.82	8.89
	Std. Dev.	1.55	0.79	1.13
	No. of Samples	195	217	217
Total Phosphorus	Mean	0.69	0.70	0.90
	Min.	0.03	<0.01	0.08
	Max.	1.68	1.77	2.05
	Std. Dev.	0.31	0.30	0.34
	No. of Samples	321	462	385
Chlorophyll *a* (μg/L)[10]	Mean	17	15	8
	Min.	5	2	2
	Max.	38	40	44
	Std. Dev.	8	9	7
	No. of Samples	64	64	64
Total Cyanide	Mean	0.006	0.006	0.006
	Min.	0.000	0.000	0.000
	Max.	0.048	0.062	0.015
	Std. Dev.	0.005	0.005	0.003
	No. of Samples	308	420	357
Phenols	Mean	0.014	0.021	0.012
	Min.	0.000	0.000	0.000
	Max.	0.057	0.110	0.054
	Std. Dev.	0.014	0.027	0.012
	No. of Samples	322	434	371
Fats, Oils, and Grease[11]	Mean	6	5	5
	Min.	0	0	0
	Max.	80	41	58
	Std. Dev.	9	6	7
	No. of Samples	168	245	195

TABLE A-3 (Continued): SUMMARY OF WATER QUALITY IN THE DRESDEN ISLAND POOL ON THE DES PLAINES AND ILLINOIS RIVERS FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Hardness[12]	Mean	279	205	225
	Min.	191	166	166
	Max.	364	257	357
	Std. Dev.	38	18	31
	No. of Samples	147	168	168
Fecal Coliform (cfu/100 mL)	Mean	514	3,993	1,148
	Min.	<10	<10	<10
	Max.	7,000	1,001,000	14,000
	Std. Dev.	814	48,609	2,046
	No. of Samples	315	454	378
E. coli (cfu/100 mL)[13]	Mean	34	186	296
	Min.	<10	<10	<10
	Max.	210	1,300	6,500
	Std. Dev.	47	244	946
	No. of Samples	42	49	49

[1]Water quality sampling did not occur in the years 1978–82 and 1998.
[2]Expressed in mg/L, except where noted.
[3]Field measurement. No data available for 1977.
[4]Total organic carbon data available only for 1983 and 1985–94.
[5]Field measurement taken with a water quality monitor. Data only available for years 2000–11.
[6]Dissolved oxygen was measured in the field with a water quality monitor for years 2000–11; previous years included a fixed DO sample.
[7]TKN was not analyzed for the years 1977, 1983–91, and 1993.
[8]Nitrite plus nitrate nitrogen was not analyzed for 1991.
[9]Total nitrogen data available only for 1992, 1994–97, and 1999–2011.
[10]Chlorophyll *a* data available only for 2002–2011.
[11]Fats, oils, and grease not analyzed after 1995.
[12]Hardness data available only for 1994–97, 1999–2002, and 2005–10.
[13]*E. coli* data available only during 2005–2011 Chicago to Peoria monitoring trips.

TABLE A-4: SUMMARY OF WATER QUALITY IN THE MARSEILLES POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Water Temperature (°C)[3]	Mean	17.1	27.1	17.6
	Min.	11.0	20.1	11.2
	Max.	24.7	33.5	24.2
	Std. Dev.	2.8	2.6	2.5
	No. of Samples	460	619	530
Total Suspended Solids	Mean	47	29	27
	Min.	9	1	1
	Max.	447	388	371
	Std. Dev.	46	29	29
	No. of Samples	458	619	530
Total Organic Carbon[4]	Mean	10	8	10
	Min.	3	4	2
	Max.	45	23	60
	Std. Dev.	5	3	10
	No. of Samples	240	349	280
Turbidity (NTU)[5]	Mean	53	37	28
	Min.	13	6	1
	Max.	520	1,263	213
	Std. Dev.	61	121	23
	No. of Samples	220	210	210
Conductivity (µS/cm)[5]	Mean	846	730	778
	Min.	454	630	606
	Max.	1,081	866	974
	Std. Dev.	140	53	61
	No. of Samples	220	210	210
Five-Day BOD	Mean	4	4	3
	Min.	0	0	0
	Max.	14	17	12
	Std. Dev.	2	3	2
	No. of Samples	389	617	480

TABLE A-4 (Continued): SUMMARY OF WATER QUALITY IN THE MARSEILLES POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Dissolved Oxygen[6]	Mean	8.8	7.2	8.8
	Min.	2.5	1.5	2.5
	Max.	14.9	11.5	13.5
	Std. Dev.	1.7	1.1	1.3
	No. of Samples	460	660	549
pH (units)	Mean	7.6	7.6	7.7
	Min.	5.6	5.7	5.7
	Max.	8.6	9.0	9.8
	Std. Dev.	0.5	0.6	0.6
	No. of Samples	460	659	550
Ammonia Nitrogen	Mean	0.42	0.32	0.32
	Min.	0.00	0.00	0.00
	Max.	2.90	2.40	2.80
	Std. Dev.	0.56	0.40	0.42
	No. of Samples	460	660	550
Un-ionized Ammonia	Mean	0.005	0.008	0.004
	Min.	0.000	0.000	0.000
	Max.	0.054	0.145	0.034
	Std. Dev.	0.007	0.013	0.006
	No. of Samples	450	610	518
Total Kjeldahl Nitrogen[7]	Mean	1.17	1.10	0.90
	Min.	0.18	0.44	0.03
	Max.	3.90	25.60	3.81
	Std. Dev.	0.40	1.42	0.38
	No. of Samples	280	310	310
Nitrite plus Nitrate Nitrogen[8]	Mean	4.63	3.07	3.66
	Min.	2.05	0.24	1.35
	Max.	16.04	6.47	5.96
	Std. Dev.	1.43	0.79	0.88
	No. of Samples	460	600	520

TABLE A-4 (Continued): SUMMARY OF WATER QUALITY IN THE MARSEILLES POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Nitrogen[9]	Mean	6.00	4.27	4.65
	Min.	3.63	2.25	2.24
	Max.	10.77	28.71	7.48
	Std. Dev.	1.25	1.66	0.84
	No. of Samples	280	310	310
Total Phosphorus	Mean	0.41	0.54	0.62
	Min.	0.09	<0.01	0.12
	Max.	1.46	6.98	1.87
	Std. Dev.	0.18	0.35	0.25
	No. of Samples	460	660	550
Chlorophyll *a* (µg/L)[10]	Mean	21	23	16
	Min.	5	1	3
	Max.	89	79	57
	Std. Dev.	16	13	12
	No. of Samples	52	49	48
Total Cyanide	Mean	0.005	0.005	0.004
	Min.	0.000	0.000	0.000
	Max.	0.058	0.069	0.012
	Std. Dev.	0.005	0.004	0.002
	No. of Samples	440	600	510
Phenols	Mean	0.012	0.021	0.011
	Min.	0.000	0.000	0.000
	Max.	0.310	0.200	0.056
	Std. Dev.	0.019	0.030	0.012
	No. of Samples	460	620	530
Fats, Oils, and Grease[11]	Mean	5	5	5
	Min.	0	0	0
	Max.	33	35	53
	Std. Dev.	6	6	7
	No. of Samples	240	349	280

TABLE A-4 (Continued): SUMMARY OF WATER QUALITY IN THE MARSEILLES POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Hardness[12]	Mean	296	230	252
	Min.	209	193	204
	Max.	457	294	328
	Std. Dev.	39	22	27
	No. of Samples	210	240	240
Fecal Coliform (cfu/100 mL)	Mean	226	485	306
	Min.	<10	<10	<10
	Max.	10,000	90,000	11,000
	Std. Dev.	923	3,793	896
	No. of Samples	450	649	539
E. coli (cfu/100 mL)[13]	Mean	23	59	106
	Min.	<10	<10	<10
	Max.	130	260	1,700
	Std. Dev.	28	65	298
	No. of Samples	60	70	70

[1]Water quality sampling did not occur in the years 1978–82 and 1998.
[2]Expressed in mg/L, except where noted.
[3]Field measurement. No data available for 1977.
[4]Total organic carbon data available only for 1983 and 1985–94.
[5]Field measurement taken with a water quality monitor. Data only available for years 2000–11.
[6]Dissolved oxygen was measured in the field with a water quality monitor for years 2000–11; previous years included a fixed DO sample.
[7]TKN was not analyzed for the years 1977, 1983–91, and 1993.
[8]Nitrite plus nitrate nitrogen was not analyzed for 1991.
[9]Total nitrogen data available only for 1992, 1994–97, and 1999–2011.
[10]Chlorophyll *a* data available only for 2002–2011.
[11]Fats, oils, and grease not analyzed after 1995.
[12]Hardness data available only for 1994–97, 1999–2002, and 2005–10.
[13]*E. coli* data available only during 2005–2011 Chicago to Peoria monitoring trips.

TABLE A-5: SUMMARY OF WATER QUALITY IN THE STARVED ROCK POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Water Temperature (°C)[3]	Mean	17.2	26.6	16.9
	Min.	11.0	20.0	11.0
	Max.	23.1	33.0	24.4
	Std. Dev.	2.6	2.7	2.7
	No. of Samples	276	368	318
Total Suspended Solids	Mean	52	38	26
	Min.	14	3	3
	Max.	358	679	158
	Std. Dev.	48	72	21
	No. of Samples	275	370	318
Total Organic Carbon[4]	Mean	11	8	12
	Min.	3	4	4
	Max.	53	19	61
	Std. Dev.	5	3	12
	No. of Samples	144	208	168
Turbidity (NTU)[5]	Mean	56	27	26
	Min.	15	7	3
	Max.	251	141	79
	Std. Dev.	51	17	13
	No. of Samples	132	126	125
Conductivity (µS/cm)[5]	Mean	838	739	790
	Min.	481	653	632
	Max.	1,036	839	915
	Std. Dev.	122	42	60
	No. of Samples	132	126	126
Five-Day BOD	Mean	4	4	4
	Min.	0	0	0
	Max.	11	15	10
	Std. Dev.	3	3	2
	No. of Samples	232	368	289

TABLE A-5 (Continued): SUMMARY OF WATER QUALITY IN THE STARVED ROCK POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Dissolved Oxygen[6]	Mean	9.2	7.8	9.2
	Min.	2.8	4.0	2.7
	Max.	17.4	16.5	15.8
	Std. Dev.	2.0	1.8	1.7
	No. of Samples	276	396	330
pH (units)	Mean	7.7	7.8	7.8
	Min.	5.7	5.9	5.4
	Max.	8.9	9.9	9.8
	Std. Dev.	0.6	0.6	0.7
	No. of Samples	276	396	330
Ammonia Nitrogen	Mean	0.24	0.16	0.17
	Min.	0.00	0.00	0.00
	Max.	1.90	1.20	1.20
	Std. Dev.	0.30	0.21	0.24
	No. of Samples	276	396	330
Un-ionized Ammonia	Mean	0.004	0.007	0.004
	Min.	0.000	0.000	0.000
	Max.	0.042	0.119	0.066
	Std. Dev.	0.005	0.012	0.006
	No. of Samples	270	366	308
Total Kjeldahl Nitrogen[7]	Mean	1.29	1.20	1.04
	Min.	0.35	0.62	0.31
	Max.	3.24	2.05	5.29
	Std. Dev.	0.39	0.31	0.53
	No. of Samples	168	186	186
Nitrite plus Nitrate Nitrogen[8]	Mean	4.55	2.83	3.40
	Min.	2.17	1.22	0.08
	Max.	8.10	6.44	5.83
	Std. Dev.	1.28	0.90	0.87
	No. of Samples	275	360	312

TABLE A-5 (Continued): SUMMARY OF WATER QUALITY IN THE STARVED ROCK POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Nitrogen[9]	Mean	6.03	3.99	4.40
	Min.	3.57	2.20	1.34
	Max.	8.63	7.66	9.19
	Std. Dev.	1.22	0.95	0.85
	No. of Samples	167	186	186
Total Phosphorus	Mean	0.37	0.49	0.57
	Min.	0.00	0.01	0.15
	Max.	1.05	2.14	1.31
	Std. Dev.	0.16	0.22	0.22
	No. of Samples	276	396	330
Chlorophyll *a* (µg/L)[10]	Mean	42	47	36
	Min.	5	14	6
	Max.	148	129	125
	Std. Dev.	32	25	26
	No. of Samples	50	47	47
Total Cyanide	Mean	0.005	0.005	0.004
	Min.	0.000	0.000	0.000
	Max.	0.024	0.040	0.012
	Std. Dev.	0.003	0.004	0.002
	No. of Samples	264	360	306
Phenols	Mean	0.011	0.020	0.011
	Min.	0.000	0.000	0.000
	Max.	0.055	0.165	0.064
	Std. Dev.	0.013	0.029	0.013
	No. of Samples	276	371	318
Fats, Oils, and Grease[11]	Mean	5	5	5
	Min.	0	0	0
	Max.	39	45	47
	Std. Dev.	6	8	7
	No. of Samples	144	210	168

TABLE A-5 (Continued): SUMMARY OF WATER QUALITY IN THE STARVED ROCK POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Hardness[12]	Mean	304	237	263
	Min.	222	193	190
	Max.	496	293	320
	Std. Dev.	38	21	26
	No. of Samples	126	144	144
Fecal Coliform (cfu/100 mL)	Mean	653	637	188
	Min.	<10	<10	9
	Max.	110,000	37,000	5,900
	Std. Dev.	6,784	2,830	570
	No. of Samples	270	390	323
E. coli (cfu/100 mL)[13]	Mean	21	168	57
	Min.	<10	<10	<10
	Max.	99	4,500	450
	Std. Dev.	20	690	90
	No. of Samples	36	42	42

[1]Water quality sampling did not occur in the years 1978–82 and 1998.
[2]Expressed in mg/L, except where noted.
[3]Field measurement. No data available for 1977.
[4]Total organic carbon data available only for 1983 and 1985–94.
[5]Field measurement taken with a water quality monitor. Data only available for years 2000–11.
[6]Dissolved oxygen was measured in the field with a water quality monitor for years 2000–11; previous years included a fixed DO sample.
[7]TKN was not analyzed for the years 1977, 1983–91, and 1993.
[8]Nitrite plus nitrate nitrogen was not analyzed for 1991.
[9]Total nitrogen data available only for 1992, 1994–97, and 1999–2011.
[10]Chlorophyll *a* data available only for 2002–2011.
[11]Fats, oils, and grease not analyzed after 1995.
[12]Hardness data available only for 1994–97, 1999–2002, and 2005–10.
[13]*E. coli* data available only during 2005–2011 Chicago to Peoria monitoring trips.

TABLE A-6: SUMMARY OF WATER QUALITY IN THE UPPER PEORIA POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Water Temperature (°C)[3]	Mean	17.5	26.5	16.8
	Min.	11.0	18.0	11.0
	Max.	25.0	35.0	24.4
	Std. Dev.	2.7	2.7	2.7
	No. of Samples	644	868	742
Total Suspended Solids	Mean	50	41	37
	Min.	7	9	2
	Max.	174	199	182
	Std. Dev.	29	24	22
	No. of Samples	644	866	742
Total Organic Carbon[4]	Mean	10	8	13
	Min.	5	4	2
	Max.	50	26	74
	Std. Dev.	3	3	15
	No. of Samples	336	490	392
Turbidity (NTU)[5]	Mean	72	41	42
	Min.	15	15	16
	Max.	1,570	107	161
	Std. Dev.	149	17	19
	No. of Samples	308	292	294
Conductivity (µS/cm)[5]	Mean	811	740	789
	Min.	405	659	8
	Max.	977	838	906
	Std. Dev.	119	35	75
	No. of Samples	308	294	294
Five-Day BOD	Mean	5	4	4
	Min.	0	0	0
	Max.	15	21	11
	Std. Dev.	2	3	2
	No. of Samples	546	865	686

TABLE A-6 (Continued): SUMMARY OF WATER QUALITY IN THE UPPER PEORIA POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Dissolved Oxygen[6]	Mean	9.4	7.6	9.5
	Min.	2.1	3.2	0.3
	Max.	16.9	12.7	18.8
	Std. Dev.	2.3	1.6	1.8
	No. of Samples	644	924	770
pH (units)	Mean	7.7	7.9	7.9
	Min.	5.7	6.0	5.7
	Max.	9.9	9.3	9.8
	Std. Dev.	0.7	0.7	0.7
	No. of Samples	644	922	770
Ammonia Nitrogen	Mean	0.16	0.13	0.13
	Min.	0.00	0.00	0.00
	Max.	0.70	1.60	1.17
	Std. Dev.	0.13	0.14	0.15
	No. of Samples	644	924	770
Un-ionized Ammonia	Mean	0.005	0.010	0.005
	Min.	0.000	0.000	0.000
	Max.	0.135	0.154	0.077
	Std. Dev.	0.010	0.016	0.008
	No. of Samples	630	832	727
Total Kjeldahl Nitrogen[7]	Mean	1.41	1.35	1.24
	Min.	0.39	0.58	0.58
	Max.	3.56	3.00	5.92
	Std. Dev.	0.48	0.32	0.50
	No. of Samples	392	434	434
Nitrite plus Nitrate Nitrogen[8]	Mean	4.78	2.68	3.23
	Min.	2.08	1.08	0.93
	Max.	7.84	6.99	7.02
	Std. Dev.	1.34	0.97	0.98
	No. of Samples	644	839	728

TABLE A-6 (Continued): SUMMARY OF WATER QUALITY IN THE UPPER PEORIA POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Nitrogen[9]	Mean	6.37	3.86	4.26
	Min.	3.67	2.20	2.58
	Max.	9.63	7.98	9.66
	Std. Dev.	1.32	1.00	0.77
	No. of Samples	392	434	434
Total Phosphorus	Mean	0.32	0.44	0.53
	Min.	0.01	0.01	0.00
	Max.	1.77	2.22	3.16
	Std. Dev.	0.12	0.19	0.24
	No. of Samples	644	924	770
Chlorophyll *a* (μg/L)[10]	Mean	50	49	46
	Min.	2	18	14
	Max.	135	119	138
	Std. Dev.	33	17	26
	No. of Samples	101	95	95
Total Cyanide	Mean	0.005	0.005	0.004
	Min.	0.000	0.000	0.000
	Max.	0.060	0.028	0.020
	Std. Dev.	0.005	0.003	0.002
	No. of Samples	616	840	714
Phenols	Mean	0.011	0.021	0.010
	Min.	0.000	0.000	0.000
	Max.	0.050	0.175	0.070
	Std. Dev.	0.013	0.032	0.011
	No. of Samples	644	868	742
Fats, Oils, and Grease[11]	Mean	6	5	7
	Min.	0	0	0
	Max.	38	44	130
	Std. Dev.	7	7	9
	No. of Samples	334	489	392

TABLE A-6 (Continued): SUMMARY OF WATER QUALITY IN THE UPPER PEORIA POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Hardness[12]	Mean	304	244	266
	Min.	0	202	220
	Max.	882	333	345
	Std. Dev.	55	21	23
	No. of Samples	293	336	336
Fecal Coliform (cfu/100 mL)	Mean	102	640	113
	Min.	<10	<10	<10
	Max.	1,600	110,000	3,000
	Std. Dev.	199	4,680	228
	No. of Samples	630	910	756
E. coli (cfu/100 mL)[13]	Mean	18	133	48
	Min.	<10	<10	<10
	Max.	100	1,900	300
	Std. Dev.	18	365	70
	No. of Samples	83	98	98

[1]Water quality sampling did not occur in the years 1978–82 and 1998.
[2]Expressed in mg/L, except where noted.
[3]Field measurement. No data available for 1977.
[4]Total organic carbon data available only for 1983 and 1985–94.
[5]Field measurement taken with a water quality monitor. Data only available for years 2000–11.
[6]Dissolved oxygen was measured in the field with a water quality monitor for years 2000–11; previous years included a fixed DO sample.
[7]TKN was not analyzed for the years 1977, 1983–91, and 1993.
[8]Nitrite plus nitrate nitrogen was not analyzed for 1991.
[9]Total nitrogen data available only for 1992, 1994–97, and 1999–2011.
[10]Chlorophyll *a* data available only for 2002–2011.
[11]Fats, oils, and grease not analyzed after 1995.
[12]Hardness data available only for 1994–97, 1999–2002, and 2005–10.
[13]*E. coli* data available only during 2005–2011 Chicago to Peoria monitoring trips.

TABLE A-7: SUMMARY OF WATER QUALITY IN THE LOWER PEORIA POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Water Temperature (°C)[3]	Mean	17.6	26.1	16.0
	Min.	11.0	16.0	10.0
	Max.	24.0	32.2	24.6
	Std. Dev.	2.6	2.7	2.8
	No. of Samples	368	494	424
Total Suspended Solids	Mean	64	61	59
	Min.	10	7	4
	Max.	1,066	383	546
	Std. Dev.	69	34	39
	No. of Samples	368	496	424
Total Organic Carbon[4]	Mean	10	9	12
	Min.	5	3	3
	Max.	34	28	74
	Std. Dev.	4	3	15
	No. of Samples	192	280	224
Turbidity (NTU)[5]	Mean	72	91	82
	Min.	25	32	2
	Max.	215	1,257	1,013
	Std. Dev.	32	95	79
	No. of Samples	176	168	168
Conductivity (µS/cm)[5]	Mean	800	753	775
	Min.	492	670	639
	Max.	954	889	878
	Std. Dev.	95	41	62
	No. of Samples	176	168	168
Five-Day BOD	Mean	4	4	3
	Min.	0	0	0
	Max.	11	21	10
	Std. Dev.	2	3	2
	No. of Samples	312	488	392

TABLE A-7 (Continued): SUMMARY OF WATER QUALITY IN THE LOWER PEORIA POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Dissolved Oxygen[6]	Mean	8.8	6.5	8.8
	Min.	1.7	2.2	3.6
	Max.	18.9	14.0	14.4
	Std. Dev.	2.4	1.3	1.4
	No. of Samples	368	528	440
pH (units)	Mean	7.9	7.9	7.9
	Min.	5.6	6.0	6.1
	Max.	8.9	9.5	9.2
	Std. Dev.	0.7	0.7	0.7
	No. of Samples	368	527	440
Ammonia Nitrogen	Mean	0.16	0.15	0.14
	Min.	0.00	0.00	0.00
	Max.	0.83	0.54	0.90
	Std. Dev.	0.13	0.09	0.13
	No. of Samples	368	528	440
Un-ionized Ammonia	Mean	0.008	0.014	0.007
	Min.	0.000	0.000	0.000
	Max.	0.105	0.150	0.142
	Std. Dev.	0.013	0.017	0.012
	No. of Samples	357	483	401
Total Kjeldahl Nitrogen[7]	Mean	1.41	1.48	1.30
	Min.	0.51	0.00	0.62
	Max.	2.79	3.67	5.20
	Std. Dev.	0.44	0.43	0.44
	No. of Samples	224	248	248
Nitrite plus Nitrate Nitrogen[8]	Mean	4.57	2.34	2.67
	Min.	2.49	0.73	0.06
	Max.	8.44	6.29	6.70
	Std. Dev.	1.31	1.09	1.05
	No. of Samples	368	480	416

TABLE A-7 (Continued): SUMMARY OF WATER QUALITY IN THE LOWER PEORIA POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Nitrogen[9]	Mean	6.06	3.65	3.66
	Min.	3.21	1.51	1.29
	Max.	9.17	8.07	7.96
	Std. Dev.	1.32	1.20	0.83
	No. of Samples	224	248	248
Total Phosphorus	Mean	0.31	0.43	0.48
	Min.	0.00	<0.01	0.09
	Max.	0.85	1.47	1.55
	Std. Dev.	0.13	0.21	0.19
	No. of Samples	368	528	440
Chlorophyll *a* (µg/L)[10]	Mean	64	47	47
	Min.	7	19	12
	Max.	175	177	140
	Std. Dev.	42	22	29
	No. of Samples	66	62	62
Total Cyanide	Mean	0.005	0.005	0.004
	Min.	0.000	0.000	0.000
	Max.	0.029	0.058	0.010
	Std. Dev.	0.003	0.004	0.002
	No. of Samples	352	480	408
Phenols	Mean	0.011	0.023	0.011
	Min.	0.000	0.000	0.000
	Max.	0.052	0.195	0.083
	Std. Dev.	0.013	0.036	0.012
	No. of Samples	368	496	424
Fats, Oils, and Grease[11]	Mean	7	5	7
	Min.	0	0	0
	Max.	35	40	39
	Std. Dev.	7	6	8
	No. of Samples	192	280	224

TABLE A-7 (Continued): SUMMARY OF WATER QUALITY IN THE LOWER PEORIA POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Hardness[12]	Mean	307	253	266
	Min.	214	207	203
	Max.	385	330	358
	Std. Dev.	32	18	25
	No. of Samples	168	191	192
Fecal Coliform (cfu/100 mL)	Mean	110	456	283
	Min.	<10	<10	<10
	Max.	4,000	20,000	19,000
	Std. Dev.	372	1,621	1,505
	No. of Samples	360	518	425
E. coli (cfu/100 mL)[13]	Mean	44	51	67
	Min.	<10	<10	<10
	Max.	440	390	910
	Std. Dev.	87	80	174
	No. of Samples	48	56	56

[1]Water quality sampling did not occur in the years 1978–82 and 1998.
[2]Expressed in mg/L, except where noted.
[3]Field measurement. No data available for 1977.
[4]Total organic carbon data available only for 1983 and 1985–94.
[5]Field measurement taken with a water quality monitor. Data only available for years 2000–11.
[6]Dissolved oxygen was measured in the field with a water quality monitor for years 2000–11; previous years included a fixed DO sample.
[7]TKN was not analyzed for the years 1977, 1983–91, and 1993.
[8]Nitrite plus nitrate nitrogen was not analyzed for 1991.
[9]Total nitrogen data available only for 1992, 1994–97, and 1999–2011.
[10]Chlorophyll *a* data available only for 2002–2011.
[11]Fats, oils, and grease not analyzed after 1995.
[12]Hardness data available only for 1994–97, 1999–2002, and 2005–10.
[13]*E. coli* data available only during 2005–2011 Chicago to Peoria monitoring trips.

TABLE A-8: SUMMARY OF TRACE METALS IN THE LOCKPORT POOL ON THE CHICAGO SANITARY AND SHIP CANAL FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Arsenic	Mean	0.03	0.02	0.03
	Min.	0.00	0.00	0.00
	Max.	0.20	0.20	0.20
	Std. Dev.	0.06	0.05	0.06
	No. of Samples	46	60	53
Dissolved Arsenic	Mean	0.00	0.01	0.01
	Min.	0.00	0.00	0.00
	Max.	0.01	0.03	0.03
	Std. Dev.	0.00	0.01	0.01
	No. of Samples	16	16	16
Total Cadmium	Mean	0.004	0.006	0.004
	Min.	0.000	0.000	0.000
	Max.	0.020	0.027	0.020
	Std. Dev.	0.006	0.007	0.006
	No. of Samples	46	60	53
Dissolved Cadmium	Mean	0.0005	0.0007	0.0005
	Min.	0.0001	0.0002	0.0000
	Max.	0.0010	0.0020	0.0020
	Std. Dev.	0.0003	0.0006	0.0006
	No. of Samples	16	16	16
Total Chromium	Mean	0.01	0.01	0.01
	Min.	0.00	0.00	0.00
	Max.	0.07	0.06	0.03
	Std. Dev.	0.02	0.01	0.01
	No. of Samples	46	60	53
Dissolved Chromium	Mean	0.0023	0.0020	0.0017
	Min.	0.0008	0.0000	0.0004
	Max.	0.0070	0.0090	0.0040
	Std. Dev.	0.0018	0.0022	0.0010
	No. of Samples	16	16	16

TABLE A-8 (Continued): SUMMARY OF TRACE METALS IN THE LOCKPORT POOL ON THE CHICAGO SANITARY AND SHIP CANAL FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Copper	Mean	0.02	0.03	0.01
	Min.	0.00	0.00	0.00
	Max.	0.20	0.59	0.04
	Std. Dev.	0.04	0.08	0.01
	No. of Samples	46	60	53
Dissolved Copper	Mean	0.002	0.004	0.003
	Min.	0.000	0.000	0.000
	Max.	0.004	0.010	0.010
	Std. Dev.	0.001	0.004	0.003
	No. of Samples	16	16	16
Total Iron	Mean	0.8	0.4	0.4
	Min.	0.0	0.0	0.0
	Max.	11.4	3.3	2.1
	Std. Dev.	1.9	0.4	0.3
	No. of Samples	46	60	53
Dissolved Iron	Mean	0.055	0.034	0.029
	Min.	0.021	0.004	0.006
	Max.	0.171	0.094	0.083
	Std. Dev.	0.041	0.033	0.019
	No. of Samples	16	16	16
Total Lead	Mean	0.02	0.03	0.01
	Min.	0.00	0.00	0.00
	Max.	0.11	0.70	0.04
	Std. Dev.	0.03	0.09	0.01
	No. of Samples	46	60	53
Dissolved Lead	Mean	0.0049	0.0068	0.0060
	Min.	0.0000	0.0000	0.0009
	Max.	0.0086	0.0200	0.0200
	Std. Dev.	0.0030	0.0061	0.0058
	No. of Samples	16	16	16

TABLE A-8 (Continued): SUMMARY OF TRACE METALS IN THE LOCKPORT POOL ON THE CHICAGO SANITARY AND SHIP CANAL FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Manganese	Mean	0.063	0.037	0.042
	Min.	0.000	0.000	0.010
	Max.	0.370	0.340	0.320
	Std. Dev.	0.072	0.043	0.049
	No. of Samples	46	60	53
Dissolved Manganese	Mean	0.0308	0.0157	0.0171
	Min.	0.0220	0.0076	0.0003
	Max.	0.0454	0.0442	0.0236
	Std. Dev.	0.0053	0.0085	0.0065
	No. of Samples	16	16	16
Total Mercury (µg/L)	Mean	0.14	0.19	0.14
	Min.	0.00	0.00	0.00
	Max.	0.50	0.70	0.50
	Std. Dev.	0.16	0.20	0.16
	No. of Samples	46	60	53
Dissolved Mercury[3] (µg/L)	Mean	0.06	NA	0.05
	Min.	0.06	NA	0.04
	Max.	0.06	NA	0.06
	Std. Dev.	NA	NA	0.01
	No. of Samples	1	0	2
Total Nickel	Mean	0.048	0.032	0.032
	Min.	0.000	0.000	0.000
	Max.	0.300	0.400	0.200
	Std. Dev.	0.080	0.071	0.062
	No. of Samples	46	60	53
Dissolved Nickel	Mean	0.004	0.003	0.003
	Min.	0.002	0.001	0.002
	Max.	0.010	0.004	0.005
	Std. Dev.	0.002	0.001	0.001
	No. of Samples	16	16	16

TABLE A-8 (Continued): SUMMARY OF TRACE METALS IN THE LOCKPORT POOL ON THE CHICAGO SANITARY AND SHIP CANAL FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Silver	Mean	0.003	0.003	0.003
	Min.	0.000	0.000	0.000
	Max.	0.020	0.020	0.020
	Std. Dev.	0.006	0.005	0.006
	No. of Samples	46	60	53
Dissolved Silver	Mean	0.0006	0.0009	0.0007
	Min.	0.0000	0.0000	0.0000
	Max.	0.0020	0.0030	0.0030
	Std. Dev.	0.0009	0.0011	0.0010
	No. of Samples	16	16	16
Total Zinc	Mean	0.12	0.09	0.11
	Min.	0.00	0.00	0.00
	Max.	1.20	0.80	1.80
	Std. Dev.	0.21	0.13	0.25
	No. of Samples	46	60	53
Dissolved Zinc	Mean	0.020	0.012	0.016
	Min.	0.011	0.003	0.008
	Max.	0.034	0.035	0.029
	Std. Dev.	0.007	0.007	0.005
	No. of Samples	16	16	16

[1]Water quality sampling did not occur in the years 1978–82 and 1998.
[2]Expressed in mg/L, except where noted. Dissolved metals only analyzed for years 2001–08.
[3]Dissolved Mercury was analyzed if the Total Mercury result was greater than the limit of quantitation.

TABLE A-9: SUMMARY OF TRACE METALS IN THE BRANDON ROAD POOL ON THE CHICAGO SANITARY AND SHIP CANAL AND DES PLAINES RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Arsenic	Mean	0.03	0.02	0.03
	Min.	0.00	0.00	0.00
	Max.	0.20	0.20	0.30
	Std. Dev.	0.06	0.05	0.06
	No. of Samples	138	180	159
Dissolved Arsenic	Mean	0.00	0.01	0.01
	Min.	0.00	0.00	0.00
	Max.	0.02	0.03	0.03
	Std. Dev.	0.00	0.01	0.01
	No. of Samples	48	48	48
Total Cadmium	Mean	0.004	0.005	0.004
	Min.	0.000	0.000	0.000
	Max.	0.020	0.020	0.020
	Std. Dev.	0.006	0.006	0.006
	No. of Samples	138	180	159
Dissolved Cadmium	Mean	0.0005	0.0007	0.0005
	Min.	0.0001	0.0000	0.0000
	Max.	0.0013	0.0020	0.0020
	Std. Dev.	0.0003	0.0006	0.0006
	No. of Samples	48	48	48
Total Chromium	Mean	0.01	0.01	0.01
	Min.	0.00	0.00	0.00
	Max.	0.12	0.08	0.08
	Std. Dev.	0.02	0.01	0.01
	No. of Samples	138	180	159
Dissolved Chromium	Mean	0.0035	0.0021	0.0017
	Min.	0.0005	0.0000	0.0003
	Max.	0.0410	0.0120	0.0040
	Std. Dev.	0.0067	0.0027	0.0010
	No. of Samples	47	48	48

TABLE A-9 (Continued): SUMMARY OF TRACE METALS IN THE BRANDON ROAD POOL ON THE CHICAGO SANITARY AND SHIP CANAL AND DES PLAINES RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Copper	Mean	0.02	0.02	0.01
	Min.	0.00	0.00	0.00
	Max.	0.29	1.20	0.09
	Std. Dev.	0.04	0.10	0.01
	No. of Samples	138	180	159
Dissolved Copper	Mean	0.001	0.004	0.003
	Min.	0.000	0.000	0.000
	Max.	0.006	0.010	0.010
	Std. Dev.	0.002	0.003	0.003
	No. of Samples	48	48	48
Total Iron	Mean	0.8	0.4	0.5
	Min.	0.0	0.0	0.0
	Max.	16.1	3.4	3.5
	Std. Dev.	1.9	0.4	0.3
	No. of Samples	138	180	159
Dissolved Iron	Mean	0.060	0.033	0.029
	Min.	0.015	0.002	0.008
	Max.	0.221	0.098	0.088
	Std. Dev.	0.052	0.029	0.020
	No. of Samples	48	48	48
Total Lead	Mean	0.02	0.01	0.01
	Min.	0.00	0.00	0.00
	Max.	0.18	0.07	0.13
	Std. Dev.	0.03	0.01	0.02
	No. of Samples	138	180	159
Dissolved Lead	Mean	0.0052	0.0064	0.0061
	Min.	0.0000	0.0000	0.0009
	Max.	0.0138	0.0200	0.0200
	Std. Dev.	0.0028	0.0060	0.0060
	No. of Samples	48	48	48

TABLE A-9 (Continued): SUMMARY OF TRACE METALS IN THE BRANDON ROAD POOL ON THE CHICAGO SANITARY AND SHIP CANAL AND DES PLAINES RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Manganese	Mean	0.070	0.037	0.038
	Min.	0.020	0.000	0.019
	Max.	0.522	0.120	0.250
	Std. Dev.	0.087	0.018	0.025
	No. of Samples	138	180	159
Dissolved Manganese	Mean	0.0275	0.0149	0.0171
	Min.	0.0122	0.0071	0.0004
	Max.	0.0382	0.0434	0.0394
	Std. Dev.	0.0052	0.0066	0.0064
	No. of Samples	48	48	48
Total Mercury (µg/L)	Mean	0.15	0.19	0.14
	Min.	0.00	0.00	0.00
	Max.	0.50	1.00	0.50
	Std. Dev.	0.15	0.21	0.16
	No. of Samples	138	186	159
Dissolved Mercury[3] (µg/L)	Mean	0.09	0.04	0.05
	Min.	0.04	0.04	0.04
	Max.	0.21	0.04	0.06
	Std. Dev.	0.07	0.00	0.01
	No. of Samples	5	2	7
Total Nickel	Mean	0.046	0.030	0.033
	Min.	0.000	0.000	0.000
	Max.	0.300	0.300	0.200
	Std. Dev.	0.073	0.058	0.060
	No. of Samples	138	180	159
Dissolved Nickel	Mean	0.004	0.003	0.004
	Min.	0.002	0.001	0.001
	Max.	0.031	0.005	0.006
	Std. Dev.	0.004	0.001	0.001
	No. of Samples	48	48	48

TABLE A-9 (Continued): SUMMARY OF TRACE METALS IN THE BRANDON ROAD POOL ON THE CHICAGO SANITARY AND SHIP CANAL AND DES PLAINES RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Silver	Mean	0.004	0.004	0.003
	Min.	0.000	0.000	0.000
	Max.	0.100	0.020	0.020
	Std. Dev.	0.010	0.006	0.006
	No. of Samples	138	180	159
Dissolved Silver	Mean	0.0007	0.0009	0.0008
	Min.	0.0000	0.0000	0.0000
	Max.	0.0070	0.0030	0.0030
	Std. Dev.	0.0012	0.0011	0.0010
	No. of Samples	48	48	48
Total Zinc	Mean	0.09	0.08	0.07
	Min.	0.00	0.00	0.00
	Max.	0.72	1.10	0.70
	Std. Dev.	0.12	0.13	0.08
	No. of Samples	138	180	158
Dissolved Zinc	Mean	0.017	0.013	0.016
	Min.	0.007	0.000	0.006
	Max.	0.032	0.078	0.023
	Std. Dev.	0.005	0.011	0.004
	No. of Samples	48	48	48

[1]Water quality sampling did not occur in the years 1978–82 and 1998.
[2]Expressed in mg/L, except where noted. Dissolved metals only analyzed for years 2001–08.
[3]Dissolved Mercury was analyzed if the Total Mercury result was greater than the limit of quantitation.

TABLE A-10: SUMMARY OF TRACE METALS IN THE DRESDEN ISLAND POOL ON THE DES PLAINES AND ILLINOIS RIVERS FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Arsenic	Mean	0.03	0.02	0.03
	Min.	0.00	0.00	0.00
	Max.	0.20	0.20	0.20
	Std. Dev.	0.06	0.05	0.06
	No. of Samples	320	434	371
Dissolved Arsenic	Mean	0.00	0.01	0.01
	Min.	0.00	0.00	0.00
	Max.	0.02	0.03	0.03
	Std. Dev.	0.00	0.01	0.01
	No. of Samples	112	112	112
Total Cadmium	Mean	0.004	0.005	0.004
	Min.	0.000	0.000	0.000
	Max.	0.020	0.030	0.020
	Std. Dev.	0.006	0.006	0.006
	No. of Samples	322	434	371
Dissolved Cadmium	Mean	0.0005	0.0006	0.0005
	Min.	0.0001	0.0000	0.0000
	Max.	0.0016	0.0020	0.0020
	Std. Dev.	0.0003	0.0006	0.0006
	No. of Samples	112	112	112
Total Chromium	Mean	0.01	0.01	0.01
	Min.	0.00	0.00	0.00
	Max.	0.08	0.06	0.09
	Std. Dev.	0.01	0.01	0.01
	No. of Samples	322	434	371
Dissolved Chromium	Mean	0.0021	0.0019	0.0021
	Min.	0.0005	0.0000	0.0004
	Max.	0.0190	0.0190	0.0130
	Std. Dev.	0.0027	0.0026	0.0023
	No. of Samples	112	112	112

TABLE A-10 (Continued): SUMMARY OF TRACE METALS IN THE DRESDEN ISLAND POOL ON THE DES PLAINES AND ILLINOIS RIVERS FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Copper	Mean	0.02	0.01	0.01
	Min.	0.00	0.00	0.00
	Max.	0.24	0.21	0.64
	Std. Dev.	0.03	0.02	0.03
	No. of Samples	322	434	370
Dissolved Copper	Mean	0.002	0.004	0.003
	Min.	0.000	0.000	0.000
	Max.	0.010	0.034	0.010
	Std. Dev.	0.002	0.004	0.003
	No. of Samples	112	112	112
Total Iron	Mean	1.0	0.5	0.5
	Min.	0.0	0.0	0.0
	Max.	18.1	2.7	9.9
	Std. Dev.	2.0	0.4	0.6
	No. of Samples	322	434	370
Dissolved Iron	Mean	0.051	0.031	0.026
	Min.	0.013	0.000	0.004
	Max.	0.215	0.106	0.087
	Std. Dev.	0.047	0.031	0.020
	No. of Samples	112	112	112
Total Lead	Mean	0.02	0.01	0.01
	Min.	0.00	0.00	0.00
	Max.	0.13	0.05	0.05
	Std. Dev.	0.02	0.01	0.01
	No. of Samples	322	434	371
Dissolved Lead	Mean	0.0047	0.0066	0.0058
	Min.	0.0000	0.0000	0.0007
	Max.	0.0090	0.0200	0.0200
	Std. Dev.	0.0027	0.0062	0.0058
	No. of Samples	112	112	112

TABLE A-10 (Continued): SUMMARY OF TRACE METALS IN THE DRESDEN ISLAND POOL ON THE DES PLAINES AND ILLINOIS RIVERS FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Manganese	Mean	0.076	0.041	0.039
	Min.	0.020	0.000	0.010
	Max.	0.737	0.400	0.460
	Std. Dev.	0.100	0.031	0.031
	No. of Samples	322	434	370
Dissolved Manganese	Mean	0.0212	0.0083	0.0121
	Min.	0.0020	0.0000	0.0001
	Max.	0.0614	0.0254	0.0311
	Std. Dev.	0.0096	0.0055	0.0066
	No. of Samples	112	112	112
Total Mercury (µg/L)	Mean	0.15	0.18	0.15
	Min.	0.00	0.00	0.00
	Max.	0.75	0.70	0.90
	Std. Dev.	0.17	0.19	0.18
	No. of Samples	322	434	371
Dissolved Mercury[3] (µg/L)	Mean	0.16	0.02	0.02
	Min.	0.01	0.00	0.00
	Max.	0.48	0.04	0.05
	Std. Dev.	0.15	0.02	0.02
	No. of Samples	15	6	14
Total Nickel	Mean	0.037	0.030	0.036
	Min.	0.000	0.000	0.000
	Max.	0.200	0.400	0.300
	Std. Dev.	0.061	0.058	0.063
	No. of Samples	322	434	371
Dissolved Nickel	Mean	0.003	0.003	0.004
	Min.	0.001	0.001	0.001
	Max.	0.009	0.006	0.009
	Std. Dev.	0.002	0.001	0.002
	No. of Samples	112	112	112

TABLE A-10 (Continued): SUMMARY OF TRACE METALS IN THE DRESDEN ISLAND POOL ON THE DES PLAINES AND ILLINOIS RIVERS FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Silver	Mean	0.003	0.003	0.003
	Min.	0.000	0.000	0.000
	Max.	0.050	0.020	0.020
	Std. Dev.	0.007	0.005	0.006
	No. of Samples	322	434	371
Dissolved Silver	Mean	0.0007	0.0010	0.0008
	Min.	0.0000	0.0000	0.0000
	Max.	0.0050	0.0050	0.0030
	Std. Dev.	0.0010	0.0012	0.0010
	No. of Samples	112	112	112
Total Zinc	Mean	0.09	0.06	0.07
	Min.	0.00	0.00	0.00
	Max.	1.90	1.60	2.50
	Std. Dev.	0.14	0.11	0.15
	No. of Samples	322	434	370
Dissolved Zinc	Mean	0.014	0.011	0.015
	Min.	0.001	0.000	0.004
	Max.	0.043	0.036	0.029
	Std. Dev.	0.007	0.007	0.005
	No. of Samples	112	112	112

[1]Water quality sampling did not occur in the years 1978–82 and 1998.
[2]Expressed in mg/L, except where noted. Dissolved metals only analyzed for years 2001–08.
[3]Dissolved Mercury was analyzed if the Total Mercury result was greater than the limit of quantitation.

TABLE A-11: SUMMARY OF TRACE METALS IN THE MARSEILLES POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Arsenic	Mean	0.03	0.02	0.03
	Min.	0.00	0.00	0.00
	Max.	0.20	0.20	0.20
	Std. Dev.	0.06	0.05	0.06
	No. of Samples	460	620	530
Dissolved Arsenic	Mean	0.00	0.01	0.01
	Min.	0.00	0.00	0.00
	Max.	0.01	0.03	0.03
	Std. Dev.	0.00	0.01	0.01
	No. of Samples	160	160	160
Total Cadmium	Mean	0.004	0.005	0.004
	Min.	0.000	0.000	0.000
	Max.	0.020	0.020	0.020
	Std. Dev.	0.006	0.006	0.006
	No. of Samples	460	620	530
Dissolved Cadmium	Mean	0.0004	0.0006	0.0005
	Min.	0.0000	0.0000	0.0000
	Max.	0.0016	0.0020	0.0020
	Std. Dev.	0.0003	0.0006	0.0006
	No. of Samples	160	160	160
Total Chromium	Mean	0.01	0.01	0.01
	Min.	0.00	0.00	0.00
	Max.	0.22	3.49	0.71
	Std. Dev.	0.02	0.14	0.04
	No. of Samples	460	620	530
Dissolved Chromium	Mean	0.0021	0.0021	0.0016
	Min.	0.0001	0.0000	0.0001
	Max.	0.0210	0.0150	0.0090
	Std. Dev.	0.0030	0.0028	0.0014
	No. of Samples	160	160	160

TABLE A-11 (Continued): SUMMARY OF TRACE METALS IN THE MARSEILLES POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Copper	Mean	0.02	0.01	0.01
	Min.	0.00	0.00	0.00
	Max.	0.40	0.20	0.10
	Std. Dev.	0.04	0.01	0.01
	No. of Samples	460	620	530
Dissolved Copper	Mean	0.001	0.003	0.003
	Min.	0.000	0.000	0.000
	Max.	0.006	0.011	0.010
	Std. Dev.	0.001	0.003	0.003
	No. of Samples	160	160	160
Total Iron	Mean	1.7	0.6	0.6
	Min.	0.0	0.0	0.0
	Max.	89.3	10.3	6.7
	Std. Dev.	5.3	0.7	0.6
	No. of Samples	460	620	527
Dissolved Iron	Mean	0.041	0.029	0.021
	Min.	0.006	0.000	0.002
	Max.	0.335	0.139	0.106
	Std. Dev.	0.050	0.034	0.022
	No. of Samples	160	160	157
Total Lead	Mean	0.02	0.01	0.01
	Min.	0.00	0.00	0.00
	Max.	0.33	0.06	0.07
	Std. Dev.	0.03	0.01	0.01
	No. of Samples	460	620	530
Dissolved Lead	Mean	0.0047	0.0068	0.0057
	Min.	0.0000	0.0000	0.0004
	Max.	0.0098	0.0742	0.0200
	Std. Dev.	0.0029	0.0084	0.0058
	No. of Samples	160	151	160

TABLE A-11 (Continued): SUMMARY OF TRACE METALS IN THE MARSEILLES POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Manganese	Mean	0.112	0.052	0.046
	Min.	0.002	0.017	0.000
	Max.	4.777	0.215	0.340
	Std. Dev.	0.282	0.026	0.036
	No. of Samples	460	620	527
Dissolved Manganese	Mean	0.0058	0.0021	0.0038
	Min.	0.0007	0.0000	0.0002
	Max.	0.0907	0.0144	0.0273
	Std. Dev.	0.0089	0.0020	0.0045
	No. of Samples	160	160	157
Total Mercury (µg/L)	Mean	0.14	0.19	0.14
	Min.	0.00	0.00	0.00
	Max.	1.00	0.90	0.70
	Std. Dev.	0.16	0.20	0.16
	No. of Samples	460	620	530
Dissolved Mercury[3] (µg/L)	Mean	0.05	0.04	0.05
	Min.	0.04	0.00	0.04
	Max.	0.06	0.05	0.10
	Std. Dev.	0.01	0.02	0.01
	No. of Samples	6	8	30
Total Nickel	Mean	0.035	0.027	0.037
	Min.	0.000	0.000	0.000
	Max.	0.300	0.300	1.500
	Std. Dev.	0.061	0.054	0.099
	No. of Samples	460	620	530
Dissolved Nickel	Mean	0.002	0.002	0.002
	Min.	0.000	0.001	0.001
	Max.	0.006	0.007	0.007
	Std. Dev.	0.001	0.001	0.001
	No. of Samples	160	160	160

TABLE A-11 (Continued): SUMMARY OF TRACE METALS IN THE MARSEILLES POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Silver	Mean	0.003	0.003	0.003
	Min.	0.000	0.000	0.000
	Max.	0.020	0.020	0.020
	Std. Dev.	0.006	0.005	0.006
	No. of Samples	460	620	530
Dissolved Silver	Mean	0.0006	0.0009	0.0008
	Min.	0.0000	0.0000	0.0000
	Max.	0.0070	0.0050	0.0030
	Std. Dev.	0.0011	0.0012	0.0010
	No. of Samples	160	155	160
Total Zinc	Mean	0.06	0.04	0.06
	Min.	0.00	0.00	0.00
	Max.	1.32	0.40	1.30
	Std. Dev.	0.10	0.06	0.09
	No. of Samples	460	620	530
Dissolved Zinc	Mean	0.007	0.007	0.009
	Min.	0.001	0.000	0.002
	Max.	0.034	0.018	0.024
	Std. Dev.	0.004	0.004	0.004
	No. of Samples	160	160	160

[1]Water quality sampling did not occur in the years 1978–82 and 1998.
[2]Expressed in mg/L, except where noted. Dissolved metals only analyzed for years 2001–08.
[3]Dissolved Mercury was analyzed if the Total Mercury result was greater than the limit of quantitation.

TABLE A-12: SUMMARY OF TRACE METALS IN THE STARVED ROCK POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Arsenic	Mean	0.03	0.02	0.03
	Min.	0.00	0.00	0.00
	Max.	0.20	0.24	0.20
	Std. Dev.	0.06	0.05	0.06
	No. of Samples	276	372	318
Dissolved Arsenic	Mean	0.00	0.01	0.01
	Min.	0.00	0.00	0.00
	Max.	0.02	0.03	0.03
	Std. Dev.	0.00	0.01	0.01
	No. of Samples	96	96	96
Total Cadmium	Mean	0.004	0.005	0.004
	Min.	0.000	0.000	0.000
	Max.	0.020	0.048	0.020
	Std. Dev.	0.006	0.006	0.006
	No. of Samples	276	372	318
Dissolved Cadmium	Mean	0.0004	0.0007	0.0005
	Min.	0.0001	0.0000	0.0000
	Max.	0.0016	0.0020	0.0020
	Std. Dev.	0.0003	0.0006	0.0006
	No. of Samples	96	96	96
Total Chromium	Mean	0.01	0.01	0.01
	Min.	0.00	0.00	0.00
	Max.	0.14	0.06	0.18
	Std. Dev.	0.02	0.01	0.01
	No. of Samples	276	372	318
Dissolved Chromium	Mean	0.0021	0.0016	0.0015
	Min.	0.0003	0.0000	0.0001
	Max.	0.0270	0.0120	0.0100
	Std. Dev.	0.0034	0.0018	0.0013
	No. of Samples	96	96	96

TABLE A-12 (Continued): SUMMARY OF TRACE METALS IN THE STARVED ROCK POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Copper	Mean	0.02	0.01	0.01
	Min.	0.00	0.00	0.00
	Max.	0.25	0.12	0.14
	Std. Dev.	0.04	0.01	0.01
	No. of Samples	276	372	318
Dissolved Copper	Mean	0.001	0.003	0.003
	Min.	0.000	0.000	0.000
	Max.	0.004	0.011	0.010
	Std. Dev.	0.001	0.003	0.003
	No. of Samples	96	96	96
Total Iron	Mean	1.8	0.8	0.5
	Min.	0.0	0.0	0.0
	Max.	38.1	24.4	4.3
	Std. Dev.	4.6	2.5	0.4
	No. of Samples	276	372	318
Dissolved Iron	Mean	0.040	0.038	0.020
	Min.	0.005	0.000	0.004
	Max.	0.201	0.410	0.093
	Std. Dev.	0.044	0.058	0.023
	No. of Samples	96	96	96
Total Lead	Mean	0.02	0.01	0.01
	Min.	0.00	0.00	0.00
	Max.	0.21	0.06	0.20
	Std. Dev.	0.03	0.01	0.02
	No. of Samples	276	372	318
Dissolved Lead	Mean	0.0046	0.0064	0.0056
	Min.	0.0000	0.0000	0.0000
	Max.	0.0090	0.0200	0.0200
	Std. Dev.	0.0028	0.0062	0.0058
	No. of Samples	96	96	96

TABLE A-12 (Continued): SUMMARY OF TRACE METALS IN THE STARVED ROCK POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Manganese	Mean	0.112	0.053	0.045
	Min.	0.020	0.000	0.000
	Max.	1.671	0.320	0.190
	Std. Dev.	0.225	0.033	0.026
	No. of Samples	276	372	318
Dissolved Manganese	Mean	0.0031	0.0020	0.0018
	Min.	0.0006	0.0000	0.0000
	Max.	0.0190	0.0392	0.0066
	Std. Dev.	0.0033	0.0043	0.0013
	No. of Samples	96	96	96
Total Mercury (µg/L)	Mean	0.13	0.20	0.14
	Min.	0.00	0.00	0.00
	Max.	0.50	3.00	0.90
	Std. Dev.	0.15	0.25	0.16
	No. of Samples	276	372	318
Dissolved Mercury[3] (µg/L)	Mean	0.04	0.04	0.06
	Min.	0.04	0.04	0.04
	Max.	0.04	0.05	0.10
	Std. Dev.	0.00	0.01	0.02
	No. of Samples	4	3	13
Total Nickel	Mean	0.032	0.027	0.034
	Min.	0.000	0.000	0.000
	Max.	0.200	0.200	0.200
	Std. Dev.	0.059	0.053	0.062
	No. of Samples	276	372	318
Dissolved Nickel	Mean	0.002	0.002	0.002
	Min.	0.000	0.001	0.000
	Max.	0.006	0.005	0.005
	Std. Dev.	0.001	0.001	0.001
	No. of Samples	96	96	96

TABLE A-12 (Continued): SUMMARY OF TRACE METALS IN THE STARVED ROCK POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Silver	Mean	0.004	0.003	0.004
	Min.	0.000	0.000	0.000
	Max.	0.020	0.020	0.100
	Std. Dev.	0.006	0.005	0.011
	No. of Samples	276	372	318
Dissolved Silver	Mean	0.0006	0.0010	0.0008
	Min.	0.0000	0.0000	0.0000
	Max.	0.0060	0.0040	0.0030
	Std. Dev.	0.0010	0.0012	0.0010
	No. of Samples	96	96	96
Total Zinc	Mean	0.07	0.04	0.06
	Min.	0.00	0.00	0.00
	Max.	1.70	0.70	1.10
	Std. Dev.	0.14	0.07	0.09
	No. of Samples	276	372	318
Dissolved Zinc	Mean	0.006	0.006	0.009
	Min.	0.002	0.000	0.001
	Max.	0.025	0.018	0.026
	Std. Dev.	0.003	0.004	0.005
	No. of Samples	96	96	96

[1]Water quality sampling did not occur in the years 1978–82 and 1998.
[2]Expressed in mg/L, except where noted. Dissolved metals only analyzed for years 2001–08.
[3]Dissolved Mercury was analyzed if the Total Mercury result was greater than the limit of quantitation.

TABLE A-13: SUMMARY OF TRACE METALS IN THE UPPER PEORIA POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Arsenic	Mean	0.03	0.03	0.03
	Min.	0.00	0.00	0.00
	Max.	0.20	0.41	0.30
	Std. Dev.	0.06	0.06	0.06
	No. of Samples	643	868	742
Dissolved Arsenic	Mean	0.00	0.01	0.01
	Min.	0.00	0.00	0.00
	Max.	0.03	0.03	0.03
	Std. Dev.	0.00	0.01	0.01
	No. of Samples	223	224	224
Total Cadmium	Mean	0.004	0.005	0.004
	Min.	0.000	0.000	0.000
	Max.	0.020	0.050	0.020
	Std. Dev.	0.006	0.006	0.006
	No. of Samples	643	868	742
Dissolved Cadmium	Mean	0.0004	0.0007	0.0005
	Min.	0.0000	0.0000	0.0000
	Max.	0.0014	0.0035	0.0020
	Std. Dev.	0.0003	0.0006	0.0006
	No. of Samples	223	224	224
Total Chromium	Mean	0.01	0.01	0.01
	Min.	0.00	0.00	0.00
	Max.	0.09	0.33	0.21
	Std. Dev.	0.01	0.01	0.01
	No. of Samples	643	868	742
Dissolved Chromium	Mean	0.0021	0.0019	0.0016
	Min.	0.0002	0.0000	0.0000
	Max.	0.0250	0.0140	0.0283
	Std. Dev.	0.0033	0.0023	0.0022
	No. of Samples	223	224	224

TABLE A-13 (Continued): SUMMARY OF TRACE METALS IN THE UPPER PEORIA POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Copper	Mean	0.02	0.01	0.01
	Min.	0.00	0.00	0.00
	Max.	0.20	0.09	0.37
	Std. Dev.	0.03	0.01	0.02
	No. of Samples	643	868	742
Dissolved Copper	Mean	0.001	0.003	0.003
	Min.	0.000	0.000	0.000
	Max.	0.015	0.010	0.010
	Std. Dev.	0.002	0.003	0.003
	No. of Samples	223	224	224
Total Iron	Mean	1.9	0.7	0.7
	Min.	0.0	0.0	0.0
	Max.	48.8	4.0	4.3
	Std. Dev.	5.5	0.5	0.5
	No. of Samples	643	868	742
Dissolved Iron	Mean	0.049	0.031	0.022
	Min.	0.004	0.000	0.002
	Max.	2.119	0.397	0.134
	Std. Dev.	0.148	0.046	0.024
	No. of Samples	223	223	224
Total Lead	Mean	0.02	0.01	0.01
	Min.	0.00	0.00	0.00
	Max.	0.16	0.09	0.11
	Std. Dev.	0.02	0.01	0.01
	No. of Samples	643	868	742
Dissolved Lead	Mean	0.0045	0.0064	0.0057
	Min.	0.0000	0.0000	0.0003
	Max.	0.0110	0.0200	0.0250
	Std. Dev.	0.0028	0.0062	0.0061
	No. of Samples	223	224	224

TABLE A-13 (Continued): SUMMARY OF TRACE METALS IN THE UPPER PEORIA POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Manganese	Mean	0.116	0.068	0.057
	Min.	0.020	0.010	0.000
	Max.	1.875	0.400	0.632
	Std. Dev.	0.232	0.026	0.031
	No. of Samples	643	868	742
Dissolved Manganese	Mean	0.0031	0.0017	0.0029
	Min.	0.0007	0.0000	0.0001
	Max.	0.1157	0.0158	0.0173
	Std. Dev.	0.0079	0.0016	0.0028
	No. of Samples	223	224	224
Total Mercury (µg/L)	Mean	0.14	0.21	0.16
	Min.	0.00	0.00	0.00
	Max.	1.30	9.80	1.80
	Std. Dev.	0.17	0.40	0.20
	No. of Samples	644	868	742
Dissolved Mercury[3] (µg/L)	Mean	0.07	0.05	0.07
	Min.	0.00	0.04	0.05
	Max.	0.26	0.10	0.11
	Std. Dev.	0.06	0.02	0.02
	No. of Samples	12	8	13
Total Nickel	Mean	0.036	0.029	0.035
	Min.	0.000	0.000	0.000
	Max.	0.200	0.400	0.300
	Std. Dev.	0.060	0.057	0.063
	No. of Samples	643	868	742
Dissolved Nickel	Mean	0.001	0.002	0.002
	Min.	0.000	0.001	0.000
	Max.	0.007	0.007	0.011
	Std. Dev.	0.001	0.001	0.001
	No. of Samples	223	224	224

TABLE A-13 (Continued): SUMMARY OF TRACE METALS IN THE UPPER PEORIA POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Silver	Mean	0.003	0.003	0.003
	Min.	0.000	0.000	0.000
	Max.	0.030	0.025	0.080
	Std. Dev.	0.006	0.005	0.007
	No. of Samples	643	868	742
Dissolved Silver	Mean	0.0006	0.0010	0.0008
	Min.	0.0000	0.0000	0.0000
	Max.	0.0040	0.0070	0.0030
	Std. Dev.	0.0009	0.0013	0.0010
	No. of Samples	223	224	224
Total Zinc	Mean	0.07	0.04	0.06
	Min.	0.00	0.00	0.00
	Max.	0.60	0.63	1.41
	Std. Dev.	0.09	0.06	0.11
	No. of Samples	643	868	742
Dissolved Zinc	Mean	0.006	0.005	0.007
	Min.	0.001	0.000	0.001
	Max.	0.108	0.037	0.027
	Std. Dev.	0.008	0.004	0.005
	No. of Samples	223	224	224

[1]Water quality sampling did not occur in the years 1978–82 and 1998.
[2]Expressed in mg/L, except where noted. Dissolved metals only analyzed for years 2001–08.
[3]Dissolved Mercury was analyzed if the Total Mercury result was greater than the limit of quantitation.

TABLE A-14: SUMMARY OF TRACE METALS IN THE LOWER PEORIA POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Arsenic	Mean	0.03	0.02	0.03
	Min.	0.00	0.00	0.00
	Max.	0.20	0.20	0.20
	Std. Dev.	0.06	0.05	0.06
	No. of Samples	368	495	424
Dissolved Arsenic	Mean	0.00	0.01	0.01
	Min.	0.00	0.00	0.00
	Max.	0.01	0.03	0.03
	Std. Dev.	0.00	0.01	0.01
	No. of Samples	128	128	128
Total Cadmium	Mean	0.005	0.005	0.004
	Min.	0.000	0.000	0.000
	Max.	0.020	0.020	0.020
	Std. Dev.	0.007	0.006	0.006
	No. of Samples	368	495	424
Dissolved Cadmium	Mean	0.0004	0.0006	0.0005
	Min.	0.0001	0.0000	0.0000
	Max.	0.0015	0.0020	0.0020
	Std. Dev.	0.0003	0.0006	0.0006
	No. of Samples	128	128	128
Total Chromium	Mean	0.01	0.01	0.01
	Min.	0.00	0.00	0.00
	Max.	0.08	0.06	0.11
	Std. Dev.	0.01	0.01	0.01
	No. of Samples	368	495	424
Dissolved Chromium	Mean	0.0018	0.0022	0.0014
	Min.	0.0003	0.0000	0.0000
	Max.	0.0150	0.0130	0.0110
	Std. Dev.	0.0022	0.0028	0.0013
	No. of Samples	128	128	128

TABLE A-14 (Continued): SUMMARY OF TRACE METALS IN THE LOWER PEORIA POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Copper	Mean	0.02	0.01	0.01
	Min.	0.00	0.00	0.00
	Max.	0.24	0.10	0.04
	Std. Dev.	0.03	0.01	0.01
	No. of Samples	368	495	424
Dissolved Copper	Mean	0.002	0.004	0.003
	Min.	0.000	0.000	0.000
	Max.	0.011	0.015	0.010
	Std. Dev.	0.002	0.004	0.003
	No. of Samples	128	128	128
Total Iron	Mean	2.0	1.2	1.2
	Min.	0.0	0.1	0.0
	Max.	43.0	6.9	11.8
	Std. Dev.	4.8	0.9	0.8
	No. of Samples	368	495	424
Dissolved Iron	Mean	0.036	0.034	0.025
	Min.	0.004	0.000	0.004
	Max.	0.195	0.181	0.328
	Std. Dev.	0.044	0.042	0.043
	No. of Samples	128	128	128
Total Lead	Mean	0.01	0.02	0.01
	Min.	0.00	0.00	0.00
	Max.	0.13	0.80	0.07
	Std. Dev.	0.02	0.05	0.01
	No. of Samples	368	495	424
Dissolved Lead	Mean	0.0045	0.0065	0.0057
	Min.	0.0000	0.0000	0.0009
	Max.	0.0090	0.0200	0.0240
	Std. Dev.	0.0029	0.0061	0.0061
	No. of Samples	128	128	128

TABLE A-14 (Continued): SUMMARY OF TRACE METALS IN THE LOWER PEORIA POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Manganese	Mean	0.124	0.116	0.085
	Min.	0.010	0.000	0.010
	Max.	1.493	1.960	0.377
	Std. Dev.	0.189	0.091	0.031
	No. of Samples	368	495	424
Dissolved Manganese	Mean	0.0027	0.0028	0.0035
	Min.	0.0007	0.0000	0.0001
	Max.	0.0158	0.0222	0.0341
	Std. Dev.	0.0021	0.0028	0.0046
	No. of Samples	128	128	128
Total Mercury (µg/L)	Mean	0.15	0.19	0.14
	Min.	0.00	0.00	0.00
	Max.	3.00	2.30	1.00
	Std. Dev.	0.2	0.22	0.17
	No. of Samples	368	496	424
Dissolved Mercury[3] (µg/L)	Mean	0.06	0.04	0.05
	Min.	0.04	0.00	0.04
	Max.	0.10	0.05	0.08
	Std. Dev.	0.02	0.01	0.01
	No. of Samples	9	9	10
Total Nickel	Mean	0.033	0.026	0.037
	Min.	0.000	0.000	0.000
	Max.	0.200	0.200	0.300
	Std. Dev.	0.060	0.053	0.065
	No. of Samples	368	495	424
Dissolved Nickel	Mean	0.002	0.003	0.002
	Min.	0.000	0.000	0.000
	Max.	0.005	0.007	0.006
	Std. Dev.	0.001	0.001	0.001
	No. of Samples	128	128	128

TABLE A-14 (Continued): SUMMARY OF TRACE METALS IN THE LOWER PEORIA POOL ON THE ILLINOIS RIVER FROM 1977–2011[1]

Constituents[2]		Spring	Summer	Fall
Total Silver	Mean	0.004	0.003	0.003
	Min.	0.000	0.000	0.000
	Max.	0.030	0.030	0.030
	Std. Dev.	0.007	0.006	0.006
	No. of Samples	368	495	424
Dissolved Silver	Mean	0.0006	0.0010	0.0008
	Min.	0.0000	0.0000	0.0000
	Max.	0.0040	0.0070	0.0030
	Std. Dev.	0.0009	0.0012	0.0010
	No. of Samples	128	128	128
Total Zinc	Mean	0.07	0.04	0.05
	Min.	0.00	0.00	0.00
	Max.	1.40	0.50	0.40
	Std. Dev.	0.12	0.06	0.06
	No. of Samples	368	495	424
Dissolved Zinc	Mean	0.005	0.005	0.006
	Min.	0.001	0.000	0.001
	Max.	0.023	0.022	0.030
	Std. Dev.	0.003	0.004	0.004
	No. of Samples	128	128	128

[1]Water quality sampling did not occur in the years 1978–82 and 1998.
[2]Expressed in mg/L, except where noted. Dissolved metals only analyzed for years 2001–08.
[3]Dissolved Mercury was analyzed if the Total Mercury result was greater than the limit of quantitation.

APPENDIX B

ANNUAL SEASONAL MEANS FOR SELECTED WATER QUALITY PARAMETERS MEASURED DURING THE ILLINOIS WATERWAY MONITORING PROGRAM

FIGURE B-1: AMMONIA NITROGEN CONCENTRATIONS VERSUS TIME FOR SEVEN ILLINOIS WATERWAY POOLS[1]

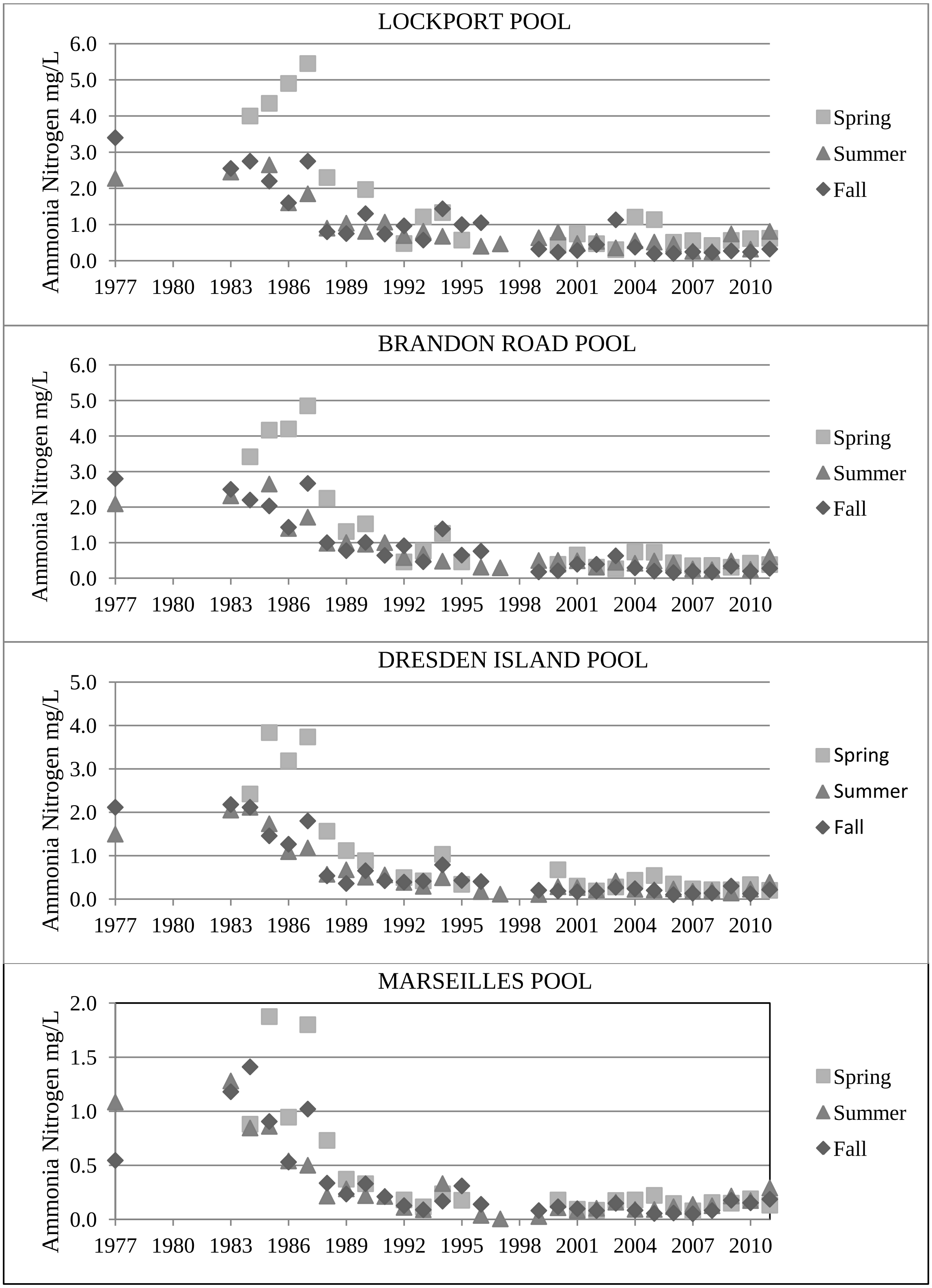
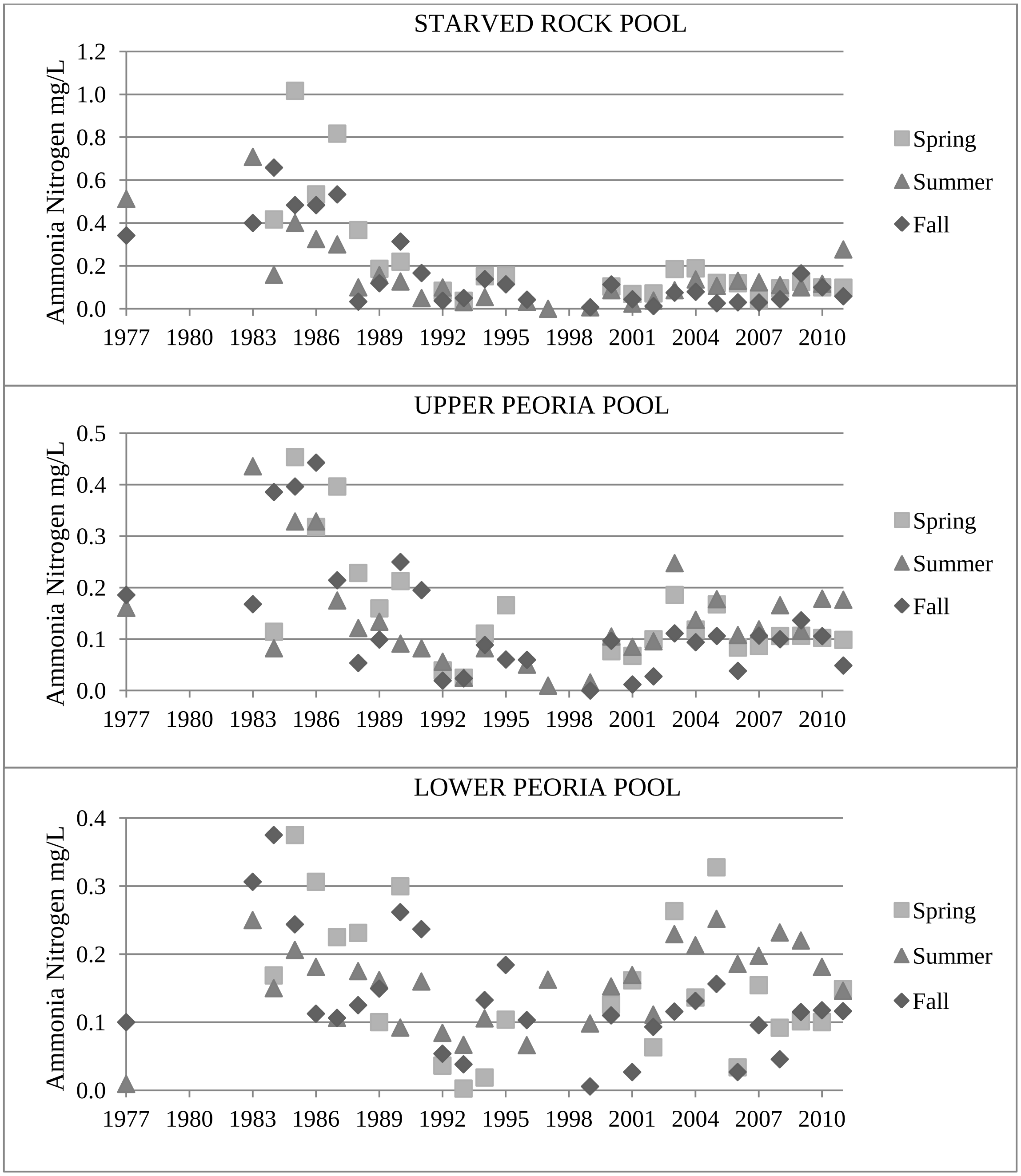
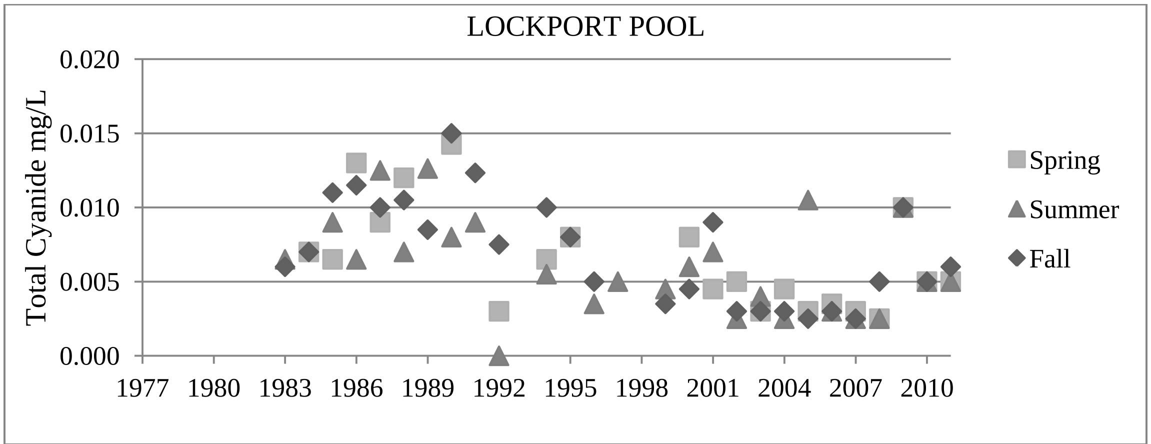


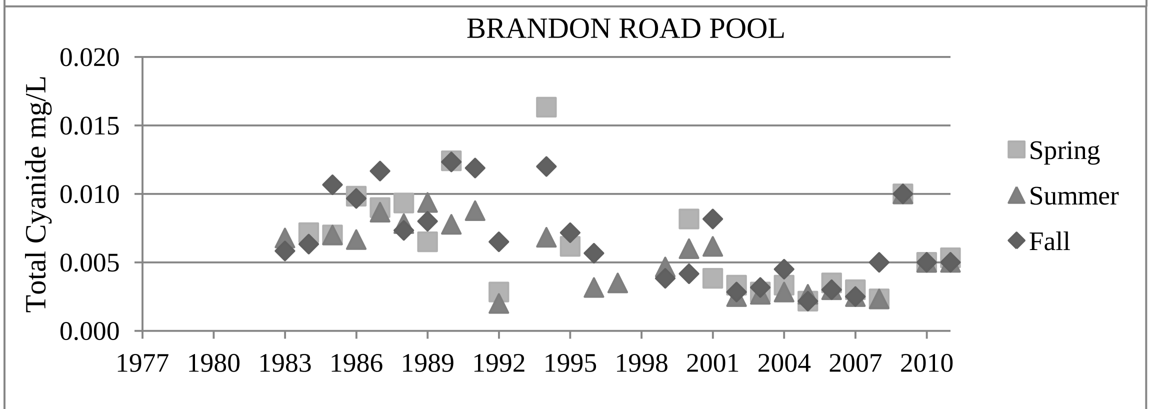
FIGURE B-1 (Continued): AMMONIA NITROGEN CONCENTRATIONS VERSUS TIME FOR SEVEN ILLINOIS WATERWAY POOLS[1]

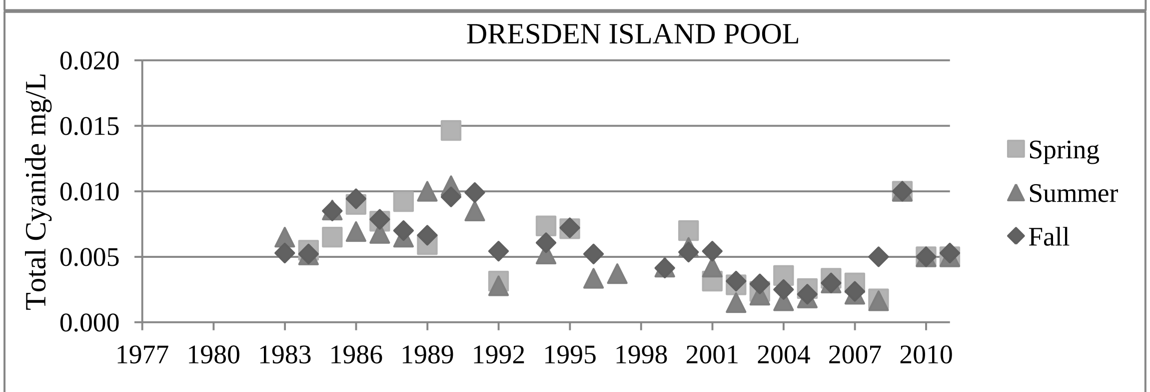


[1] Points on graph represent the yearly seasonal average.

FIGURE B-2: TOTAL CYANIDE CONCENTRATIONS VERSUS TIME FOR SEVEN ILLINOIS WATERWAY POOLS[1]







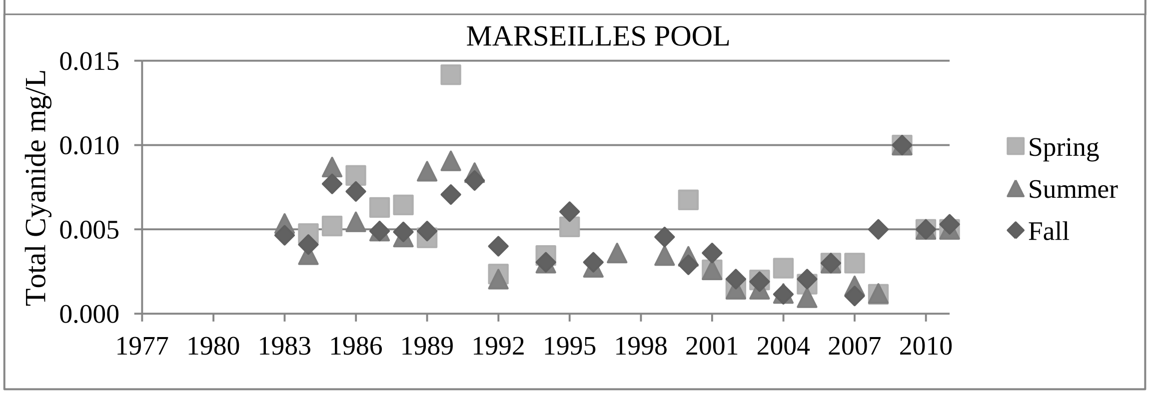
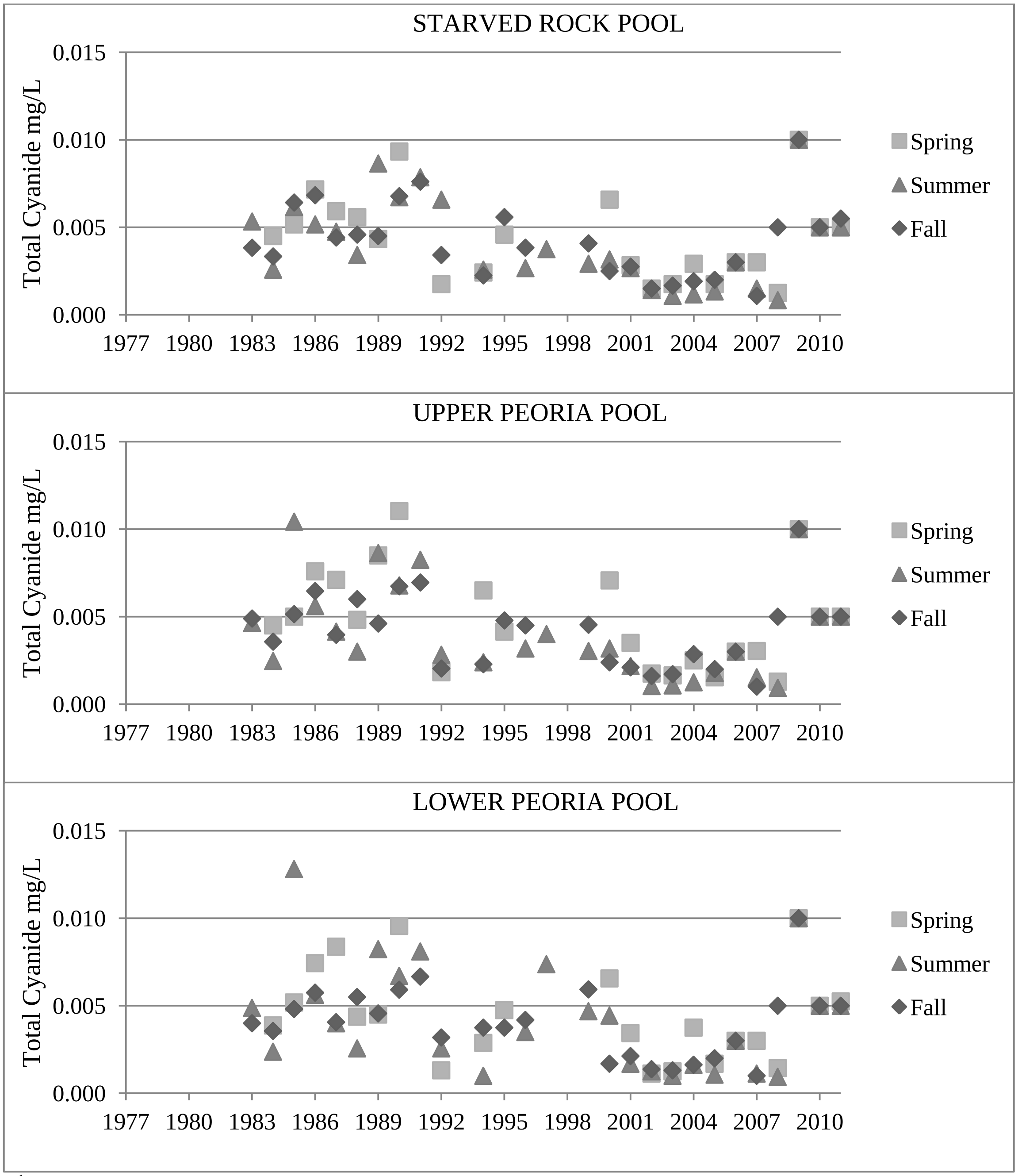


FIGURE B-2 (Continued): TOTAL CYANIDE CONCENTRATIONS VERSUS TIME FOR SEVEN ILLINOIS WATERWAY POOLS[1]



[1] Points on graph represent the yearly seasonal average.

FIGURE B-3: DISSOLVED OXYGEN CONCENTRATIONS VERSUS TIME FOR SEVEN ILLINOIS WATERWAY POOLS[1]

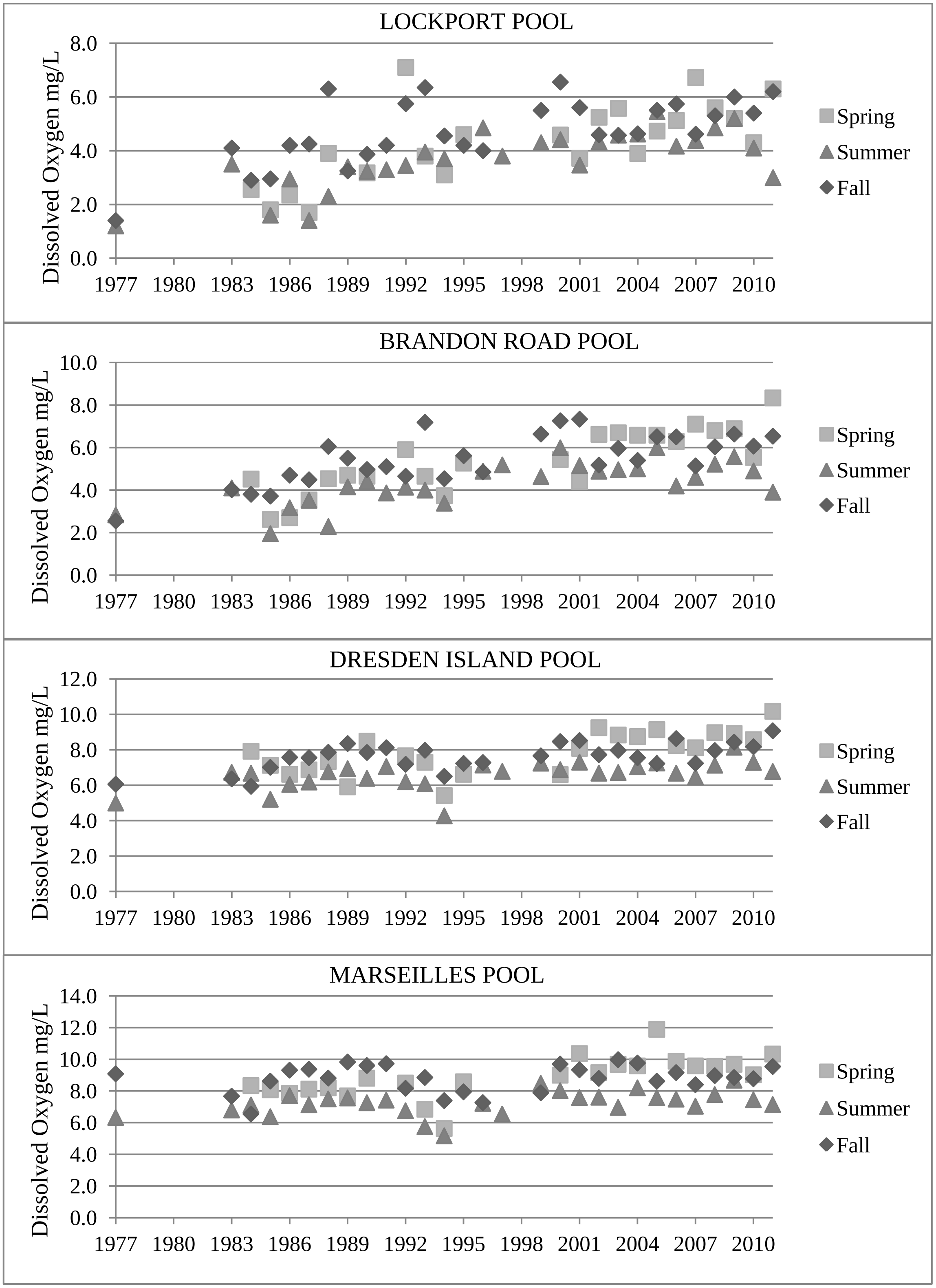
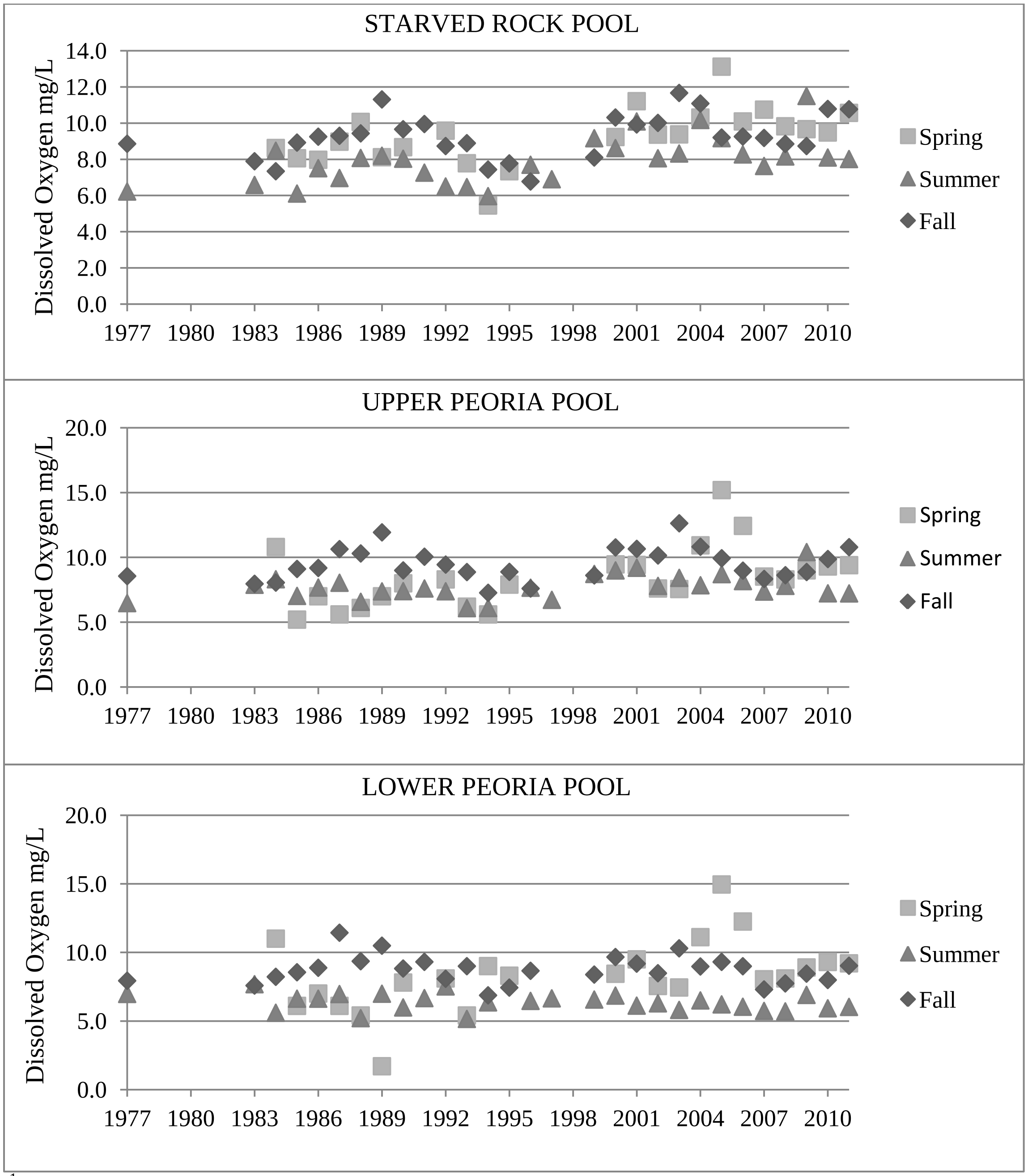


FIGURE B-3 (Continued): DISSOLVED OXYGEN CONCENTRATIONS VERSUS TIME FOR SEVEN ILLINOIS WATERWAY POOLS[1]



[1] Points on graph represent the yearly seasonal average.

FIGURE B-4: TOTAL NITROGEN CONCENTRATIONS VERSUS TIME FOR SEVEN ILLINOIS WATERWAY POOLS[1]

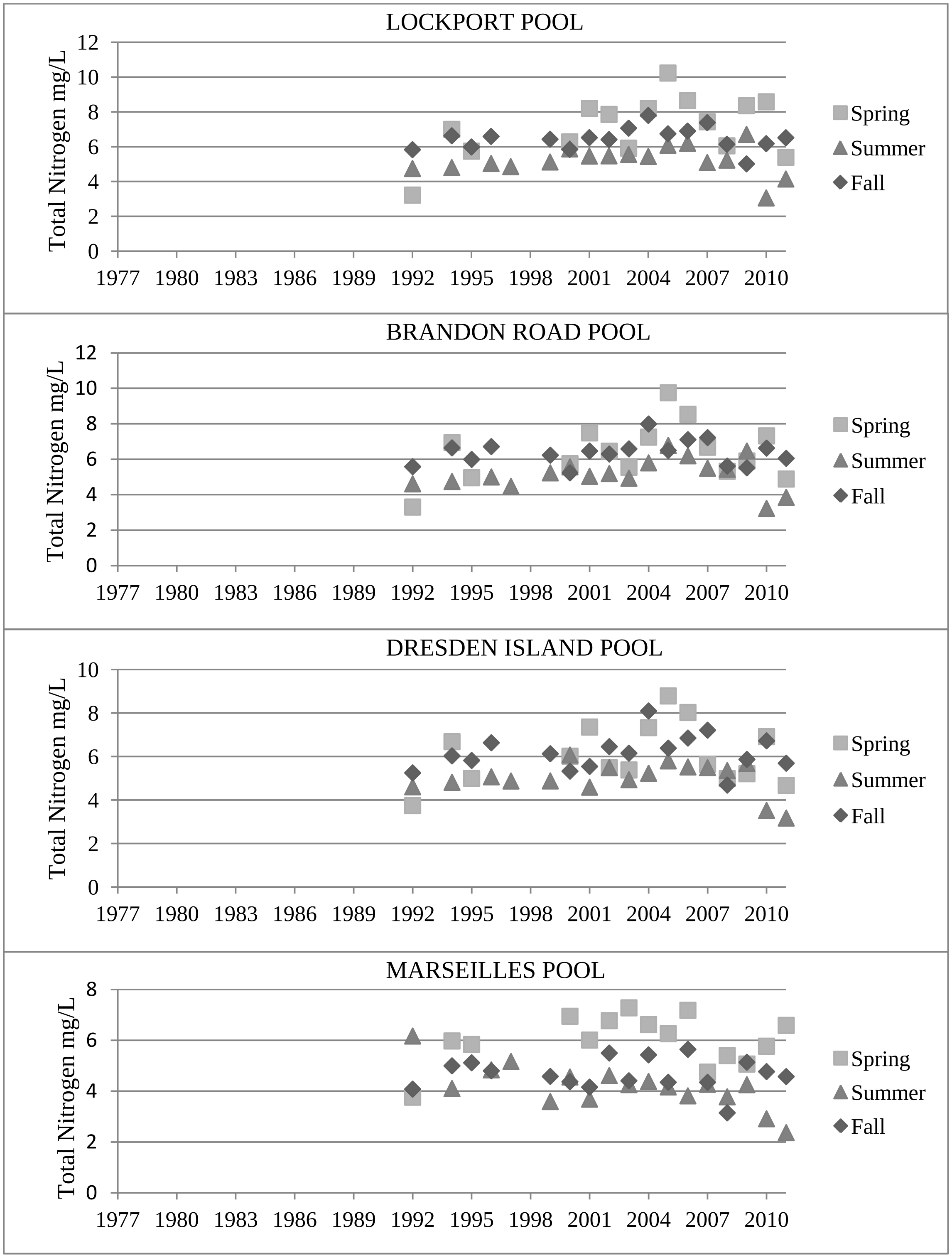
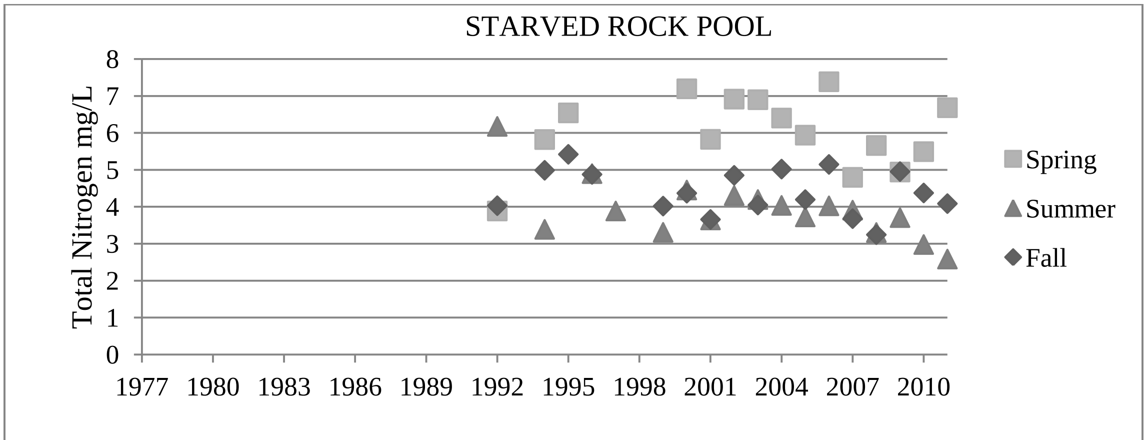
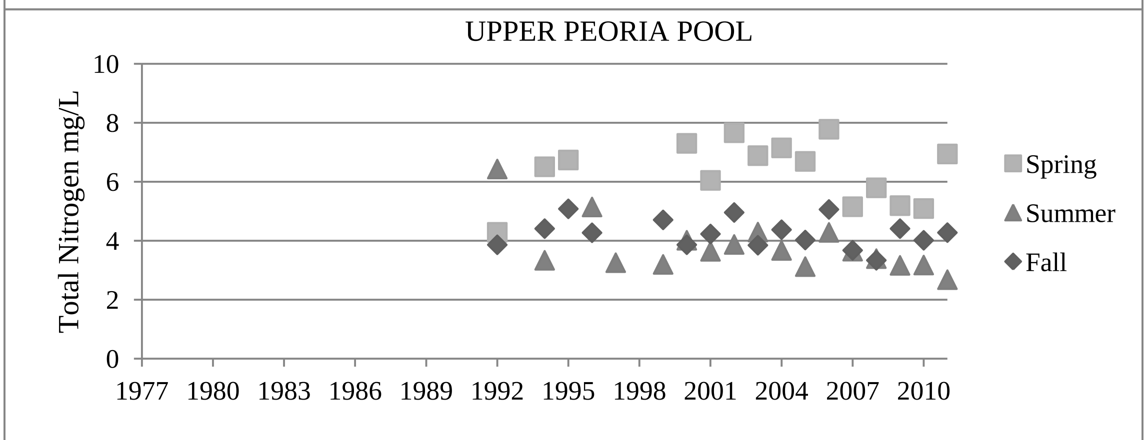
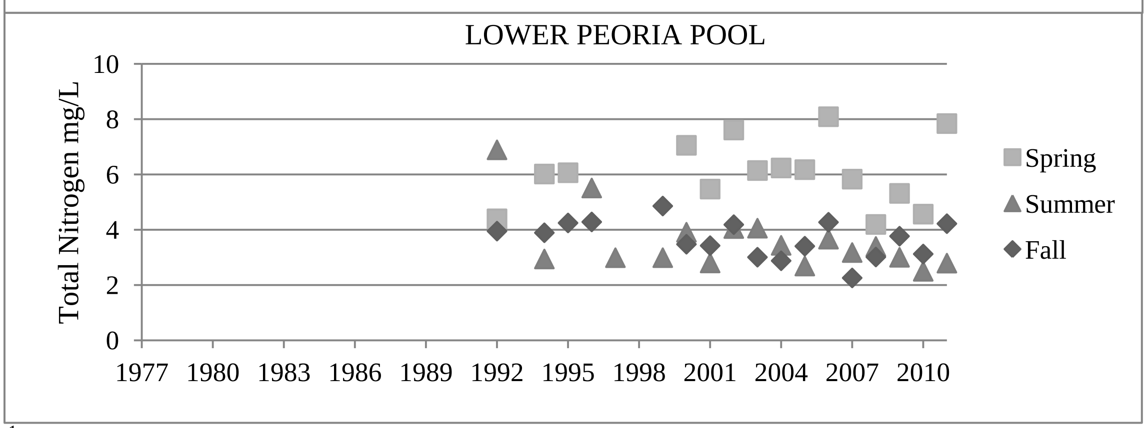


FIGURE B-4 (Continued): TOTAL NITROGEN CONCENTRATIONS VERSUS TIME FOR SEVEN ILLINOIS WATERWAY POOLS[1]







[1] Points on graph represent the yearly seasonal average.

FIGURE B-5: TOTAL PHOSPHORUS CONCENTRATIONS VERSUS TIME FOR SEVEN ILLINOIS WATERWAY POOLS[1]

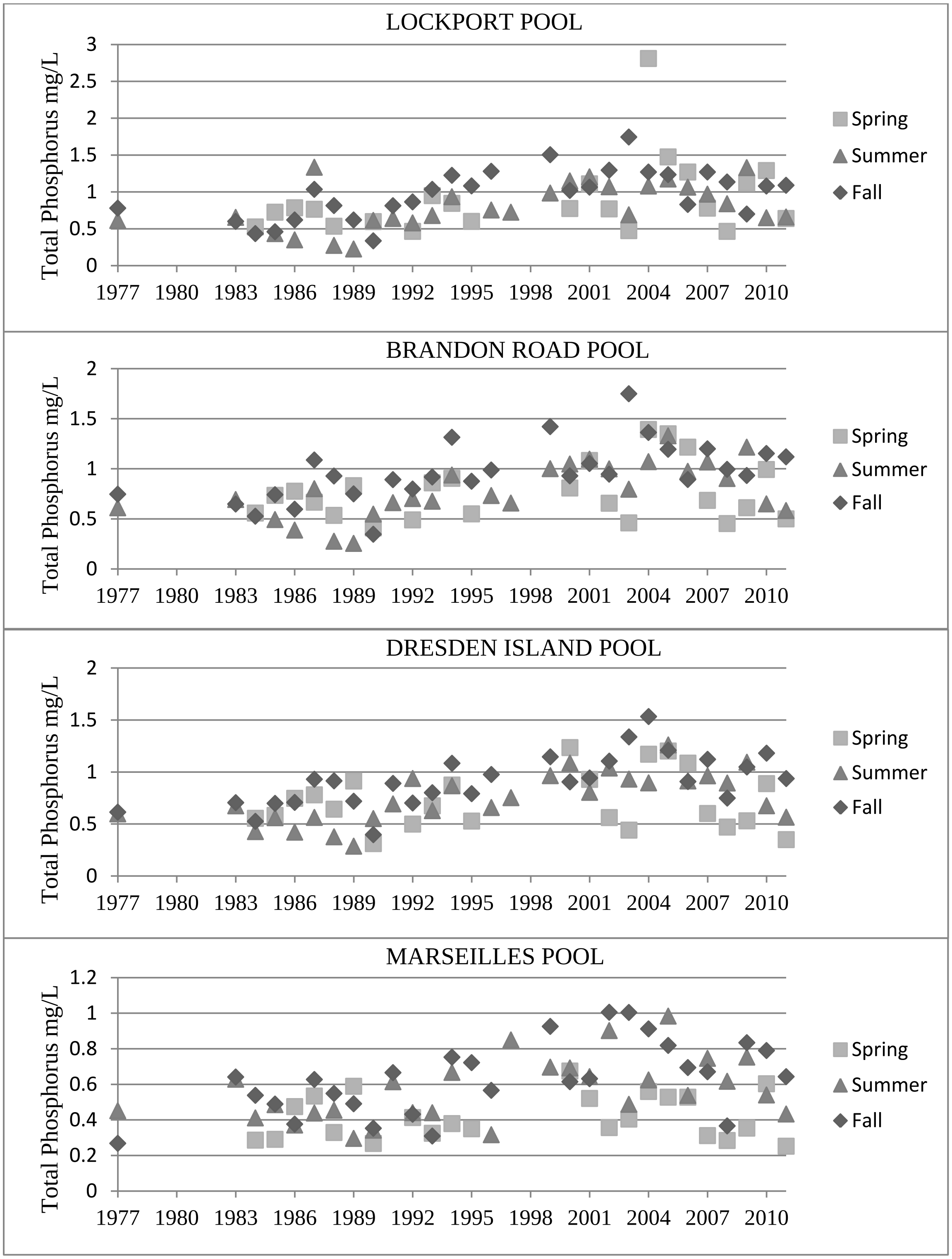
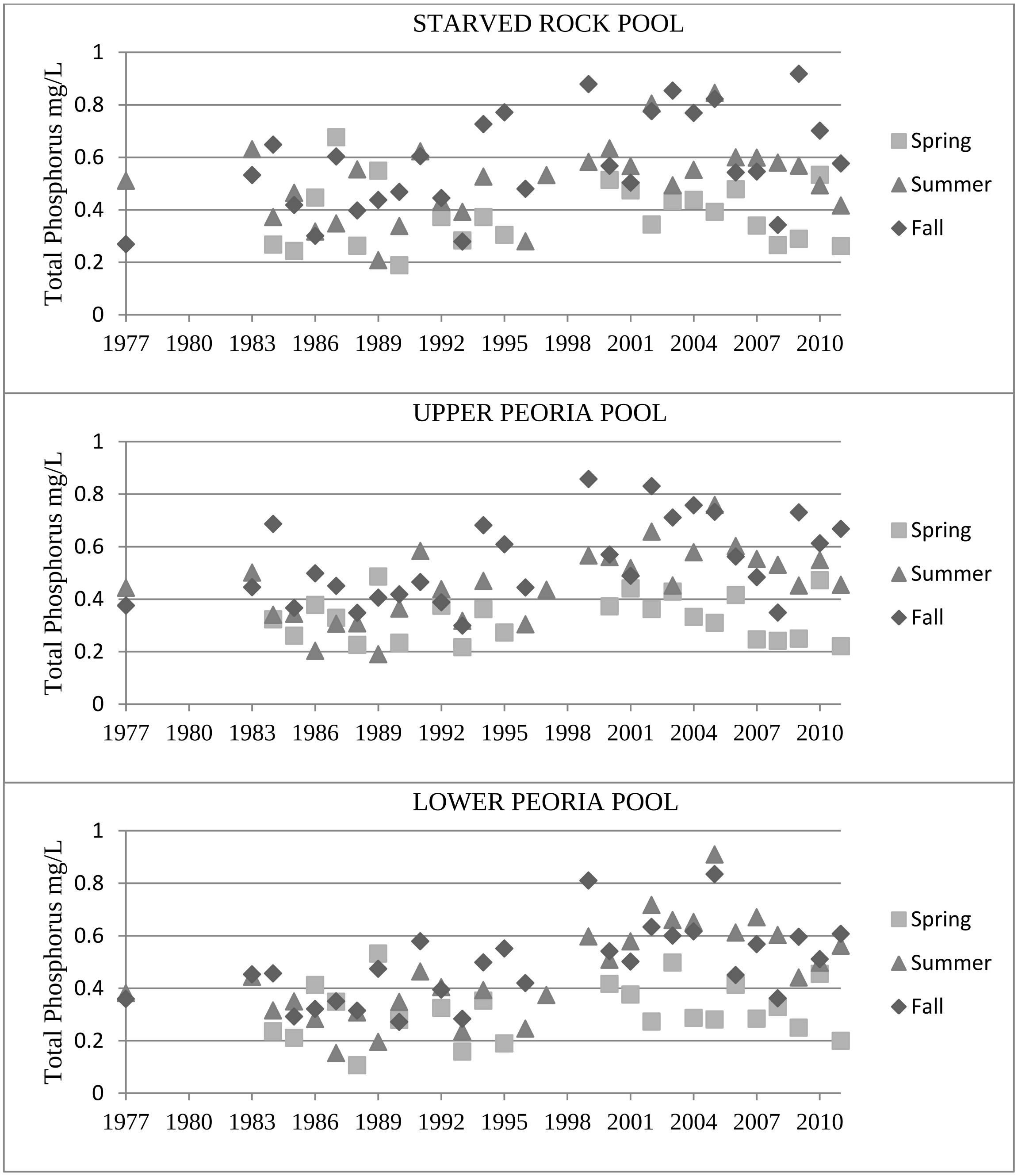


FIGURE B-5 (Continued): TOTAL PHOSPHOROUS CONCENTRATIONS VERSUS TIME FOR SEVEN ILLINOIS WATERWAY POOLS[1]



[1] Points on graph represent the yearly seasonal average.

APPENDIX C

SEDIMENT QUALITY SUMMARY FOR THE ILLINOIS WATERWAY MONITORING PROGRAM

TABLE C-1: CHEMICAL CHARACTERISTICS OF SEDIMENT COLLECTED FROM MONITORING STATIONS IN THE LOCKPORT, BRANDON ROAD, DRESDEN ISLAND, MARSEILLES, STARVED ROCK, AND PEORIA POOLS OF THE ILLINOIS WATERWAY FROM 1983 - 2011[1]

			Constituents (dry weight basis)								
Station No.	Pool	Stats	Total Solids (%)	Total Volatile Solids (% of Total)	Chemical Oxygen Demand[2] (mg/kg)	Ammonia Nitrogen (mg/kg)	Total Kjeldahl Nitrogen (mg/kg)	Nitrite + Nitrate Nitrogen[3] (mg/kg)	Total Phosphorus (mg/kg)	Total Cyanide (mg/kg)	Phenols (mg/kg)
1	Lockport	Mean	39	12	202,566	283	4,839	14	5,629	3.109	2.793
		Min	28	10	91,900	36	100	2	1,782	0.233	0.032
		Max	52	16	337,403	1,614	27,999	45	30,230	15.970	19.500
2	Brandon Rd.	Mean	53	12	101,950	130	2,289	8	3,423	2.171	1.696
		Min	25	4	5,936	0	33	1	190	0.074	0.057
		Max	71	29	251,186	1,286	10,093	25	10,143	14.710	15.300
5	Dresden Island	Mean	69	5	34,831	51	1,242	4	1,701	0.773	0.268
		Min	29	1	1,679	0	7	2	278	0.054	0.007
		Max	82	17	96,163	498	7,540	6	5,683	5.080	1.200
8	Dresden Island	Mean	54	9	99,792	104	2,890	8	3,248	1.311	0.342
		Min	25	2	8,114	1	7	1	277	0.005	0.006
		Max	75	19	383,718	793	8,673	23	11,214	7.710	1.200
12	Marseilles	Mean	74	2	12,581	5	381	3	1,119	0.135	0.240
		Min	55	1	2,652	0	1	1	8	0.000	0.000
		Max	86	10	60,452	24	1,426	7	3,238	0.530	0.900
18	Marseilles	Mean	73	2	15,765	9	578	4	644	0.261	0.183
		Min	52	1	677	0	2	1	25	0.000	0.007
		Max	84	4	98,168	30	2,474	17	2,098	2.315	0.900

TABLE C-1 (Continued): CHEMICAL CHARACTERISTICS OF SEDIMENT COLLECTED FROM MONITORING STATIONS IN THE LOCKPORT, BRANDON ROAD, DRESDEN ISLAND, MARSEILLES, STARVED ROCK, AND PEORIA POOLS OF THE ILLINOIS WATERWAY FROM 1983 - 2011[1]

			Constituents (dry weight basis)								
Station No.	Pool	Stats	Total Solids (%)	Total Volatile Solids (% of Total)	Chemical Oxygen Demand[2] (mg/kg)	Ammonia Nitrogen (mg/kg)	Total Kjeldahl Nitrogen (mg/kg)	Nitrite + Nitrate Nitrogen[3] (mg/kg)	Total Phosphorus (mg/kg)	Total Cyanide (mg/kg)	Phenols (mg/kg)
23	Starved Rock	Mean	80	1	4,413	5	509	3	279	0.117	0.107
		Min	74	1	345	0	1	1	5	0.000	0.009
		Max	85	6	17,000	27	8,695	9	1,667	0.700	0.500
28	Upper Peoria	Mean	74	2	12,645	6	415	2	574	0.097	0.132
		Min	53	0	1,343	0	2	0	20	0.000	0.015
		Max	84	9	66,542	29	2,499	5	4,120	0.360	0.372
32	Upper Peoria	Mean	76	2	6,599	6	263	3	393	0.148	0.153
		Min	62	1	483	0	1	1	14	0.009	0.003
		Max	89	6	15,450	30	958	5	1,878	0.710	0.551
35	Upper Peoria	Mean	70	3	19,399	25	818	4	742	0.200	0.187
		Min	55	1	1,399	0	6	1	74	0.006	0.007
		Max	79	9	49,848	172	6,247	8	3,324	0.870	0.800
38	Upper Peoria	Mean	57	5	47,047	76	1,517	4	1,249	0.278	0.222
		Min	41	2	17,500	1	18	2	333	0.034	0.007
		Max	76	8	96,352	657	5,838	7	3,074	1.760	0.800
41	Upper Peoria	Mean	58	5	59,297	80	1,951	5	1,926	0.268	0.641
		Min	38	2	18,328	0	0	1	0	0.004	0.024
		Max	93	10	125,774	899	14,589	16	11,151	1.580	4.300

TABLE C-1 (Continued): CHEMICAL CHARACTERISTICS OF SEDIMENT COLLECTED FROM MONITORING STATIONS IN THE LOCKPORT, BRANDON ROAD, DRESDEN ISLAND, MARSEILLES, STARVED ROCK, AND PEORIA POOLS OF THE ILLINOIS WATERWAY from 1983 - 2011[1]

			Constituents (dry weight basis)								
Station No.	Pool	Stats	Total Solids (%)	Total Volatile Solids (% of Total)	Chemical Oxygen Demand[2] (mg/kg)	Ammonia Nitrogen (mg/kg)	Total Kjeldahl Nitrogen (mg/kg)	Nitrite + Nitrate Nitrogen[3] (mg/kg)	Total Phosphorus (mg/kg)	Total Cyanide (mg/kg)	Phenols (mg/kg)
44	Lower Peoria	Mean	42	8	89,601	99	2,943	13	1,713	0.300	0.910
		Min	23	6	52,700	9	20	0	245	0.058	0.028
		Max	53	16	129,385	474	11,202	50	5,772	1.280	7.400
48	Lower Peoria	Mean	61	4	53,566	58	1,465	5	895	0.241	0.712
		Min	38	2	14,231	0	9	1	44	0.002	0.000
		Max	81	9	141,143	369	8,650	19	3,885	1.460	7.900

[1] Sediment Samples were not collected for the years 1997, 1998, and 2010.
[2] Chemical Oxygen Demand analysis was only conducted for years 1983 – 1994.
[3] Nitrite plus Nitrate Nitrogen analysis was only conducted for years 2001 - 2011.

TABLE C-2: TRACE METALS IN SEDIMENT COLLECTED FROM MONITORING STATIONS IN THE LOCKPORT, BRANDON ROAD, DRESDEN ISLAND, MARSEILLES, STARVED ROCK, AND PEORIA POOLS OF THE ILLINOIS WATERWAY, FROM 1983-2011[1]

Station No.	Navigational Pool	Stats	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Silver	Zinc
			(mg/kg dry weight)										
1	Lockport	Mean	3	22	220	221	24,683	242	410	1.187	86	5	1,065
		Min	<1	7	96	103	8,210	90	271	<0.100	30	<1	566
		Max	13	82	510	579	32,450	540	588	7.550	427	15	3,180
2	Brandon Road	Mean	3	9	117	124	19,572	231	408	0.744	55	3	560
		Min	<1	1	18	21	4,320	46	142	<0.100	19	<1	138
		Max	16	38	323	313	36,446	468	862	4.900	216	7	1,595
5	Dresden Island	Mean	2	4	68	49	13,152	105	284	0.371	39	2	234
		Min	<1	0	1	10	4,000	23	140	<0.100	13	<1	75
		Max	11	29	433	307	21,045	506	493	2.791	110	8	990
8	Dresden Island	Mean	3	7	69	94	16,998	95	371	1.094	44	2	449
		Min	<1	1	10	16	916	11	145	<0.100	22	<1	110
		Max	20	48	384	478	35,195	284	710	6.900	113	8	1,747
12	Marseilles	Mean	2	1	21	12	8,126	19	262	0.113	14	2	78
		Min	<1	0	5	1	4,500	0	98	0.016	3	<1	33
		Max	7	5	92	42	20,064	78	690	0.200	43	11	257
18	Marseilles	Mean	2	2	23	14	6,291	14	206	0.237	26	1	63
		Min	<1	0	2	0	737	1	81	0.018	2	<1	14
		Max	6	7	118	50	18,267	70	417	1.500	347	4	258
23	Starved Rock	Mean	2	1	14	5	6,337	7	182	0.123	12	1	38
		Min	<1	0	3	1	319	0	95	0.012	2	<1	20
		Max	11	2	104	13	15,000	27	489	0.345	30	5	68

TABLE C-2 (CONTINUED): TRACE METALS IN SEDIMENT COLLECTED FROM MONITORING STATIONS IN THE LOCKPORT, BRANDON ROAD, DRESDEN ISLAND, MARSEILLES, STARVED ROCK, AND PEORIA POOLS OF THE ILLINOIS WATERWAY, FROM 1983-2011[1]

Station No.	Navigational Pool	Stats	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Silver	Zinc
			(mg/kg dry weight)										
28	Upper Peoria	Mean	2	1	13	7	5,774	12	202	0.122	11	2	41
		Min	<1	0	1	0	463	0	45	0.011	0	<1	9
		Max	9	2	60	36	13,866	32	853	0.216	50	7	87
32	Upper Peoria	Mean	3	1	21	7	9,375	11	376	0.125	14	1	73
		Min	<1	0	1	1	2,516	0	100	0.009	3	<1	32
		Max	15	2	207	19	29,664	33	2194	0.569	35	4	158
35	Upper Peoria	Mean	3	1	21	11	9,894	15	271	0.219	15	2	83
		Min	<1	0	3	1	760	0	94	0.027	1	<1	30
		Max	20	3	125	67	28,632	73	537	1.274	45	5	298
38	Upper Peoria	Mean	2	2	25	21	14,316	26	466	0.202	23	1	145
		Min	<1	0	7	5	1,049	0	248	0.054	5	<1	60
		Max	12	6	61	54	31,702	56	697	0.641	65	5	304
41	Upper Peoria	Mean	3	2	27	22	14,671	23	556	0.238	21	2	136
		Min	<1	0	7	0	1,540	0	301	0.011	6	<1	26
		Max	13	6	97	40	24,585	47	794	1.100	50	8	311
44	Lower Peoria	Mean	4	3	40	40	20,822	38	673	0.395	34	2	215
		Min	<1	1	20	29	2,247	8	476	0.093	19	<1	114
		Max	25	6	106	72	37,400	72	995	1.900	59	10	340
48	Lower Peoria	Mean	3	1	28	18	13,148	21	471	0.181	20	2	95
		Min	<1	1	5	3	964	0	272	0.004	6	<1	22
		Max	17	5	148	54	25,800	49	770	0.740	50	7	290

[1]Sediment samples were not collected for the years 1997, 1998, and 2010