

Protecting Our Water Environment



Metropolitan Water Reclamation District of Greater Chicago

**RESEARCH AND DEVELOPMENT
DEPARTMENT**

REPORT NO. 91-16-A

*WATER AND SEDIMENT QUALITY ALONG THE
ILLINOIS WATERWAY FROM THE
LOCKPORT LOCK AND DAM TO THE PEORIA LOCK AND DAM
DURING 1984 AND 1985
VOLUME 1*

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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

During May, August, and October of 1984 and 1985, the Metropolitan Water Reclamation District of Greater Chicago (District) conducted a water and sediment quality survey at 49 sampling stations along a 133 nautical mile reach of the Illinois Waterway from the Lockport Lock and Dam to the Peoria Lock and Dam. Based on the results from the 1984 and 1985 surveys, the following conclusions can be made concerning the water and sediment quality along the study area:

Water Quality

1984

The mean dissolved oxygen (DO) concentration in 1984 increased along the waterway from the Lockport Lock and Dam (2.7 mg/L) to the Peoria Lock and Dam (7.4 mg/L).

There was no change during 1984 in the mean five-day biochemical oxygen demand (BOD₅) from the Lockport Lock and Dam (3 mg/L) to the Peoria Lock and Dam (3 mg/L).

There was a slight decrease in the mean concentration of total organic carbon (TOC) along the study area from the Lockport Lock and Dam (8 mg/L) to the Peoria Lock and Dam (7 mg/L).

The mean concentration of total suspended solids (TSS) in 1984 increased down the Illinois Waterway from the Lockport Lock and Dam (12 mg/L) to the Peoria Lock and Dam (53 mg/L).

The mean concentration of total ammonia nitrogen ($\text{NH}_4\text{-N}$) in 1984 decreased along the Illinois Waterway from the Lockport Lock and Dam (3.4 mg/L) to the Peoria Lock and Dam (0.2 mg/L).

There was a slight decrease in the mean concentration of nitrite plus nitrate nitrogen ($\text{NO}_2\text{+NO}_3\text{-N}$) during 1984 in the Illinois Waterway from the Lockport Lock and Dam (2.72 mg/L) to the Peoria Lock and Dam (3.17 mg/L).

In 1984, mean total phosphorus (TP) decreased in concentration down the Illinois Waterway from the Lockport Lock and Dam (0.48 mg/L) to the Peoria Lock and Dam (0.28 mg/L).

pH increased along the Illinois Waterway in 1984 from the Lockport Lock and Dam (range 6.9-7.1) to the Peoria Lock and Dam (range: 7.2-7.8).

The mean concentration of cyanides measured during the 1984 survey decreased slightly along the Illinois Waterway from the Lockport Lock and Dam (0.007 mg/L) to the Peoria Lock and Dam (0.003 mg/L).

The mean phenol concentration decreased in 1984 down the Illinois Waterway from the Lockport Lock and Dam (0.032 mg/L) to the Peoria Lock and Dam (0.019 mg/L).

In 1984, no clear trend was discernible for fats, oils and greases (FOG) along the 133 mile study reach of the Illinois Waterway.

With the exception of iron and manganese, the mean concentrations of the other nine trace metals analyzed in

surface waters remained practically uniform down the Illinois Waterway from the Lockport Lock and Dam to the Peoria Lock and Dam. Iron and manganese increased in concentration in the Peoria pool (0.81 and 0.10 mg/L, respectively) compared to upstream (0.44 and 0.06 mg/L, respectively).

Fecal coliforms (FC) decreased with distance down the Illinois Waterway from the Lockport Lock and Dam (696 CFU/100 mL) to the middle portion of the Peoria pool (6 CFU/100 mL), and then increased in density along the lower portion of the Peoria pool to the Peoria Lock and Dam (48 CFU/100 mL).

During 1984, only four of 11 sampling stations (36%) yielded confirmed viruses. The virus levels ranged from a low of 0 PFU/L at seven sampling stations to a high of 0.05 PFU/L at Station 12 in the Marseilles pool.

1985

The mean DO concentration in 1985 increased along the waterway from the Lockport Lock and Dam (2.1 mg/L) to the Peoria Lock and Dam (7.4 mg/L).

The mean BOD₅ increased slightly in 1985 from the Lockport Lock and Dam (2 mg/L) to the Peoria Lock and Dam (3 mg/L).

There was a slight increase in the mean concentration of TOC along the study area from the Lockport Lock and Dam (7 mg/L) to the Peoria Lock and Dam (8 mg/L).

The mean concentration of TSS in 1985 increased down the Illinois Waterway from the Lockport Lock and Dam (11 mg/L) to the Peoria Lock and Dam (51 mg/L).

The mean concentration of NH₄-N in 1985 decreased along the Illinois Waterway from the Lockport Lock and Dam (3.1 mg/L) to the Peoria Lock and Dam (0.3 mg/L).

There was an increase in the mean concentration of NO₂+NO₃-N during 1985 in the Illinois Waterway from the Lockport Lock and Dam (1.56 mg/L) to the Peoria Lock and Dam (2.55 mg/L).

In 1985, mean TP decreased in concentration down the Illinois Waterway from the Lockport Lock and Dam (0.46 mg/L) to the Peoria Lock and Dam (0.29 mg/L).

pH increased slightly along the Illinois Waterway in 1985 from the Lockport Lock and Dam (range 5.1-7.3) to the Peoria Lock and Dam (range: 5.8-7.5).

The mean concentration of cyanides measured during the 1985 survey decreased slightly along the Illinois Waterway from the Lockport Lock and Dam (0.009 mg/L) to the Peoria Lock and Dam (0.007 mg/L).

The mean phenol concentration decreased in 1985 down the Illinois Waterway from the Lockport Lock and Dam (0.032 mg/L) to the Peoria Lock and Dam (0.024 mg/L).

In 1985, no clear trend was discernible for fats, oils and greases (FOG) along the 133 mile study reach of the Illinois Waterway.

With the exception of iron and manganese, the mean concentrations of the other nine trace metals analyzed in surface waters remained practically uniform down the Illinois Waterway from the Lockport Lock and Dam to the Peoria Lock and Dam. Iron and manganese increased in concentration in the Peoria pool (0.76 and 0.09 mg/L, respectively) compared to upstream (0.57 and 0.06 mg/L, respectively).

Fecal coliforms (FC) decreased with distance down the Illinois Waterway in 1985 from the Lockport Lock and Dam (13,342 CFU/100 mL) to the middle portion of the Peoria pool (17 CFU/100 mL), and then increased in density along the lower portion of the Peoria pool to the Peoria Lock and Dam (152 CFU/100 mL).

During 1985, only six of 22 sampling stations (27%) yielded confirmed viruses. The virus levels ranged from a low of 0 PFU/L at ten sampling stations to a high of 0.47 PFU/L at Station 20 in the Marseilles pool.

COMPARISON OF THE WATER QUALITY BETWEEN 1984 and 1985

Dissolved Oxygen. Overall, the mean DO values recorded at the 49 sampling stations were similar both in 1984 and 1985.

Biochemical Oxygen Demand. The mean BOD₅ value changed very little between 1984 and 1985.

Total Organic Carbon. Between 1984 and 1985, TOC was similar in concentration at the 49 sampling stations along the Illinois Waterway.

Total Suspended Solids. The mean TSS values changed very little between 1984 and 1985 in the Lockport, Brandon Road, Dresden Island, Marseilles, and Starved Rock pools. However, higher TSS values were recorded in the Peoria pool during 1984 (49 mg/L) compared to 1985 (42 mg/L). These higher values may be as a result of more precipitation events, subsequently more runoff to the waterway system.

Total Ammonia Nitrogen. Between 1984 and 1985, there was little change in the mean values for $\text{NH}_4\text{-N}$ at the 49 sampling stations.

Nitrite plus Nitrate Nitrogen. Higher mean $\text{NO}_2+\text{NO}_3\text{-N}$ values were measured during the 1984 survey (3.11 mg/L) compared to 1985 (2.67 mg/L). These higher values may be as a result of an increase in instream nitrification and/or a greater contribution from point and nonpoint sources.

Total Phosphorus. Mean TP values changed very little between 1984 and 1985. However, higher TP values were recorded in the Peoria pool during 1984 (0.39 mg/L) compared to 1985 (0.31 mg/L).

pH. Slightly higher pH values were measured at the 49 stations in the study area during the 1984 survey (range: 5.6-7.9) compared to the 1985 survey (range: 5.1-7.6).

Total Cyanides. Compared to 1984 (0.004 mg/L), the mean cyanide concentration increased slightly at the 49 stations during 1985 (0.007 mg/L).

Phenols. Higher mean phenol values were measured at the 49 stations during 1985 (0.027 mg/L) compared to 1984 (0.021 mg/L).

Fats, Oils and Greases. Between 1984 and 1985, there was little change in the mean value of FOG measured at the 49 stations.

Trace Metals. The mean concentrations of the 11 trace metals surveyed at the 49 stations along the waterway were similar both in 1984 and 1985.

Fecal Coliform. Higher geometric means of FC were observed during 1985 (996 CFU/100 mL) compared with 1984 (232 CFU/100 mL). This difference may be due to the natural variability of fecal coliforms in aquatic systems.

Virus. There was little difference in the concentration of confirmed virus levels from the 11 sampling stations along the Illinois Waterway collected on different sampling dates during both 1984 and 1985.

Sediment Quality

1984

The percent of total and volatile solids varied considerably from a low of 46.1 (Station 38, Peoria pool), and 0.9% (Station 32, Peoria pool), to a high of 80.9 (Station 28, Peoria pool) and 16.4% (Station 1, Lockport pool). No clear trends were discernible along the waterway for total and volatile solids in sediments.

Generally, the chemical oxygen demand (COD) in sediments decreased from Station 1 just above the Lockport Lock and Dam (176,636 mg/kg) to Station 35 in the middle portion of the Peoria pool (14,762 mg/kg), and then increased in concentration along the waterway to the Peoria Lock and Dam (54,019 mg/kg).

Total cyanides decreased in concentration in bottom sediments down the Illinois Waterway from Station 1 in the Lockport pool (0.51 mg/kg) to Station 48 in the Peoria pool (0.08 mg/kg).

FOG decreased in concentration in the sediments along the waterway from Station 2 in the Brandon Road pool (10,942 mg/kg) to Station 48 in the Peoria pool (470 mg/kg).

While the concentration of the 11 trace metals measured in sediment was quite variable among the 14 sampling stations, significantly higher levels of cadmium, chromium, copper, lead, mercury, nickel, and zinc were evident in the sediments collected from the Lockport (Station 1) and Brandon Road (Station 2) pools compared to the Dresden Island, Marseilles, Starved Rock, and Peoria pools.

1985

The percent of total and volatile solids varied considerably from a low of 48.2 (Station 41, Peoria pool), and 0.6% (Station 32, Peoria pool), to a high of 84.0 (Station 23, Starved Rock pool) and 10.1% (Station 1, Lockport pool). No

clear trends were discernible in 1985 along the waterway for total and volatile solids in sediments.

Generally, COD in sediments decreased from Station 1 just above the Lockport Lock and Dam (180,975 mg/kg) to Station 35 in the middle portion of the Peoria pool (20,368 mg/kg), and then increased in concentration along the waterway to the Peoria Lock and Dam (104,596 mg/kg).

The highest total Kjeldahl nitrogen (TKN) values in sediment were found in the Lockport pool, Station 1 (2,385 mg/kg) and lower portion of the Peoria pool, Stations 41, 44, and 48 (1,924, 2,088, and 1,043 mg/kg, respectively).

Total cyanides decreased in concentration in bottom sediments down the Illinois Waterway from Station 1 in the Lockport pool (1.40 mg/kg) to Station 48 in the Peoria pool (0.24 mg/kg).

During the 1985 survey, phenol concentrations in sediments were highest at Station 1 in the Lockport pool (1.13 mg/kg). All other sampling stations had concentrations of phenol less than 0.05 mg/kg.

FOG decreased in concentration in the sediments along the waterway from Station 1 in the Lockport pool (6,848 mg/kg) to Station 48 in the Peoria pool (839 mg/kg).

While the concentration of the 11 trace metals measured in sediment was quite variable among the 14 sampling stations, significantly higher levels of cadmium, chromium, copper, lead,

nickel, and zinc were evident in the sediments collected from the Lockport (Station 1) and Brandon Road (Station 2) pools compared to the Dresden Island, Marseilles, Starved Rock, and Peoria pools.

COMPARISON OF THE SEDIMENT QUALITY BETWEEN 1984 AND 1985

Total Solids. Overall, the mean total solids values from the six navigational pools were similar both in 1984 and 1985.

Total Volatile Solids. The mean percentage of total volatile solid in sediments were higher in 1984 (5.3 %) compared to 1985 (4.0 %).

Chemical Oxygen Demand. Between 1984 and 1985, COD in sediments was similar in concentration in the six navigational pools along the Illinois Waterway.

Total Cyanides. Compared to 1984 (0.21 mg/kg), the mean cyanide concentration increased slightly in the six navigational pools during 1985 (0.38 mg/kg).

Fats, Oils and Greases. Between 1984 and 1985, there was little change in the mean value of FOG in sediments measured in the six navigational pools.

Trace Metals. Overall, the mean concentrations of the 11 trace metals in sediments surveyed at the 14 sampling stations along the Illinois Waterway were similar both in 1984 and 1985.

INTRODUCTION

The waters of the Illinois Waterway have had great demands placed upon them by the people residing within the northeastern and central portions of the State of Illinois. The multiple uses of these water resources include agriculture, fishing, hydropower generation, industrial and potable water supply, recreation, transportation, and wastewater assimilation.

The District operates three major water reclamation plants in Cook County, Illinois whose treated discharges make up approximately 93 percent of all municipal waste flows entering the Illinois Waterway System. These water reclamation plants provide wastewater treatment for an average flow of 1,318 million gallons per day.

In August through October of 1977, the District conducted an extensive water quality survey along the Illinois Waterway from the Lockport Lock and Dam to the Peoria Lock and Dam, a distance of 133 nautical miles. The District has conducted follow-up water and sediment surveys of this same 133 mile study area during 1983, 1984, and 1985. The purpose of these surveys were to obtain data to characterize water and sediment conditions along the Illinois Waterway from Chicago to Peoria.

The results from the 1977 and 1983 surveys are presented in Research and Development (R&D) Report No. 85-14. This report presents the water and sediment quality along the 133 mile study area of the Illinois Waterway during 1984 and 1985.

DESCRIPTION OF STUDY AREA

Illinois Waterway

The Illinois Waterway extends from Grafton, Illinois, located on the Mississippi River upstream of St. Louis, Missouri, to Chicago, Illinois (Figures 1 and 2). The 327 mile waterway is composed of a series of eight navigational pools (Lockport, Brandon Road, Dresden Island, Marseilles, Starved Rock, Peoria, La Grange, and Alton), whose lengths and U.S. Army Corps of Engineers waterway mile-point designations are presented in Table 1. The pools were created by locks and dams to maintain the water depths required for commercial barge traffic. The present study area was a 133 mile area of the Illinois Waterway System extending from the Lockport Lock and Dam to the Peoria Lock and Dam.

Sampling Locations

Forty-nine sampling stations were selected for the study (Figures 1 and 2). Two stations were located on the Chicago Sanitary and Ship Canal, eight on the Lower Des Plaines River, and 39 on the Upper Illinois River. Table 2 lists the locations of the 49 sampling stations.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 1

MAP OF ILLINOIS WATERWAY
SHOWING SAMPLING STATIONS
1-21 (NUMBERED CIRCLES)

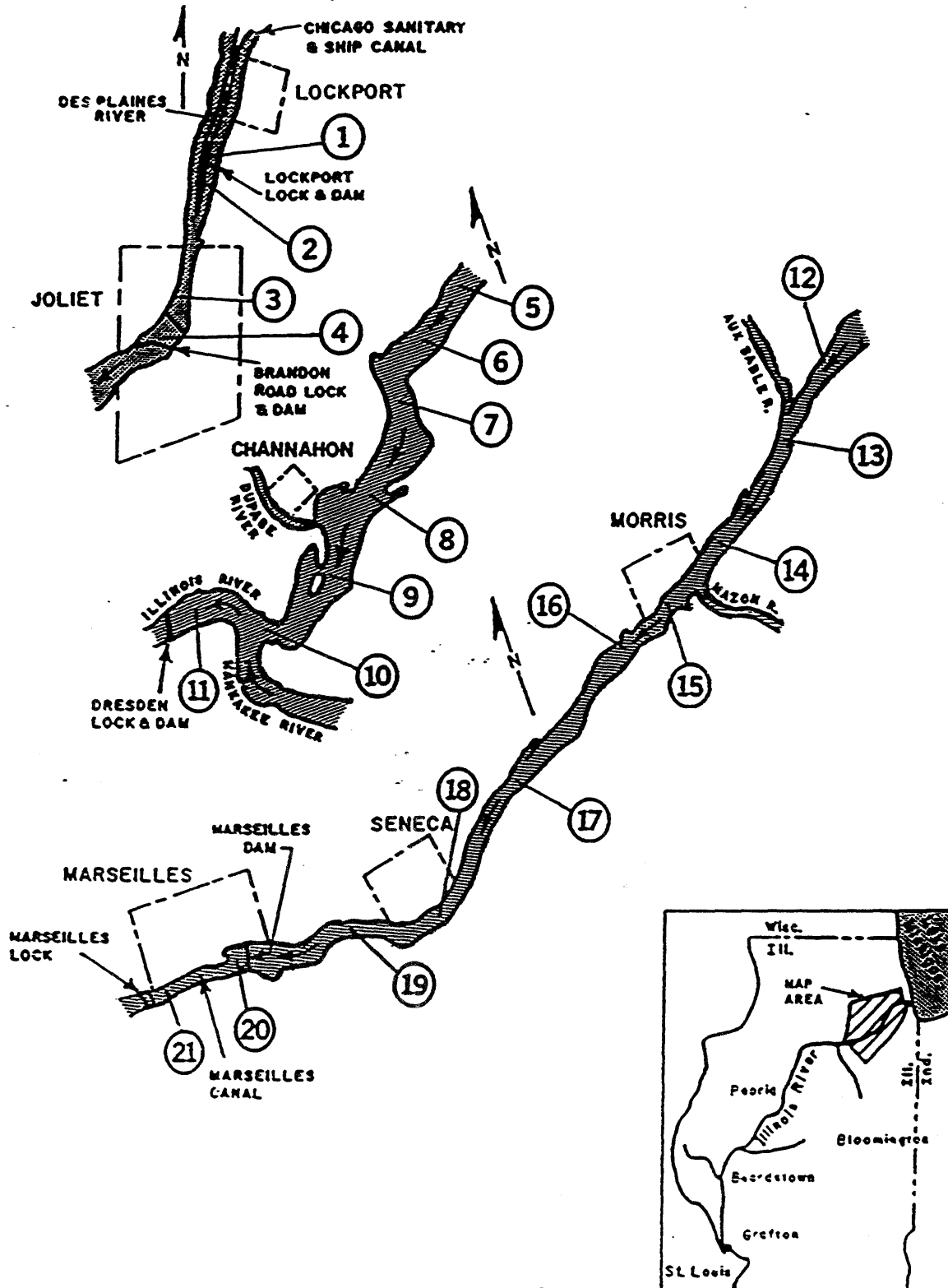
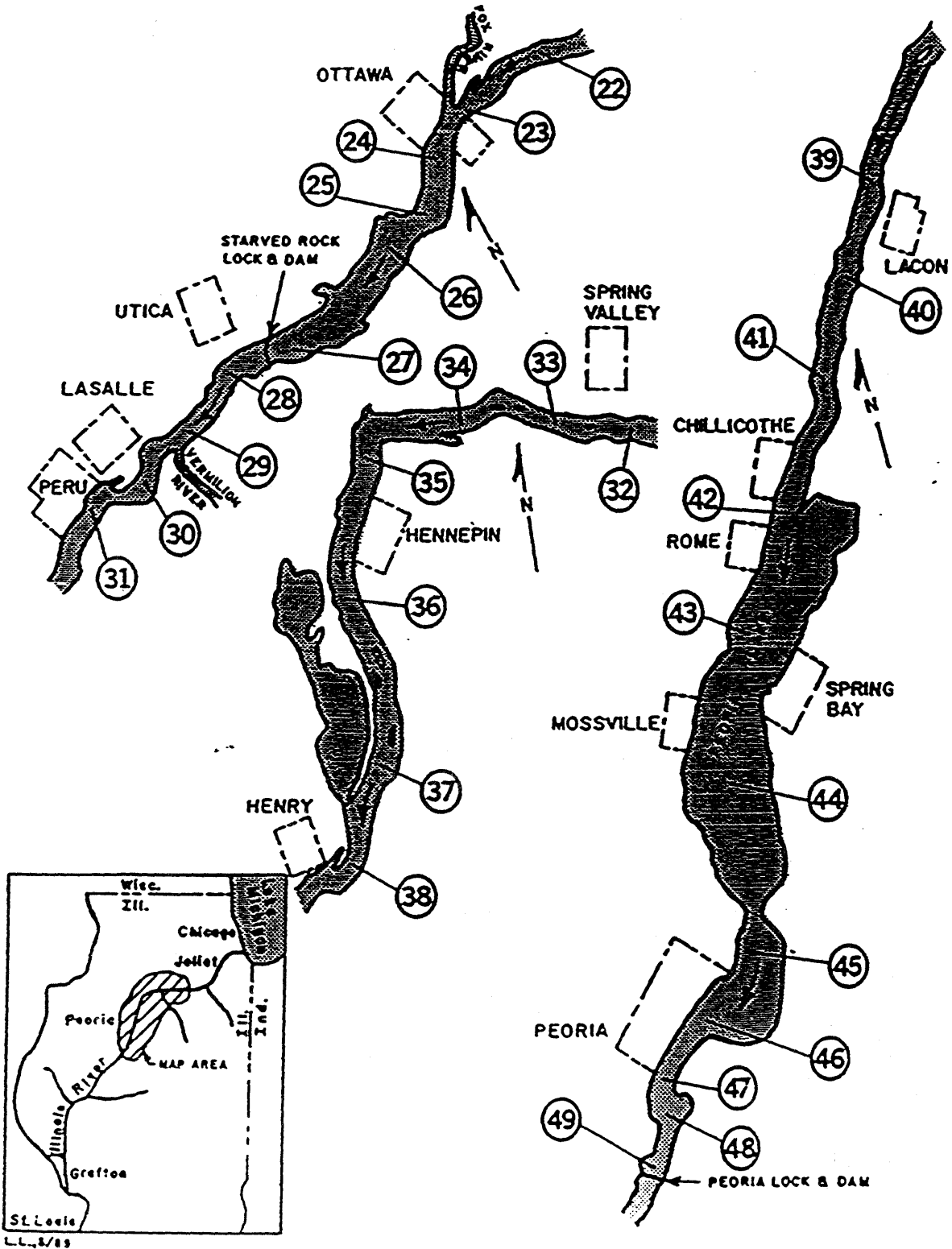


FIGURE 2

MAP OF ILLINOIS WATERWAY
SHOWING SAMPLING STATIONS
22-49 (NUMBERED CIRCLES)



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 1

ILLINOIS WATERWAY NAVIGATION POOLS

Pool	Inclusive Waterway Mile-Points	Length (Miles)
Lockport	327.2-291.0	36.2
Brandon Road	291.0-286.0	4.7
Dresden Island	286.0-271.5	14.5
Marseilles	271.5-247.0	24.5
Starved Rock	247.0-231.0	15.4
Peoria	231.0-157.6	73.4
La Grange	157.6- 80.2	77.4
Alton	80.2- 0.0	80.2

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 2

SAMPLING LOCATIONS ALONG ILLINOIS WATERWAY FROM
THE LOCKPORT LOCK AND DAM TO THE PEORIA LOCK AND DAM

Station Number	Waterway	Waterway Mile-Point Location	Navigation 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	268.9	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

Table continued on following page.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 2 (CONTINUED)

SAMPLING LOCATIONS ALONG ILLINOIS WATERWAY FROM
THE LOCKPORT LOCK AND DAM TO THE PEORIA LOCK AND DAM

Station Number	Waterway	Waterway Mile-Point Location	Navigation Pool
21	Illinois River	246.0	Starved Rock
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
39	Illinois River	190.0	Peoria
40	Illinois River	186.4	Peoria

Table continued on following page.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 2 (CONTINUED)

SAMPLING LOCATIONS ALONG ILLINOIS WATERWAY FROM
THE LOCKPORT LOCK AND DAM TO THE PEORIA LOCK AND DAM

Station Number	Waterway	Waterway Mile-Point Location	Navigation Pool
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

MATERIALS AND METHODS

Field Sampling and Laboratory Analysis

WATER

Chemical Constituents. Water samples for chemical analyses were collected from the 49 sampling stations on May 7-10, May 15-18, August 6-9, August 14-17, October 1-4, and October 9-12 during 1984, and on May 6-9, May 14-17, August 5-8, August 13-16, October 7-10, and October 15-18 in 1985. Samples were collected at a depth of three feet below the water surface in the center of the waterway with a Kemmerer water sampler. All samples were transported to the Stickney R&D laboratory in iced, insulated chests within 24 hours of collection.

The constituents analyzed, sample containers, and preservation methods are presented in Table 3. The DO samples were fixed in the field and returned to the laboratory for titration. Fixation and titration were by the Azide Modification of the Winkler Method, as described in Standard Methods, 15th Edition (1980). pH was measured in the laboratory. All constituents were analyzed by procedures set forth in Methods for Chemical Analyses of Water and Wastewater, USEPA (1979).

Fecal Coliform. Water samples for fecal coliform analyses were collected from the 49 sampling stations on the same day and at the same time as the chemical constituents. Fecal coliform samples were collected with a Kemmerer water sampler at a depth

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 3

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
Dissolved Oxygen (DO)	mg/L	Glass	Determined on Site
Water Temperature	°C	Plastic	Determined on Site
Five-Day Biochemical Oxygen Demand (BOD ₅)	mg/L	Plastic	Cool, 4°C
Total Organic Carbon (TOC)	mg/L	Plastic	Cool, 4°C
Total Suspended Solids (TSS)	mg/L	Plastic	Cool, 4°C
Total Ammonia Nitrogen (NH ₄ -N)	mg/L	Plastic	Cool, 4°C
Nitrite plus Nitrate Nitrogen (NO ₂ + NO ₃ -N)	mg/L	Plastic	Cool, 4°C
Total Phosphorus (TP)	mg/L	Plastic	Cool, 4°C
pH	units	Plastic	Cool, 4°C
Total Cyanides	mg/L	Plastic	NaOH to pH 12
Phenol	mg/L	Glass	H ₂ SO ₄ to pH <2
Fats, Oils and Greases (FOG)	mg/L	Glass	Cool, 4°C
Trace 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 Glass	Cool, 4°C, EDTA, and Thiosulfate
Virus	PFU/100 mL	Plastic	Cool, 4°C, and Thiosulfate

of three feet below the water surface in the center of the waterway. The sample was poured into a sterile, 120 mL glass bottle containing sufficient sodium thiosulfate to neutralize 15 mg/L of chlorine. The fecal coliform samples were kept cool in iced, insulated chests. The analyses were performed by the membrane filtration technique as described in the 14th Edition of Standard Methods. Fecal coliform concentrations are reported in colony forming units per 100 milliliters (CFU/100 mL).

Virus. Samples for virus analyses were collected at 11 of the 49 sampling stations (1, 2, 4, 5, 11, 12, 20, 22, 27, 28, and 49) on October 1-4 during 1984 and on October 7-10 and October 15-18 in 1985. Water samples were collected with a plastic, submersible drainage pump from the water surface in the center of the waterway. The virus samples were stored in five-gallon Nalgene® carboys and kept cool on dry ice.

The viruses in the water samples were concentrated, assayed, and confirmed by a modification of methods described by Bertucci et al., (1983). Virus concentrations are reported in plaque forming units per liter (PFU/L).

SEDIMENT

Chemical Constituents. Sediment samples were collected during the 1984 and 1985 surveys at 14 of the 49 sampling stations (1, 2, 5, 8, 12, 18, 23, 28, 32, 25, 38, 41, 44, and 48). A sediment sample was taken with a Ponar grab sampler from each of the 14 stations on October 1-4 in 1984 and during

October 7-10 in 1985. The sample was transferred into a wide mouth, quart, glass jar and analyzed for TS, TVS, COD, TKN, total cyanides, phenols, FOG, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc. The constituents analyzed, sample containers, and preservation methods are summarized in Table 4. All constituents were analyzed according to Methods for Chemical Analysis of Water and Wastes, USEPA (1979).

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 4

CONSTITUENTS ANALYZED, SAMPLE CONTAINERS, AND PRESERVATION METHODS FOR
SEDIMENT SAMPLES COLLECTED FROM THE ILLINOIS WATERWAY STUDY AREA

Constituent And Abbreviation	Units of Measurement ¹	Sample Container	Preservative
Total Solids (TS)	percent	Glass	Cool, 4°C
Total Volatile Solids (TVS)	percent	Glass	Cool, 4°C
Chemical Oxygen Demand (COD)	mg/kg	Glass	Cool, 4°C
Total Kjeldahl Nitrogen (TKN)	mg/kg	Glass	Cool, 4°C
Total Cyanides	mg/kg	Glass	Cool, 4°C
Phenols	mg/kg	Glass	Cool, 4°C
Fats, Oils and Greases (FOG)	mg/kg	Glass	Cool, 4°C
Trace Metals (Arsenic, Cadmium, Chromium, Copper, Iron, Lead, Manganese, Mercury, Nickel, Silver, and Zinc)	mg/kg	Glass	Cool, 4°C

¹Expressed on a dry weight basis.

RESULTS AND DISCUSSION

Water Quality

Traditionally, the quality of water in lotic and lentic ecosystems has been evaluated in relation to biological, chemical, and physical criteria or a combination of all three, including bacterial levels, the concentrations of various dissolved gasses, dissolved and suspended inorganic and organic compounds, nutrients, temperature, and the 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. In contrast to the sediment which reflects long-term conditions, water samples are indicative of the quality of the water at the time of sampling only.

The concentrations of constituents analyzed in water samples collected from the 49 sampling stations along the Illinois Waterway System during May, August, and October of 1984 and 1985 are presented in Appendices AI through AVI.

1984

Dissolved Oxygen. During the 1984 survey, the DO concentration along the Illinois Waterway ranged from a low of 2.5 mg/L at Station 1 (May 7, 1984) in the Lockport pool to a high of 15.3 mg/L at Station 27 (May 16, 1984) in the Starved Rock pool. The mean DO concentration in 1984 increased along the waterway from the Lockport Lock and Dam (2.7 mg/L) to

the Peoria Lock and Dam (7.4 mg/L). Three major sources of dissolved oxygen along the Illinois Waterway System are (1) reaeration at the navigational dams (Butts et al., 1975; Polls et al., 1985), (2) contribution of tributary flows, especially from the Kankakee and Fox Rivers (Butts et al., 1975), and (3) photosynthesis, oxygen produced by algae and aquatic vegetation (Butts et al., 1987).

Five-Day Biochemical Oxygen Demand. The range of values for BOD₅ for all 49 sampling stations along the Illinois Waterway during 1984 were from 1 mg/L at Stations 2, 5, 16 and 19 in the Brandon Road, Dresden Island, and Marseilles pools, respectively, to 12 mg/L at Station 47 (August 14, 1984) in the Peoria pool.

There was no change during 1984 in the mean BOD₅ from the Lockport Lock and Dam (3 mg/L) to the Peoria Lock and Dam (3 mg/L).

Total Organic Carbon. In 1984, TOC ranged from a low of 4 mg/L at Station 4 (October 12, 1984) in the Brandon Road pool to a high of 16 mg/L at Station 16 (August 19, 1984) in the Marseilles pool. There was a slight decrease in the mean concentration of TOC along the waterway from the Lockport Lock and Dam (8 mg/L) to the Peoria Lock and Dam (7 mg/L).

Total Suspended Solid. Total suspended solids values were quite variable along the 133 mile study area. During 1984, TSS ranged from 8 mg/L at Station 6 (August 6, 1984) in

the Dresden Island pool to 158 mg/L at Station 47 (October 9, 1984) in the Peoria pool.

The mean concentration of TSS in 1984 increased down the Illinois Waterway from the Lockport Lock and Dam (12 mg/L) to the Peoria Lock and Dam (53 mg/L). The increase in suspended solids is thought to be due, in part, to nonpoint agricultural soil and stream bank erosion, and the subsequent runoff of these soil particles into tributaries of the Illinois River.

Total Ammonia Nitrogen. The range of values of $\text{NH}_4\text{-N}$ for all 49 sampling stations along the waterway during the 1984 survey was from <0.1 mg/L at Stations 25 and 26 in the Starved Rock pool and 10 sampling stations in the Peoria pool to 4.2 mg/L at Station 2 (May 18, 1984) in the Brandon Road pool.

The mean concentration of $\text{NH}_4\text{-N}$ in 1984 decreased along the Illinois Waterway from the Lockport Lock and Dam (3.4 mg/L) to the Peoria pool (0.2 mg/L).

Nitrite Plus Nitrate Nitrogen. In 1984, $\text{NO}_2+\text{NO}_3\text{-N}$ ranged from a low of 1.28 mg/L at Station 45 (August 9, 1984) in the Peoria pool to a high of 5.83 mg/L at Station 48 (May 10, 1984), also in the Peoria pool.

There was a slight increase in the mean concentration of $\text{NO}_2+\text{NO}_3\text{-N}$ during 1984 in the Illinois Waterway from the Lockport Lock and Dam (2.72 mg/L) to the Peoria Lock and Dam (3.17 mg/L). This increase may be attributable to instream nitrification and/or agricultural runoff (fertilizers).

Total Phosphorus. Total phosphorus varied during 1984 from 0.08 mg/L at Station 9 (October 12, 1984) in the Dresden Island pool to 1.05 mg/L at Station 8 (May 18, 1984), also in the Dresden Island pool.

In 1984, mean TP decreased in concentration down the Illinois Waterway from the Lockport Lock and Dam (0.48 mg/L) to the Peoria Lock and Dam (0.28 mg/L). The decline in phosphorus along the waterway may be due to the settling and adsorptive capacity of the sediment, and/or the utilization of this nutrient by the aquatic plant community.

pH. During 1984, pH values in the 133 mile study area varied from a low of 5.6 at Station 16 (May 17, 1984) in the Marseilles pool to a high of 7.9 at Station 5 (August 6, 1984) in the Dresden Island pool.

In 1984, pH increased along the Illinois Waterway from the Lockport Lock and Dam (range: 6.9-7.1) to the Peoria Lock and Dam (range 7.2-7.8).

Total Cyanides. Cyanide values for all 49 sampling stations during 1984 ranged from 0.001 mg/L at Stations 22 (October 2, 1984), and 27 (August 8, 1984) in the Starved Rock pool and Stations 28 (August 9, 1984), 30 (October 3, 1984), and 44 (August 9, 1984) in the Peoria pool to 0.020 mg/L at Station 38 (October 3, 1984) in the Peoria pool.

The mean concentration of cyanides measured during 1984 decreased slightly along the Illinois Waterway from the Lockport

Lock and Dam (0.007 mg/L) to the Peoria Lock and Dam (0.003 mg/L).

Phenols. During the 1984 survey, the range of phenol values along the waterway were from 0.007 mg/L at Station 17 (May 8, 1984) in the Marseilles pool to 0.100 mg/L at Station 19 (May 8, 1984), also in the Marseilles pool.

The mean phenol concentration decreased in 1984 down the Illinois Waterway from the Lockport Lock and Dam (0.032 mg/L) to the Peoria Lock and Dam (0.019 mg/L).

Fats, Oils and Greases. Fats, oils and greases were quite variable during 1984, ranging from <1 mg/L at many of the 49 sampling stations in all the navigational pools to 80 mg/L at Station 9 (May 7, 1984) in the Dresden Island pool.

In 1984, no clear trend was discernible for FOG along the 133 mile study area of the Illinois Waterway from the Lockport Lock and Dam to the Peoria Lock and Dam.

Trace Metals. A total of 11 trace metals were measured in water samples during the 1984 survey, including arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc.

Arsenic, cadmium, chromium, and silver were generally below detection limits of <0.1, <0.01, <0.01, and <0.01 mg/L, respectively. Copper, iron, lead, manganese, mercury, nickel, and zinc ranged from a low of <0.01, <0.1, <0.01, <0.01,

<0.0001, <0.1, and <0.1 mg/L, respectively, to a high of 0.07, 13.0, 0.06, 0.15, 0.0009, 0.3, and 0.6 mg/L, respectively.

With the exception of iron and manganese, the mean concentrations of the other nine trace metals analyzed in surface waters remained practically uniform down the Illinois Waterway from the Lockport Lock and Dam to the Peoria Lock and Dam. Iron and manganese increased in concentration along the waterway in the Peoria pool (0.81 and 0.10 mg/L, respectively) compared to upstream (0.44 and 0.06 mg/L, respectively).

Fecal Coliform. During 1984, FC densities varied widely in the 133 mile study area ranging from a minimum of <10 CFU/100 mL at 18 of the 49 sampling stations in the Marseilles, Starved Rock, and Peoria pools to a maximum of 90,000 CFU/100 mL at Station 14 (August 7, 1984) in the Marseilles pool.

Fecal coliforms decreased with distance down the Illinois Waterway from the Lockport Lock and Dam (696 CFU/100 mL) to the middle portion of the Peoria pool, Station 41 (6 CFU/100 mL), and then increased in density along the lower portion of the Peoria pool to the Peoria Lock and Dam (48 CFU/100 mL). This reduction in fecal coliform counts is thought to be as a result of natural die-off.

Virus. Viruses enter aquatic systems from wastewater effluents, combined sewer overflows, and urban runoff. Except for one sampling station in the lower portion of the Lockport pool, water samples were collected and assayed for viruses from

two stations (upper and lower sections) in each of the other five navigational pools.

During 1984, only four of 11 sampling stations (36%) yielded confirmed viruses (Table 5). The virus levels ranged from a low of 0 PFU/L at seven sampling stations to a high of 0.05 PFU/L at Station 12 (October 2, 1984) in the Marseilles pool.

1985

Dissolved Oxygen. During the 1985 survey, the DO concentration along the 133 mile study area of the Illinois Waterway ranged from a low of 0.3 mg/L at Station 29 (October 9, 1985) in the Peoria pool to a high of 11.7 mg/L at Station 38 (October 9, 1985), also in the Peoria pool.

The mean DO concentration in 1985 increased along the waterway from the Lockport Lock and Dam (2.1 mg/L) to the Peoria Lock and Dam (7.4 mg/L). The increase is most likely due to reaeration and photosynthesis.

Five-Day Biochemical Oxygen Demand. The range of values for BOD₅ in 1985 for all 49 sampling stations along the study reach were from <1 mg/L at Stations 36-41 (October 16, 1985) in the Peoria pool to 14 mg/L at Station 16 (May 7, 1985) in the Marseilles pool.

The mean BOD₅ increased slightly in 1985 along the waterway from 2 mg/L at the Lockport Lock and Dam to 3 mg/l at the Peoria Lock and Dam.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 5

CONFIRMED VIRUS LEVELS AT ELEVEN STATIONS ALONG THE ILLINOIS WATERWAY
FROM THE LOCKPORT LOCK AND DAM TO THE PEORIA LOCK AND DAM,
OCTOBER 1984

Station Number	Navigational Pool	Sample Collection Date	Sample Volume (L) ¹	Total PFU ²	Percent Confirmed	Confirmed PFU/L	Detection Limit (PFU/L) ³
1	Lockport	10/12/84	34.2	5	20.0	0.03	0.03
2	Brandon Road	10/12/84	35.4	4	0	0	0.03
4	Brandon Road	10/12/84	36.3	9	11.1	0.03	0.03
5	Dresden Island	10/12/84	26.5	13	7.7	0.04	0.04
11	Dresden Island	10/02/84	29.3	21	0	0	0.03
12	Marseilles	10/02/84	19.1	12	8.3	0.05	0.05
20	Marseilles	10/02/84	28.7	11	0	0	0.03
22	Starved Rock	10/02/84	28.0	13	0	0	0.04
27	Starved Rock	10/03/84	36.1	3	0	0	0.03
28	Peoria	10/03/84	33.6	8	0	0	0.03
49	Peoria	10/04/84	37.8	24	0	0	0.03

¹Represents unconcentrated sample volume inoculated into BGM cell cultures.

²PFU - Plaque Forming Units.

³Detection Limit = 1/Sample Volume.

Total Organic Carbon. In 1985, TOC varied from a low of 3 mg/l at Station 3 (May 16, 1985) in the Brandon Road pool to a high of 53 mg/L at Station 27 (August 9, 1985) in the Starved Rock pool.

There was a slight increase in the mean concentration of TOC along the waterway from the Lockport Lock and Dam (7 mg/L) to the Peoria Lock and Dam (8 mg/L).

Total Suspended Solids. Total suspended solids values were quite variable along the 133 mile study area. The maximum TSS value in 1985 was 116 mg/L at Station 39 (May 15, 1985) in the Peoria pool, while the minimum value was 6 mg/L at Station 1 (August 5, 1985) in the Lockport pool.

The mean concentration of TSS in 1985 increased down the Illinois Waterway from the Lockport Lock and Dam (11 mg/L) to the Peoria Lock and Dam (51 mg/L). The increase in suspended solids is thought to be due, in part, to nonpoint agricultural soil and stream bank erosion, and the subsequent runoff of these soil particles into tributaries of the Illinois River.

Total Ammonia Nitrogen. During the 1985 survey, total ammonia nitrogen ranged from <0.1 mg/L at Stations 44, 45, and 46 (August 8, 1985) in the Peoria pool to 4.9 mg/L at Station 10 (May 16, 1985) in the Dresden Island pool.

The mean concentration of NH₄-N in 1985 decreased along the Illinois Waterway from the Lockport Lock and Dam (3.1 mg/L) to the Peoria pool (0.3 mg/L).

Nitrite Plus Nitrate Nitrogen. In 1985, the range of values for $\text{NO}_2+\text{NO}_3\text{-N}$ were from 0.40 mg/L at Station 2 (May 17, 1985) in the Brandon Road pool to 3.96 mg/L at Station 8 (October 18, 1985) in the Dresden Island pool.

There was an increase in the mean concentration of $\text{NO}_2+\text{NO}_3\text{-N}$ during 1985 in the Illinois Waterway from the Lockport Lock and Dam (1.56 mg/L) to the Peoria Lock and Dam (2.55 mg/L). This increase may be attributable to instream nitrification and/or agricultural runoff (fertilizers).

Total Phosphorus. Total phosphorus varied during 1985 from 0.10 mg/L at Station 24 (May 17, 1985) in the Starved Rock pool to 1.55 mg/L at Station 1 (August 5, 1985) in the Lockport pool.

In 1985, mean TP decreased in concentration down the Illinois Waterway from the Lockport Lock and Dam (0.46 mg/L) to the Peoria Lock and Dam (0.29 mg/L). The decline in phosphorus along the waterway may be due to the settling and adsorptive capacity of the sediment, and/or the utilization of this nutrient by the aquatic plant community.

pH. During 1985, the maximum pH value recorded in the 133 mile study area was 7.6 at Stations 5 (October 18, 1985), 6 (October 18, 1985), 8 (October 18, 1985), and 38 (August 17, 1985) in the Dresden Island and Peoria pools, while the minimum value was 5.1 at Station 1 (May 6, 1985) in the Lockport pool.

In 1985, pH increased slightly along the Illinois Waterway from the Lockport Lock and Dam (range: 5.1-7.3) to the Peoria Lock and Dam (range 5.8-7.5).

Total Cyanides. Total cyanides for all 49 sampling stations during 1985 ranged from 0.003 mg/L at Station 45 (May 15, 1985) in the Peoria pool to 0.017 mg/L at Station 15 (August 15, 1985) in the Marseilles pool.

The mean concentration of cyanides measured during 1985 decreased slightly along the Illinois Waterway from the Lockport Lock and Dam (0.009 mg/L) to the Peoria Lock and Dam (0.007 mg/L).

Phenols. During the 1985 survey, the range of phenol values along the waterway were from 0.005 mg/L at Station 27 (August 7, 1985) in the Starved Rock pool to 0.081 mg/L at Station 17 (August 6, 1985) in the Marseilles pool.

The mean phenol concentration decreased in 1985 down the Illinois Waterway from the Lockport Lock and Dam (0.032 mg/L) to the Peoria Lock and Dam (0.024 mg/L).

Fats, Oils and Greases. Fats, oils and greases were quite variable during 1985, ranging from <1 mg/L at most of the 49 sampling stations in all the navigational pools to 45 mg/L at Station 27 (August 7, 1985) in the Starved Rock pool.

In 1985, no clear trend was discernible for FOG along the 133 mile study reach of the Illinois Waterway from the Lockport Lock and Dam to the Peoria Lock and Dam.

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Trace Metals. A total of 11 trace metals were measured in water samples during the 1985 survey, including arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc.

Arsenic, cadmium, mercury, and silver were generally below detection limits of <0.1, <0.01, <0.0001, and <0.01 mg/L, respectively. Chromium, copper, iron, lead, manganese, nickel, and zinc ranged from a low of <0.01, <0.01, <0.1, <0.01, <0.01, <0.1, and <0.1 mg/L, respectively, to a high of 0.05, 0.09, 2.70, 0.13, 0.34, 0.2, and 0.2 mg/L, respectively.

With the exception of iron and manganese, the mean concentrations of the other nine trace metals analyzed in surface waters during the 1985 survey remained practically uniform down the Illinois Waterway from the Lockport Lock and Dam to the Peoria Lock and Dam. Iron and manganese increased in concentration along the waterway in the Peoria pool (0.76 and 0.09 mg/L, respectively) compared to upstream (0.57 and 0.06 mg/L, respectively).

Fecal Coliform. During 1985, FC densities varied widely throughout the 133 mile study area ranging from a minimum of < 10 CFU/100 mL at 15 of the 49 sampling stations in the Marseilles, Starved Rock, and Peoria pools (12 of the 15 stations) to a maximum of 180,000 CFU/100 mL at Station 2 (May 17, 1985) in the Lockport pool.

Fecal coliforms decreased with distance down the Illinois Waterway in 1985 from the Lockport Lock and Dam (13,342 CFU/100 mL) to the middle portion of the Peoria pool, Station 41 (17 CFU/100 mL), and then increased in density along the lower portion of the Peoria pool to the Peoria Lock and Dam (152 CFU/100 mL). This reduction in fecal coliform counts is thought to be as a result of natural die-off.

Virus. Viruses enter aquatic systems from wastewater effluents, combined sewer overflows, and urban runoff. Except for one sampling station in the lower portion of the Lockport pool, water samples were collected and assayed for viruses from two stations (upper and lower sections) in each of the other five navigational pools.

During 1985, only six of 22 sampling stations (27%) yielded confirmed viruses (Table 6). The virus levels ranged from a low of 0 PFU/L at ten sampling stations to a high of 0.47 PFU/L at Station 20 (October 17, 1985) in the Marseilles pool.

COMPARISON OF THE WATER QUALITY BETWEEN 1984 AND 1985

Dissolved Oxygen. Overall, the mean DO values recorded at the 49 sampling stations were similar both in 1984 and 1985 (Figure 3).

Biochemical Oxygen Demand. As shown in Figure 4, the mean BOD₅ value changed very little between 1984 and 1985.

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TABLE 6

CONFIRMED VIRUS LEVELS AT ELEVEN STATIONS ALONG THE ILLINOIS WATERWAY
FROM THE LOCKPORT LOCK AND DAM TO THE PEORIA LOCK AND DAM,
OCTOBER 1985

Station Number	Navigational Pool	Sample Collection Date	Sample Volume (L) ¹	Total PFU ²	Percent Confirmed	Confirmed PFU/L	Detection Limit (PFU/L) ³
1	Lockport	10/07/85	21.0	13	15.4	0.10	0.05
1	Lockport	10/18/85	2.2	5	0	0	0.46
2	Brandon Road	10/07/85	2.8	3	33.3	0.36	0.36
2	Brandon Road	10/18/85	12.3	16	0	0	0.08
4	Brandon Road	10/07/85	21.6	3	0	0	0.05
4	Brandon Road	10/18/85	1.8	0	0	0	0.54
5	Dresden Island	10/07/85	22.6	3	0	0	0.04
5	Dresden Island	10/18/85	12.2	10	0	0	0.08
11	Dresden Island	10/08/85	21.9	4	50.0	0.09	0.05
11	Dresden Island	10/17/85	20.5	5	0	0	0.05
12	Marseilles	10/08/85	23.0	6	0	0	0.04
12	Marseilles	10/17/85	12.4	5	0	0	0.08

Table continued on following page.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 6 (CONTINUED)

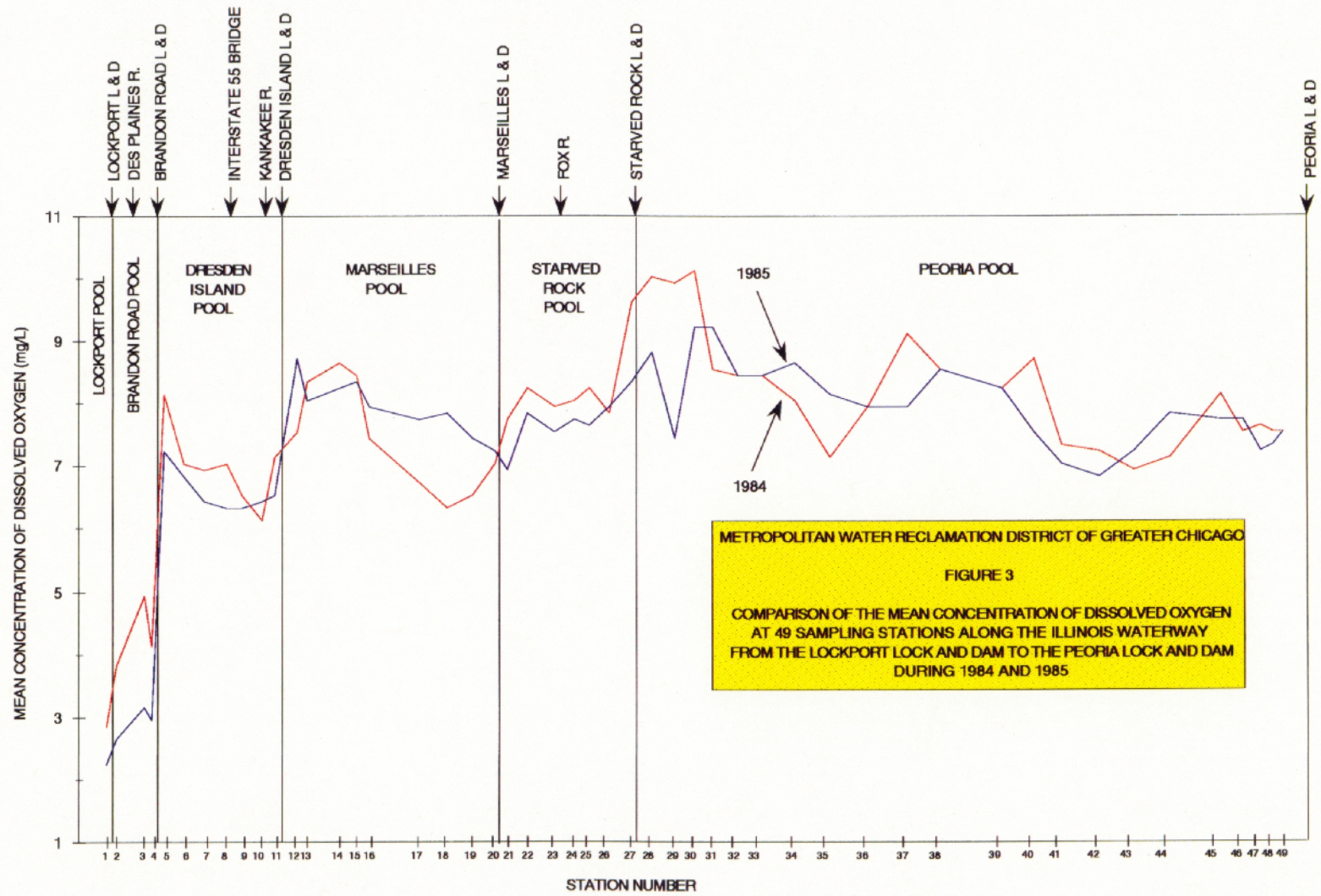
CONFIRMED VIRUS LEVELS AT ELEVEN STATIONS ALONG THE ILLINOIS WATERWAY
FROM THE LOCKPORT LOCK AND DAM TO THE PEORIA LOCK AND DAM,
OCTOBER 1985

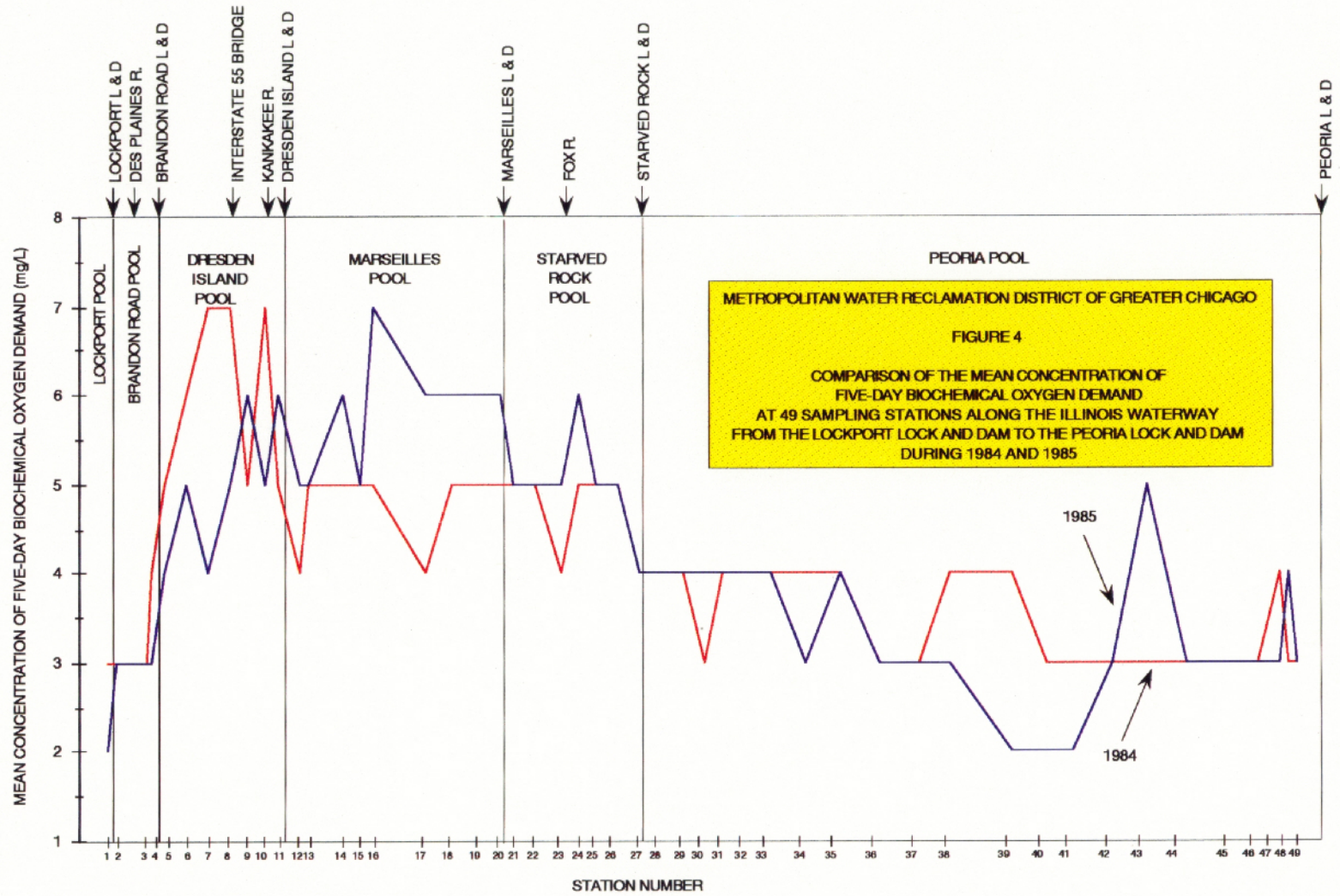
Station Number	Navigational Pool	Sample Collection Date	Sample Volume (L) ¹	Total PFU ²	Percent Confirmed	Confirmed PFU/L	Detection Limit (PFU/L) ³
20	Marseilles	10/08/85	21.9	1	100.0	0.05	0.05
20	Marseilles	10/17/85	2.1	2	50.0	0.47	0.47
22	Starved Rock	10/08/85	22.0	6	0	0	0.05
22	Starved Rock	10/17/85	21.2	14	0	0	0.05
27	Starved Rock	10/09/85	22.3	4	0	0	0.04
27	Starved Rock	10/16/85	26.2	8	0	0	0.04
28	Peoria	10/09/85	21.7	5	0	0	0.05
28	Peoria	10/16/85	21.8	20	0	0	0.05
49	Peoria	10/10/85	24.1	16	12.5	0.08	0.04
49	Peoria	10/15/85	22.0	5	0	0	0.05

¹Represents unconcentrated sample volume inoculated into BGM cell cultures.

²PFU = Plaque Forming Units.

³Detection Limit = 1/Sample Volume.





Total Organic Carbon. Between 1984 and 1985, TOC was similar in concentration at the 49 sampling stations along the Illinois Waterway (Figure 5).

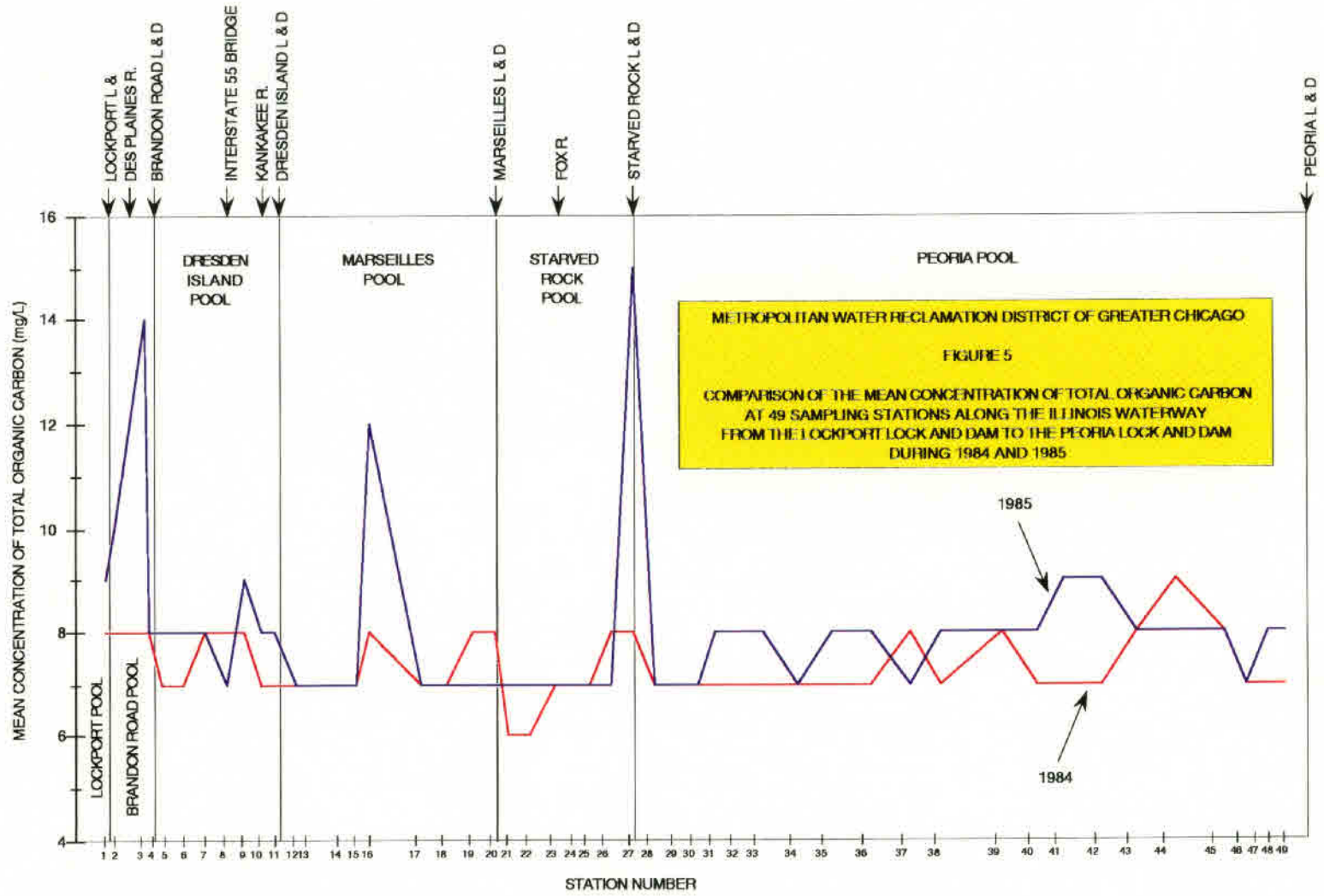
Total Suspended Solids. As seen in Figure 6, the mean TSS values changed very little between 1984 and 1985 in the Lockport, Brandon Road, Dresden Island, Marseilles, and Starved Rock pools. However, higher TSS values were recorded in the Peoria pool during 1984 (49 mg/L) compared to 1985 (42 mg/L). These higher values may be as a result of more precipitation events, subsequently more runoff to the waterway system.

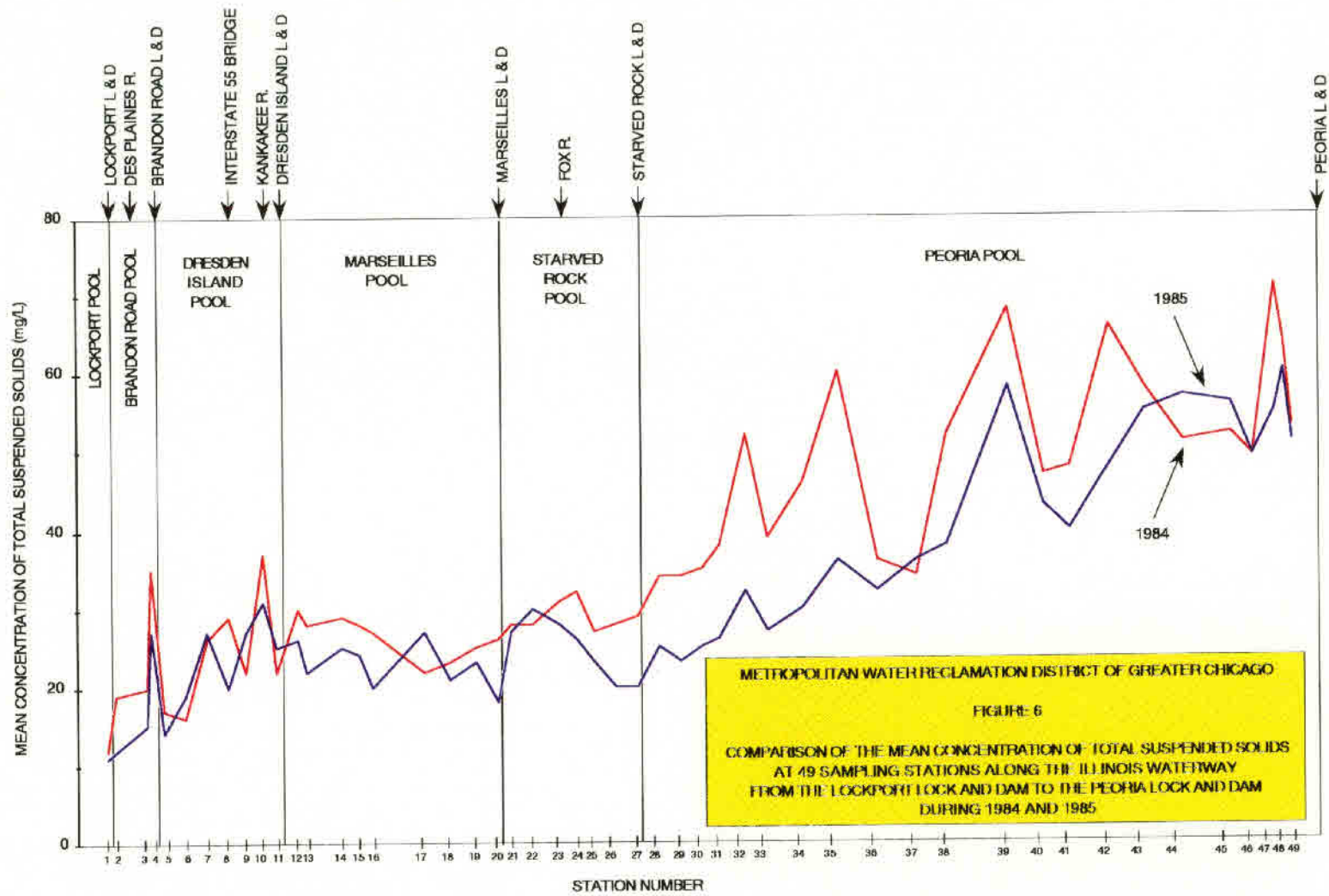
Total Ammonia Nitrogen. Between 1984 and 1985, there was little change in the mean values for $\text{NH}_4\text{-N}$ at the 49 sampling stations (Figure 7).

Nitrite plus Nitrate Nitrogen. Higher mean $\text{NO}_2+\text{NO}_3\text{-N}$ values were measured during the 1984 survey (3.11 mg/L) compared to 1985 (2.67 mg/L) (Figure 8). These higher values may be the result of an increase in instream nitrification and/or a greater contribution from point and nonpoint sources.

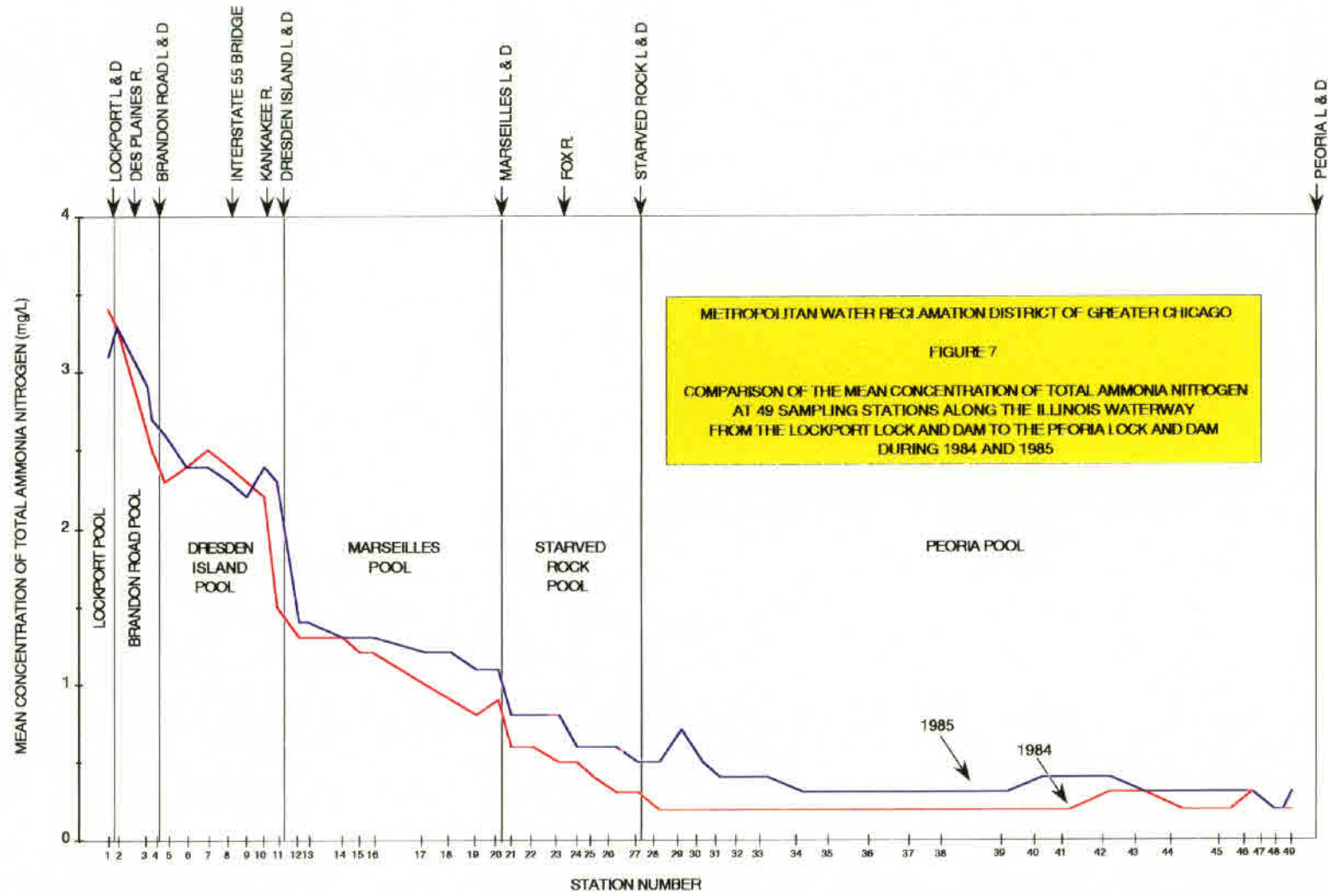
Total Phosphorus. Mean TP values changed very little between 1984 and 1985 (Figure 9). However, higher TP values were recorded in the Peoria pool during 1984 (0.39 mg/L) compared to 1985 (0.31 mg/L).

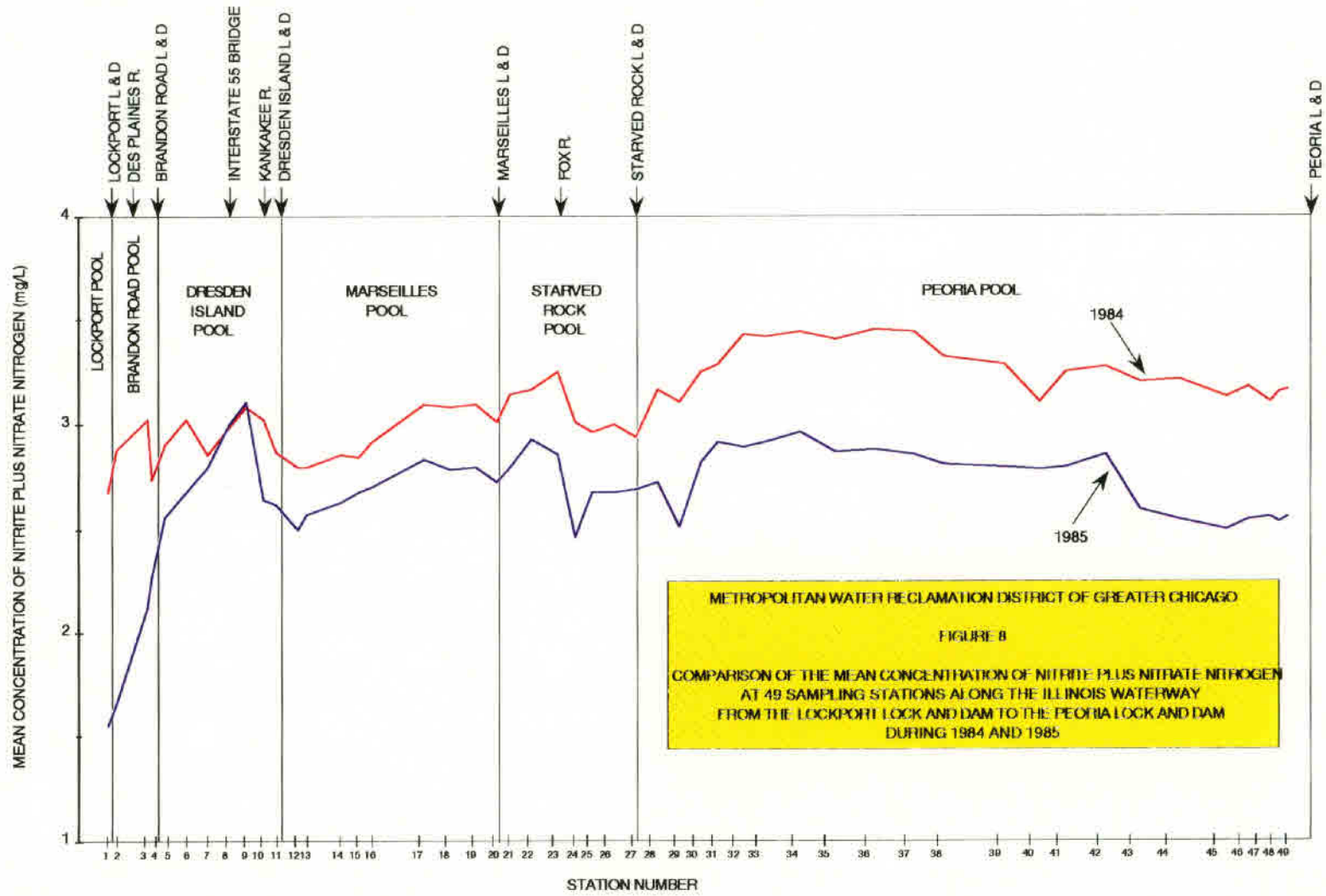
pH. Slightly higher pH values were measured at the 49 stations in the study area during the 1984 survey (range: 5.6-7.9) compared to the 1985 survey (range: 5.1-7.6).

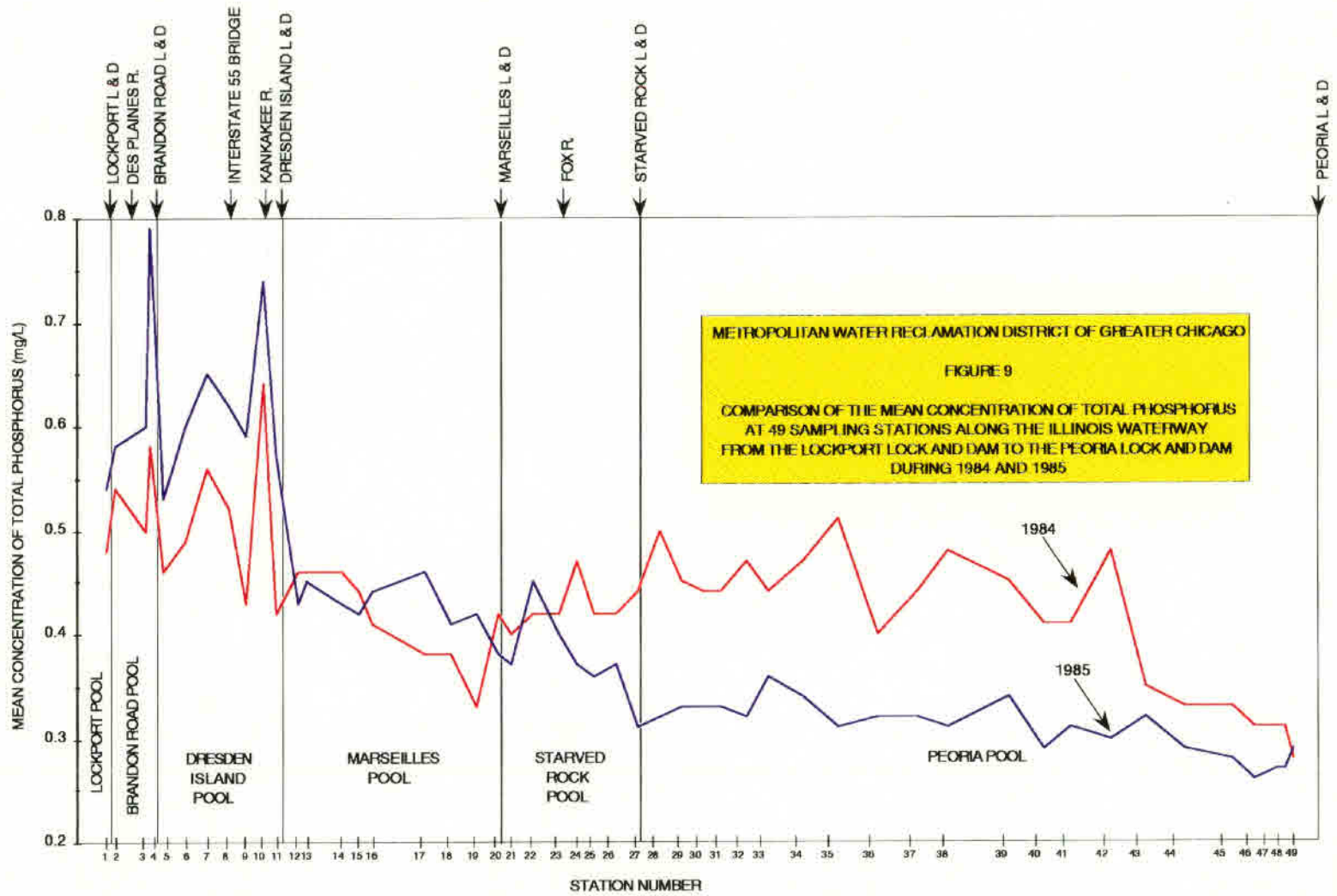




METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO
 FIGURE 6
 COMPARISON OF THE MEAN CONCENTRATION OF TOTAL SUSPENDED SOLIDS
 AT 49 SAMPLING STATIONS ALONG THE ILLINOIS WATERWAY
 FROM THE LOCKPORT LOCK AND DAM TO THE PEORIA LOCK AND DAM
 DURING 1984 AND 1985







Total Cyanides. Compared to 1984 (0.004 mg/L), the mean cyanide concentration increased slightly at the 49 stations during 1985 (0.007 mg/L) (Figure 10).

Phenols. As shown in Figure 11, higher mean phenol values were measured at the 49 stations during 1985 (0.027 mg/L) compared to 1984 (0.021 mg/L).

Fats, Oils and Greases. Between 1984 and 1985, there was little change in the mean value of FOG measured at the 49 stations (Figure 12).

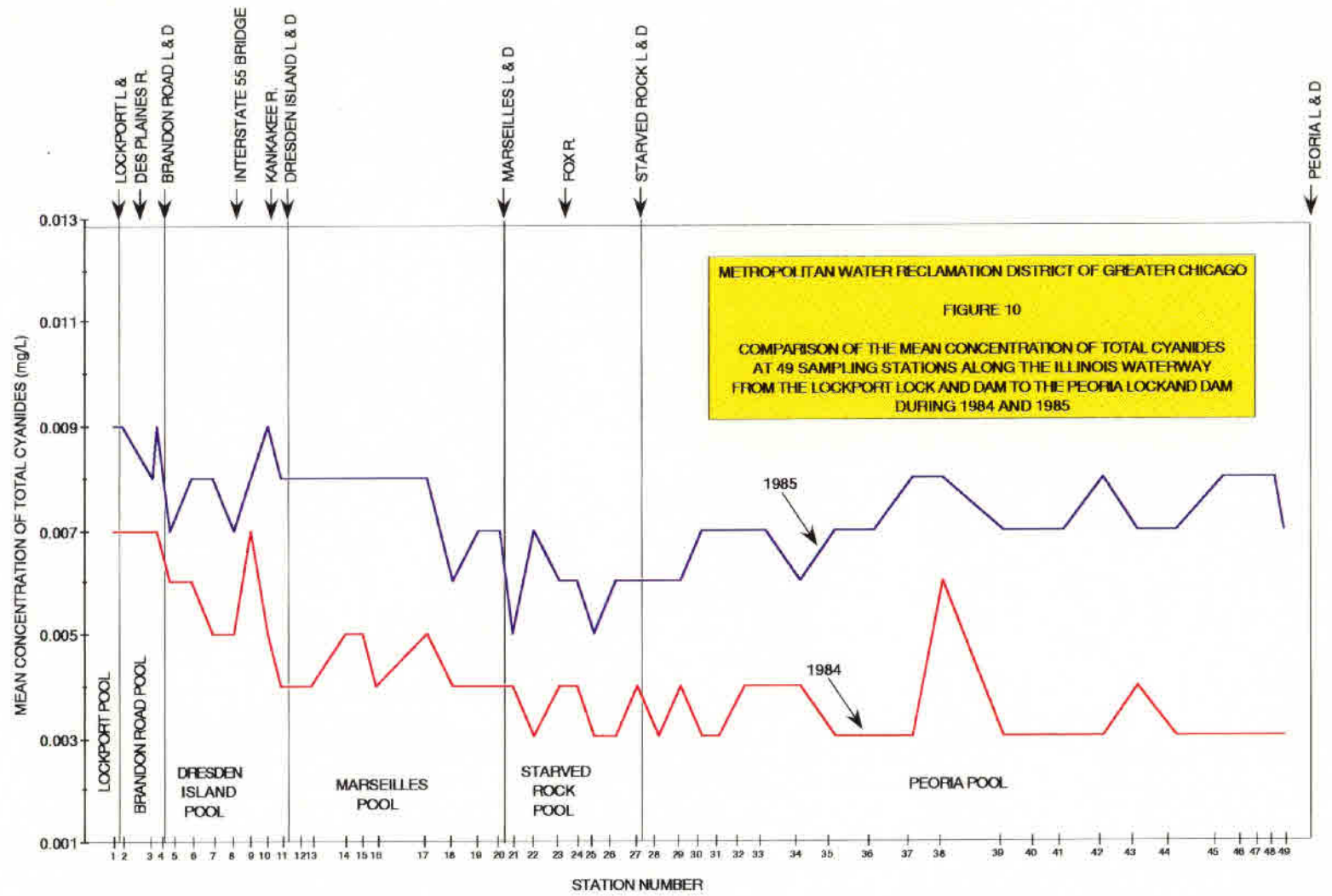
Trace Metals. The mean concentrations of the 11 trace metals surveyed in the six navigational pools were similar both in 1984 and 1985 (Figures 13-23).

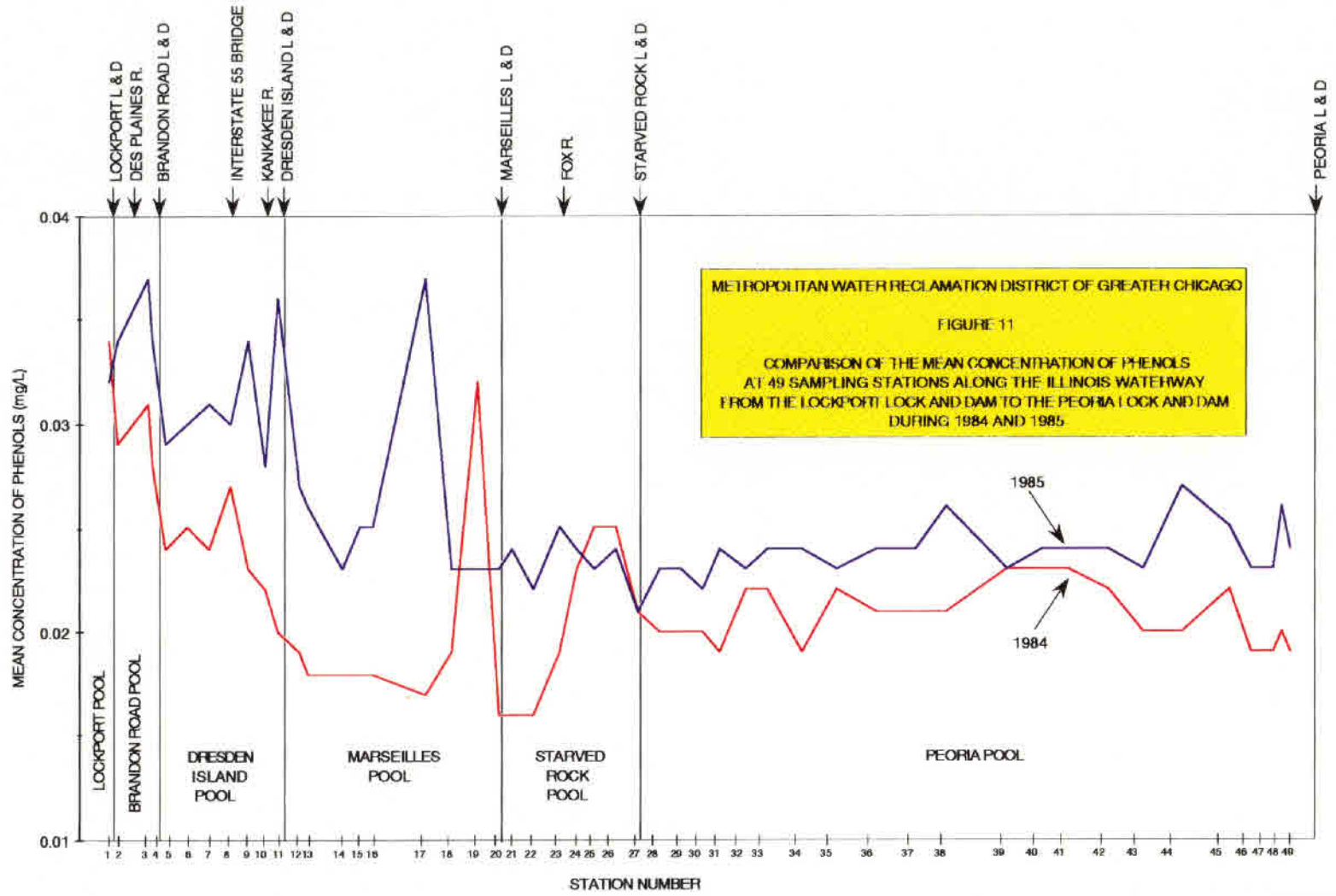
Fecal Coliform. Higher geometric means of FC were observed during 1985 (996 CFU/100 mL) compared with 1984 (232 CFU/100 mL) (Figure 24). This difference may be due to the natural variability of fecal coliforms in aquatic systems.

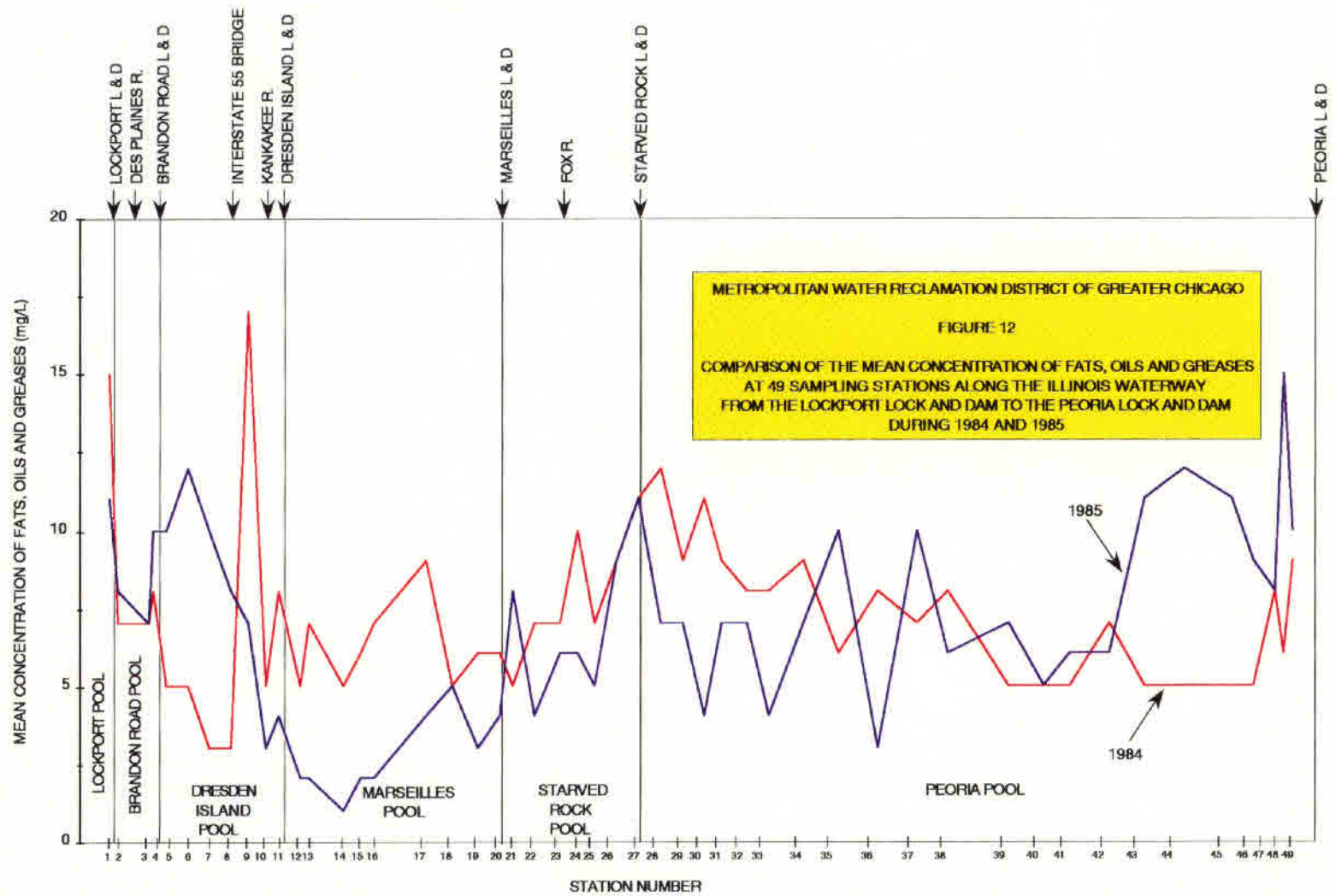
Virus. There was little difference in the concentration of confirmed virus levels from the 11 sampling stations along the Illinois Waterway collected on different sampling dates during both 1984 and 1985 (Tables 5 and 6).

Sediment Quality

Much of the suspended material that has been discharged from municipal and industrial users and urban and rural runoff, eventually settles to the bottom of aquatic systems. Many of



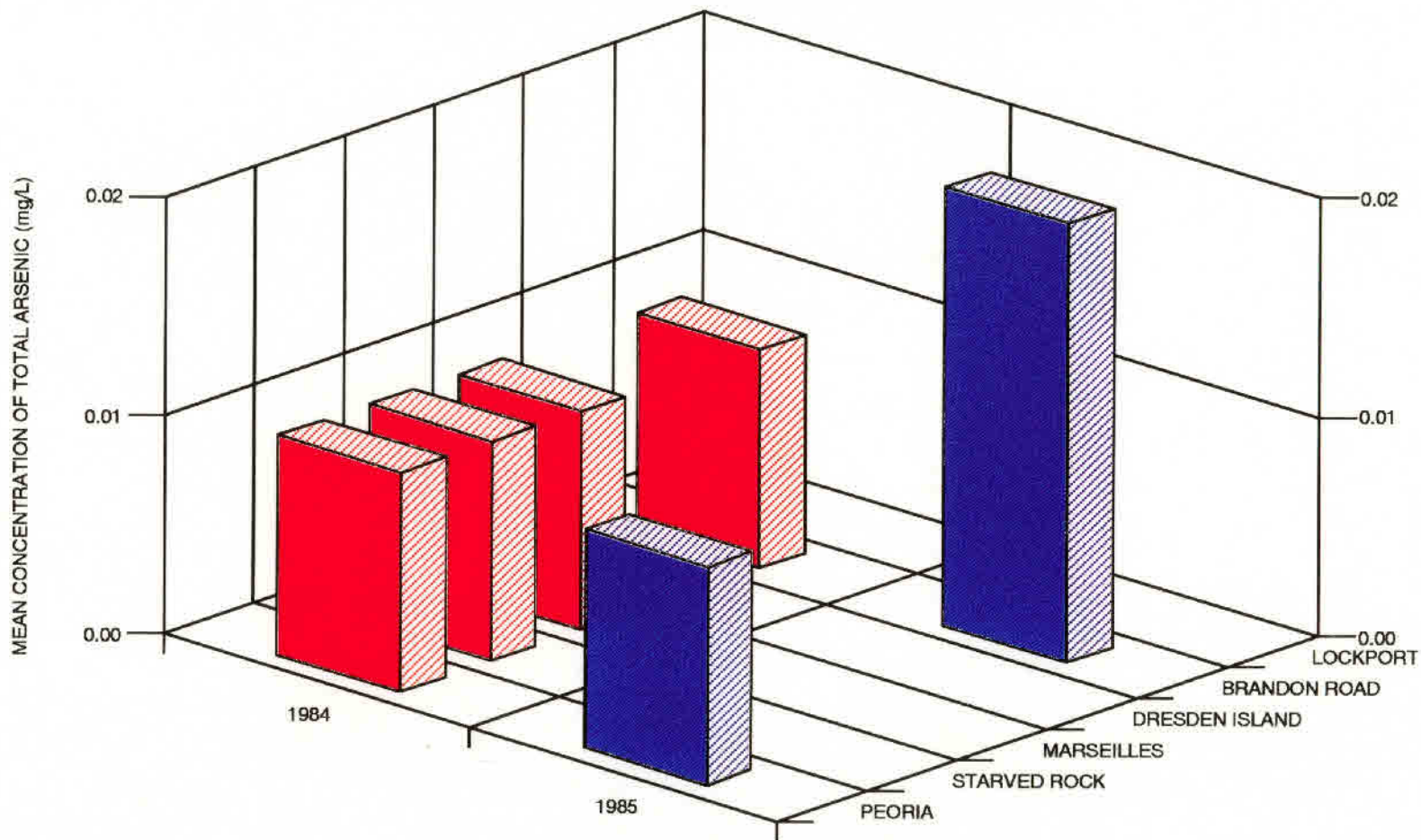




METROPOLITAN WATER RECALAMATION DISTRICT OF GREATER CHICAGO

FIGURE 13

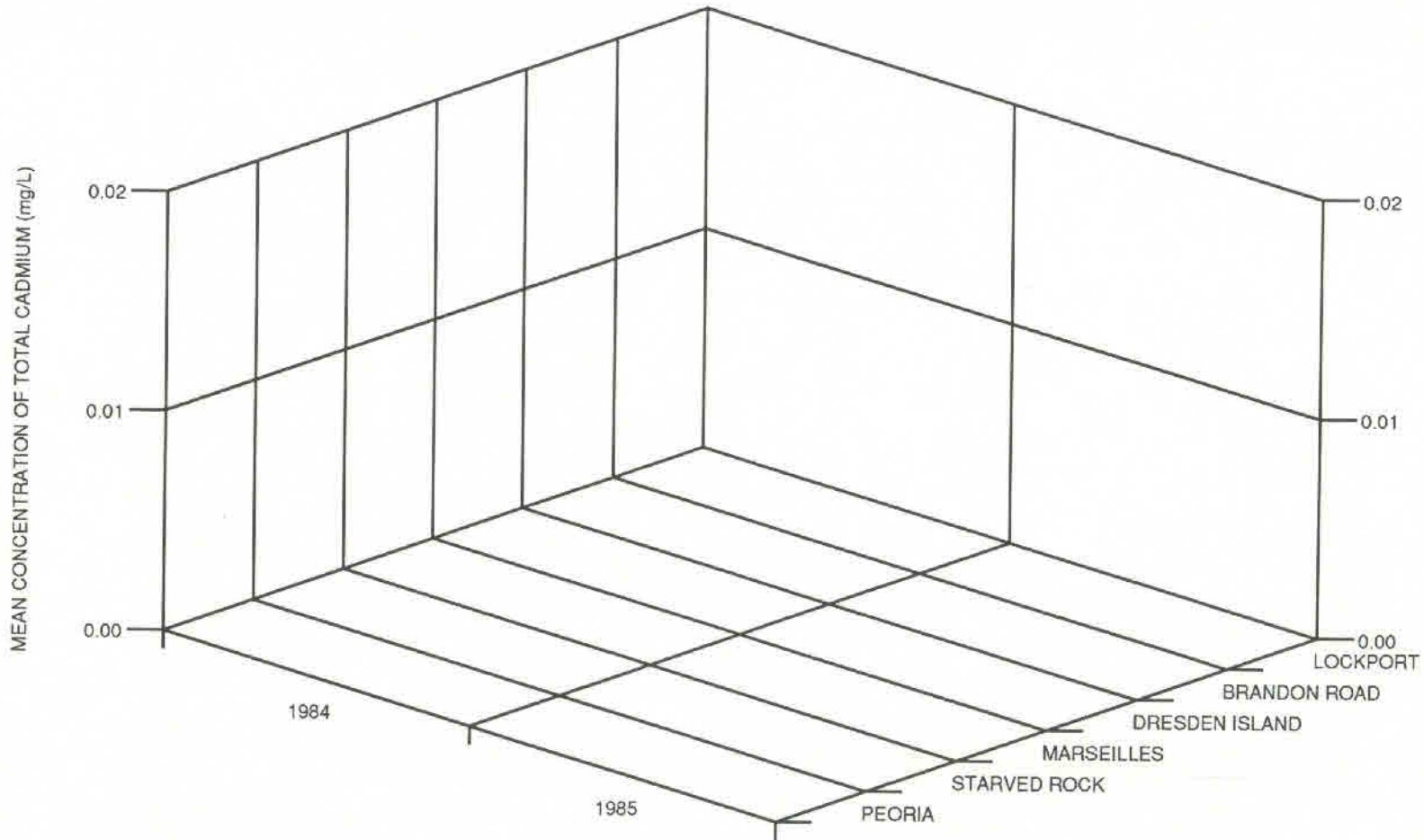
COMPARISON OF THE MEAN CONCENTRATION OF TOTAL ARSENIC IN WATER ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT POOL TO THE PEORIA POOL DURING 1984 AND 1985



METROPOLITAN WATER RECALAMATION DISTRICT OF GREATER CHICAGO

FIGURE 14

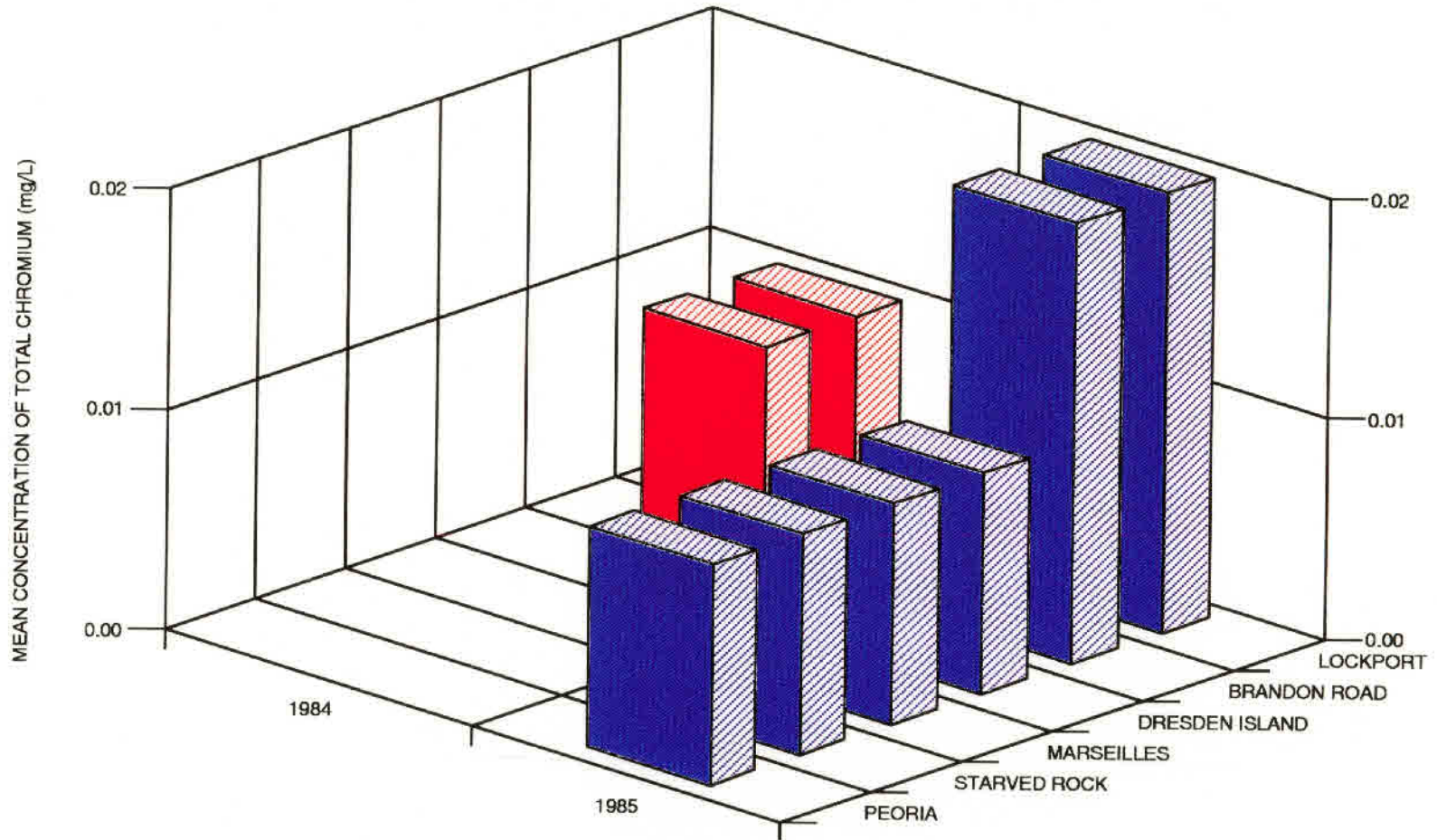
COMPARISON OF THE MEAN CONCENTRATION OF TOTAL CADMIUM IN WATER ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT POOL TO THE PEORIA POOL DURING 1984 AND 1985



METROPOLITAN WATER RECALAMATION DISTRICT OF GREATER CHICAGO

FIGURE 15

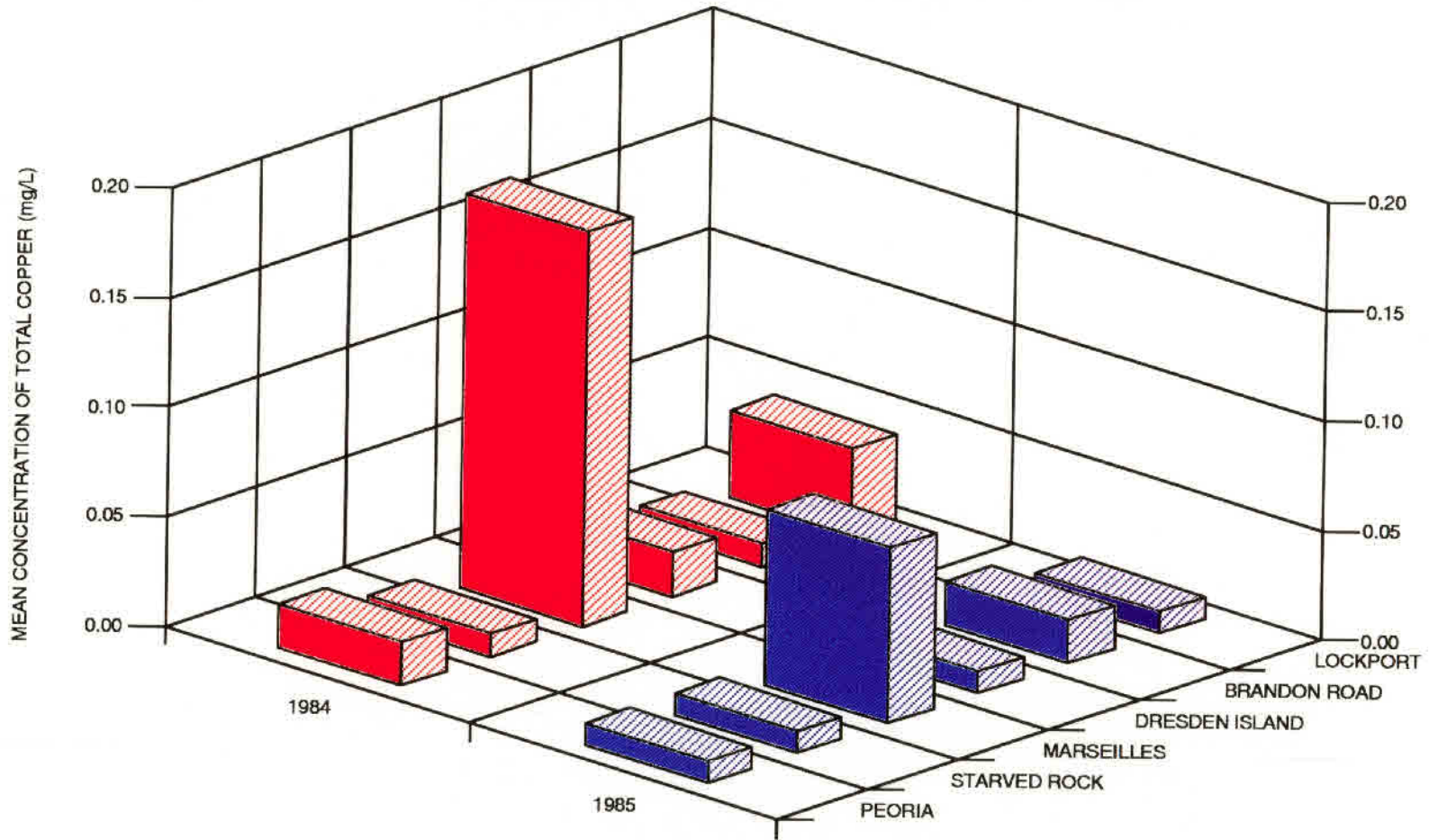
COMPARISON OF THE MEAN CONCENTRATION OF TOTAL CHROMIUM IN WATER ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT POOL TO THE PEORIA POOL DURING 1984 AND 1985



METROPOLITAN WATER RECALAMATION DISTRICT OF GREATER CHICAGO

FIGURE 16

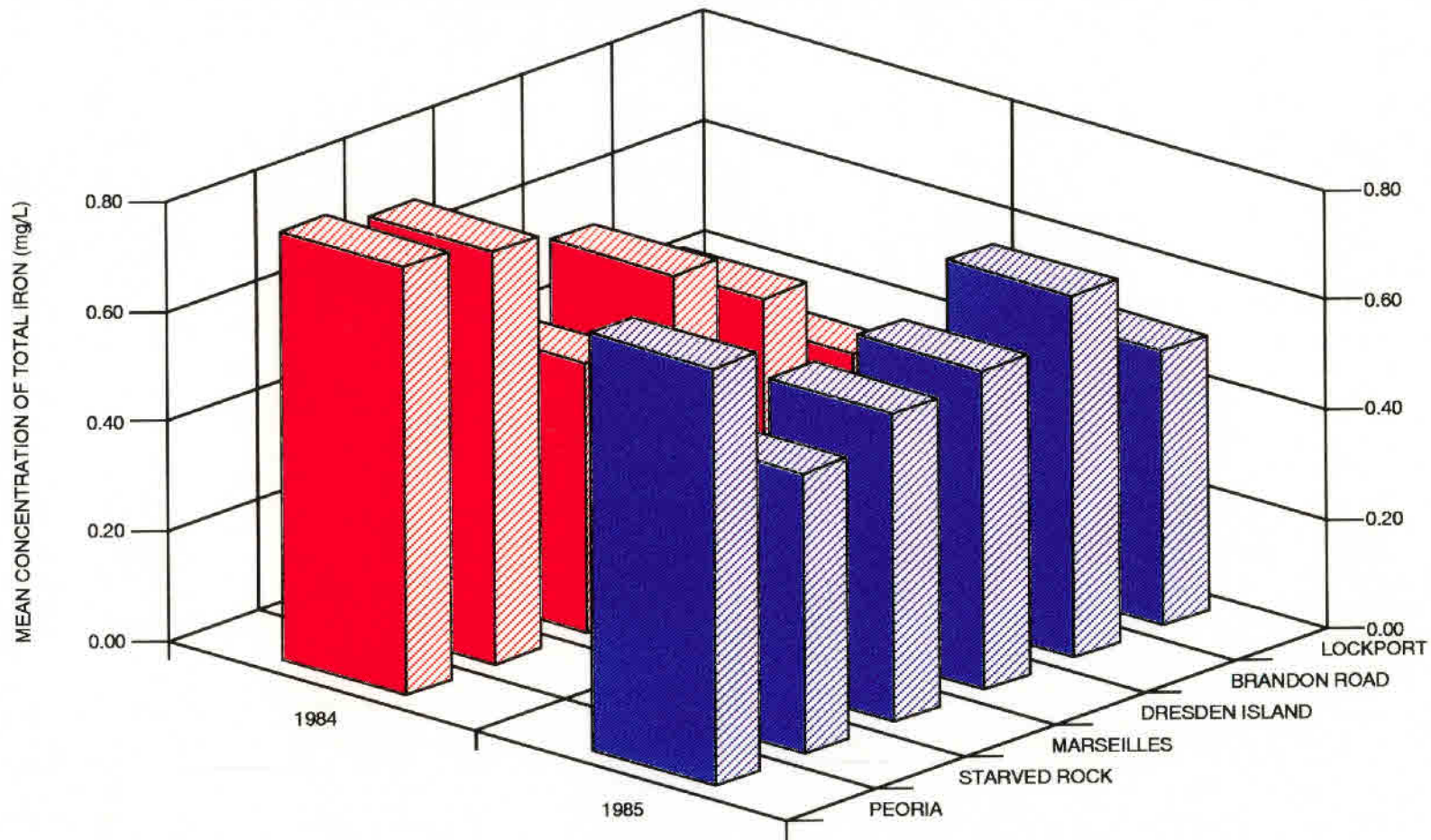
COMPARISON OF THE MEAN CONCENTRATION OF TOTAL COPPER IN WATER ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT POOL TO THE PEORIA POOL DURING 1984 AND 1985



METROPOLITAN WATER RECALAMATION DISTRICT OF GREATER CHICAGO

FIGURE 17

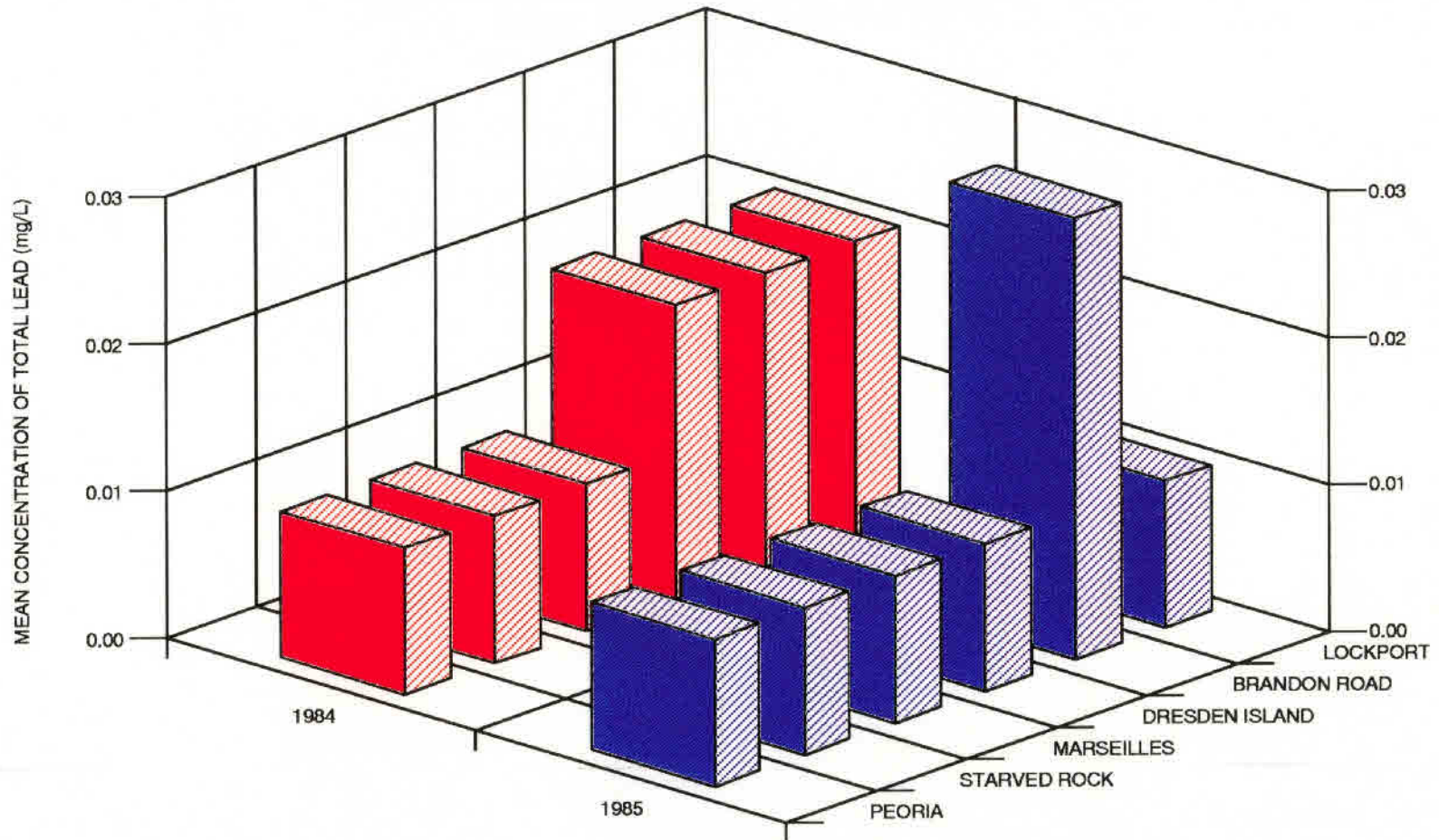
COMPARISON OF THE MEAN CONCENTRATION OF TOTAL IRON IN WATER ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT POOL TO THE PEORIA POOL DURING 1984 AND 1985



METROPOLITAN WATER RECALAMATION DISTRICT OF GREATER CHICAGO

FIGURE 18

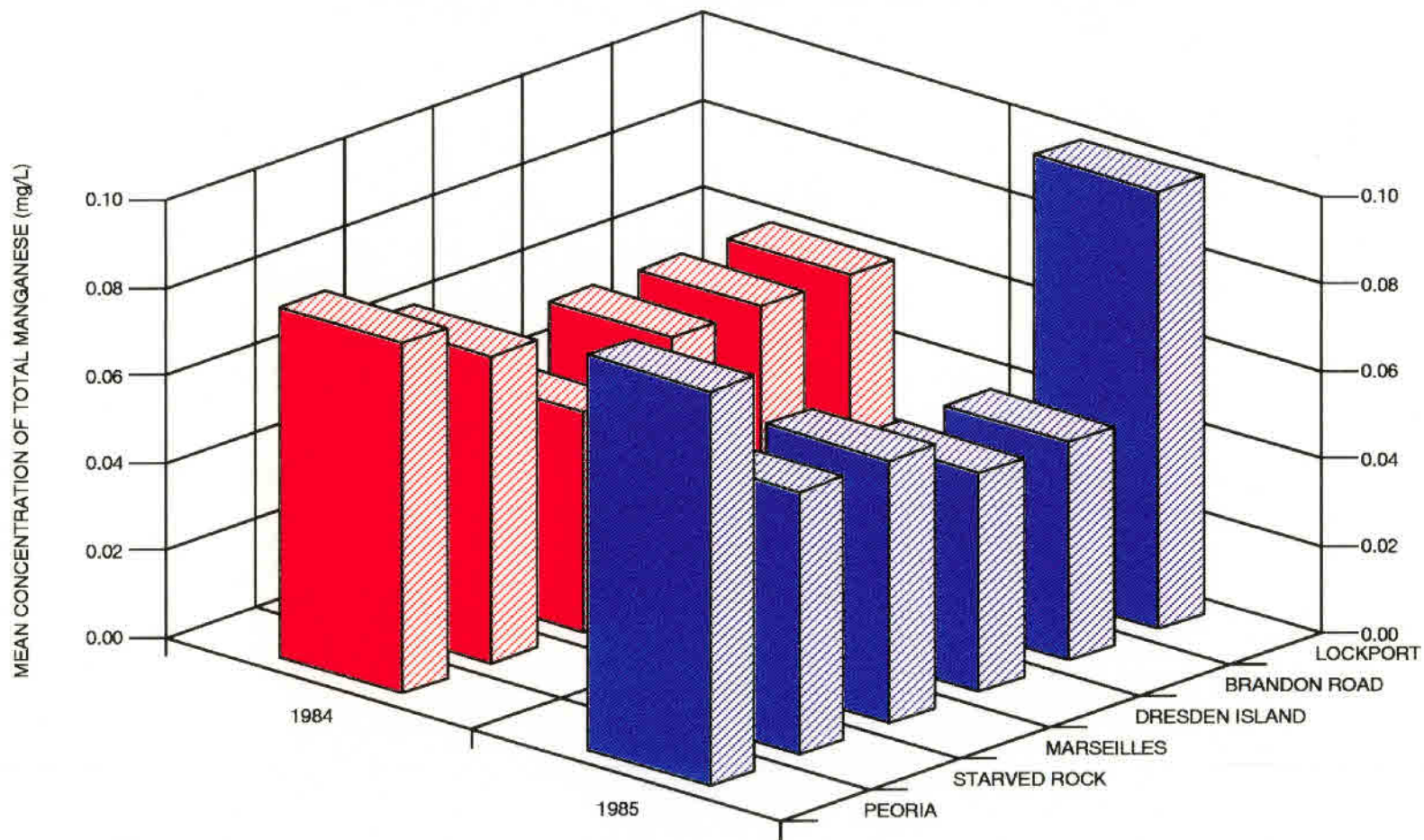
COMPARISON OF THE MEAN CONCENTRATION OF TOTAL LEAD IN WATER ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT POOL TO THE PEORIA POOL DURING 1984 AND 1985



METROPOLITAN WATER RECALAMATION DISTRICT OF GREATER CHICAGO

FIGURE 19

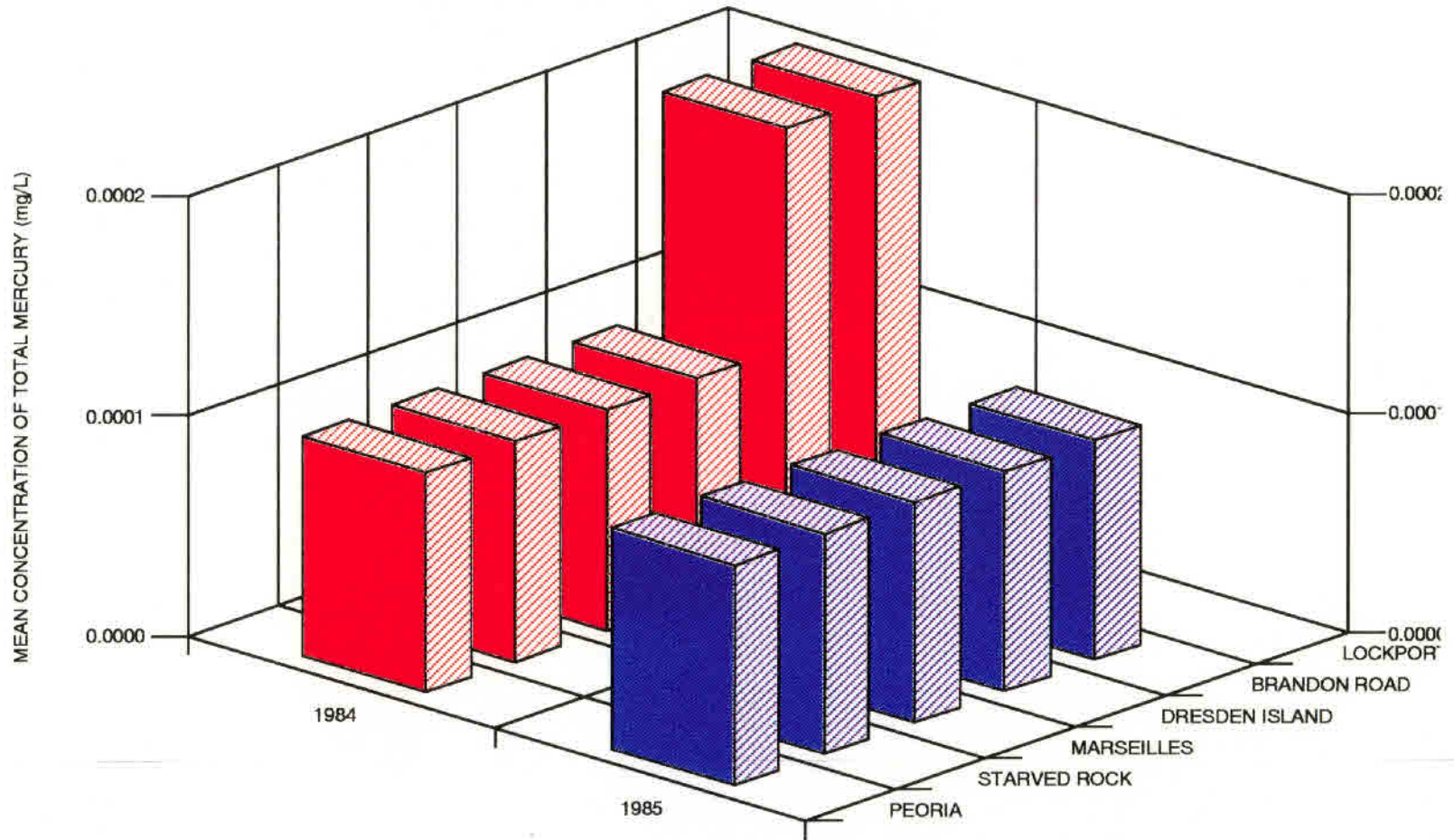
COMPARISON OF THE MEAN CONCENTRATION OF TOTAL MANGANESE IN WATER ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT POOL TO THE PEORIA POOL DURING 1984 AND 1985



METROPOLITAN WATER RECALAMATION DISTRICT OF GREATER CHICAGO

FIGURE 20

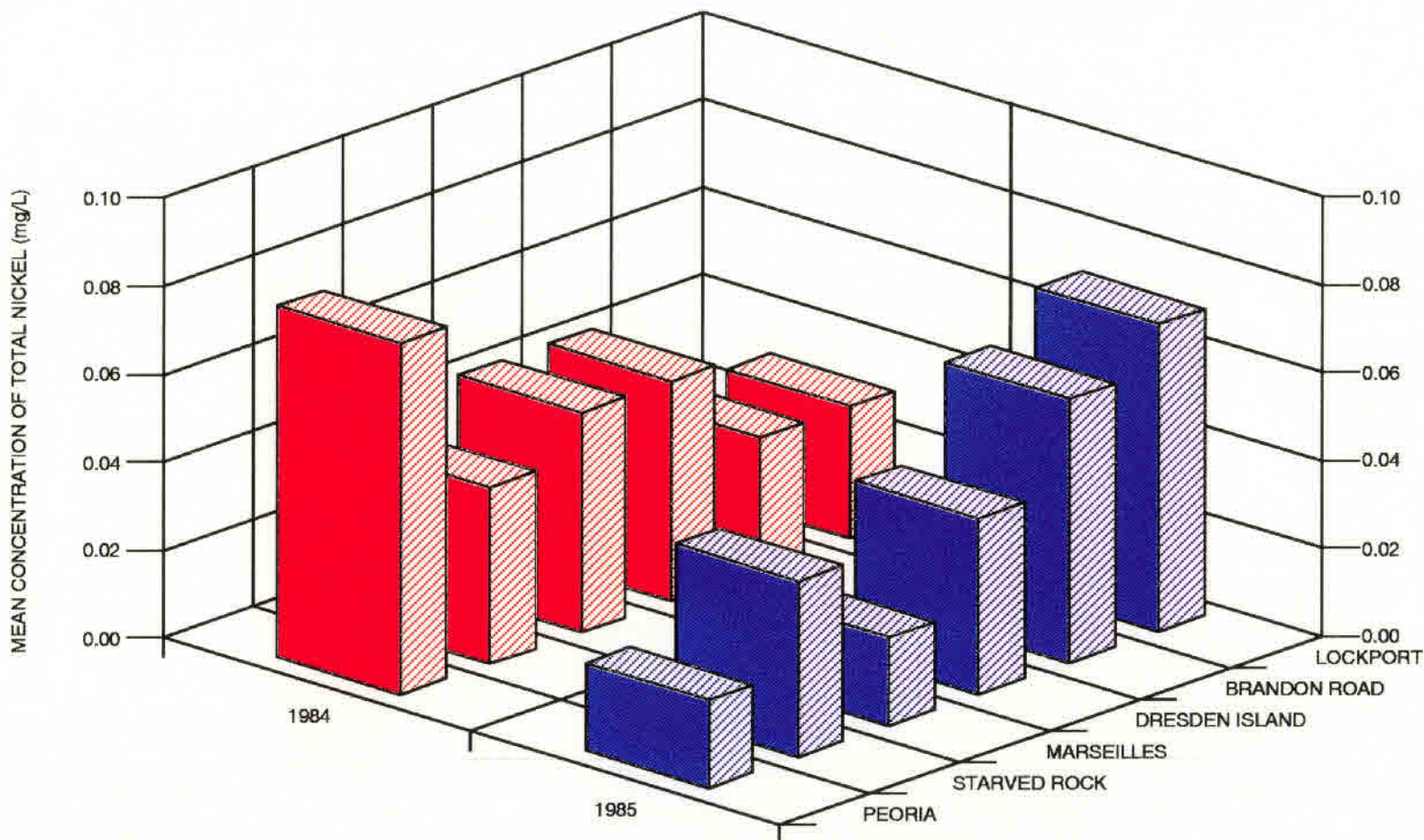
COMPARISON OF THE MEAN CONCENTRATION OF TOTAL MERCURY IN WATER ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT POOL TO THE PEORIA POOL DURING 1984 AND 1985



METROPOLITAN WATER RECALAMATION DISTRICT OF GREATER CHICAGO

FIGURE 21

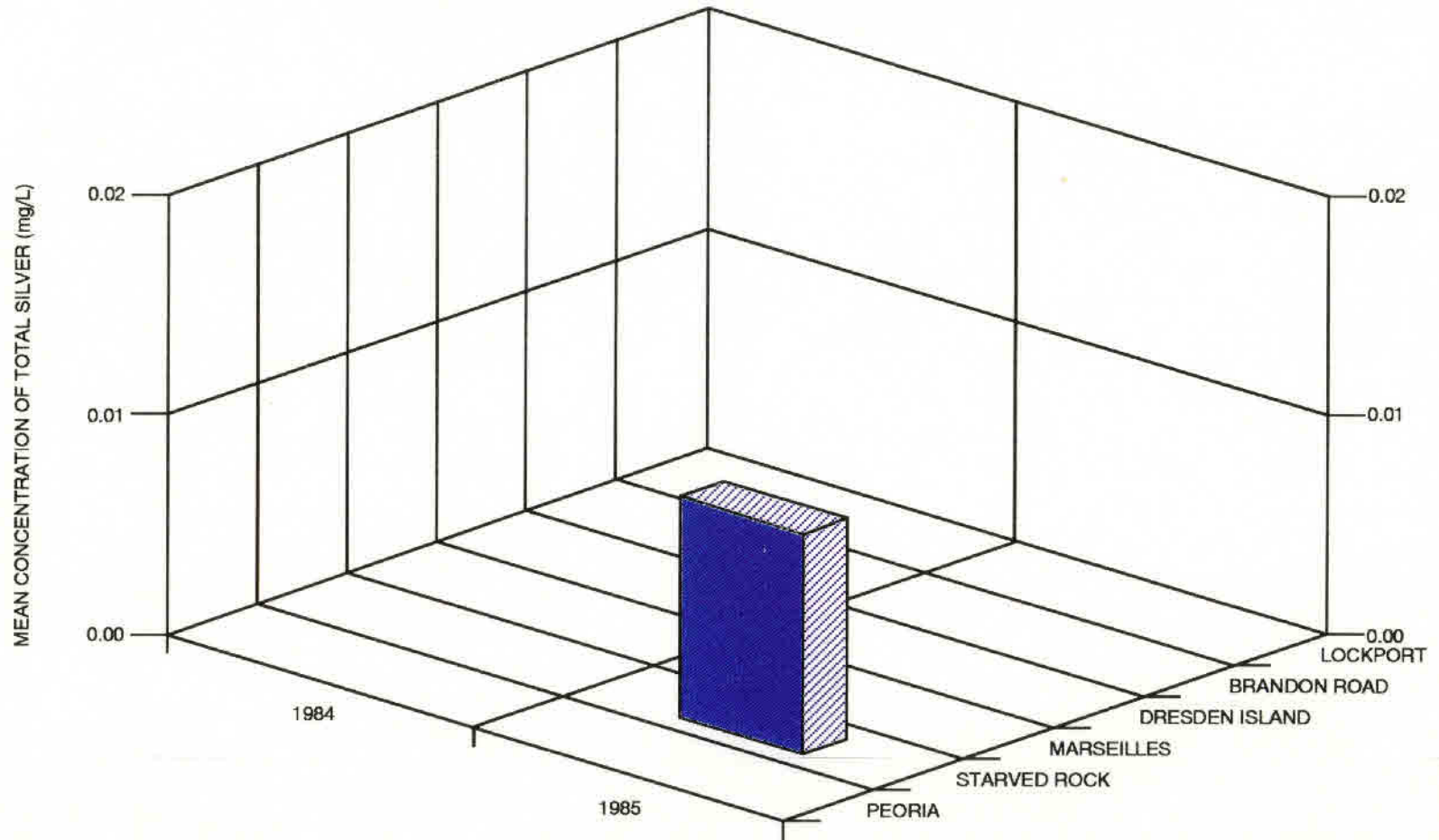
COMPARISON OF THE MEAN CONCENTRATION OF TOTAL NICKEL IN WATER ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT POOL TO THE PEORIA POOL DURING 1984 AND 1985



METROPOLITAN WATER RECALAMATION DISTRICT OF GREATER CHICAGO

FIGURE 22

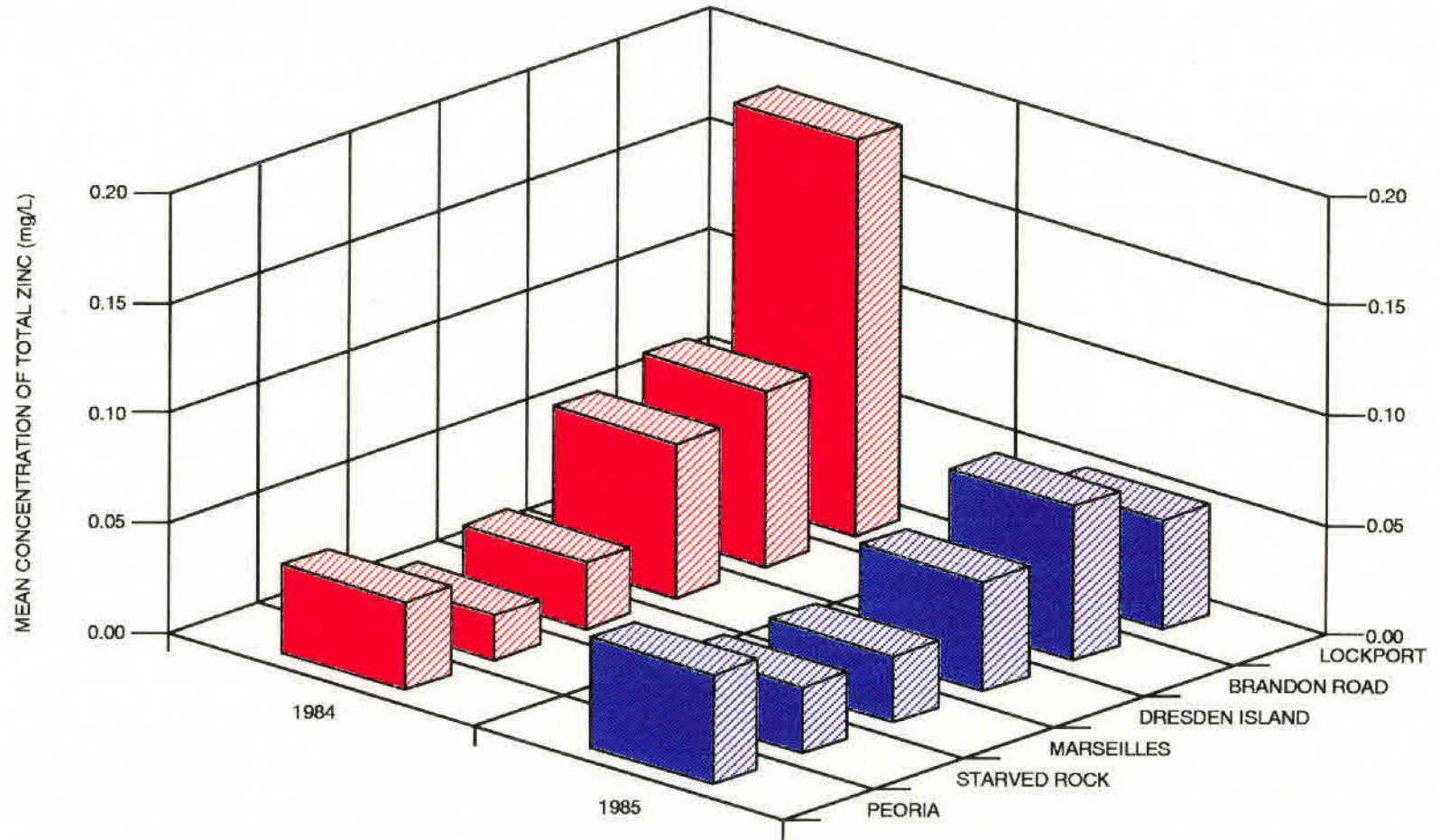
COMPARISON OF THE MEAN CONCENTRATION OF TOTAL SILVER IN WATER ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT POOL TO THE PEORIA POOL DURING 1984 AND 1985

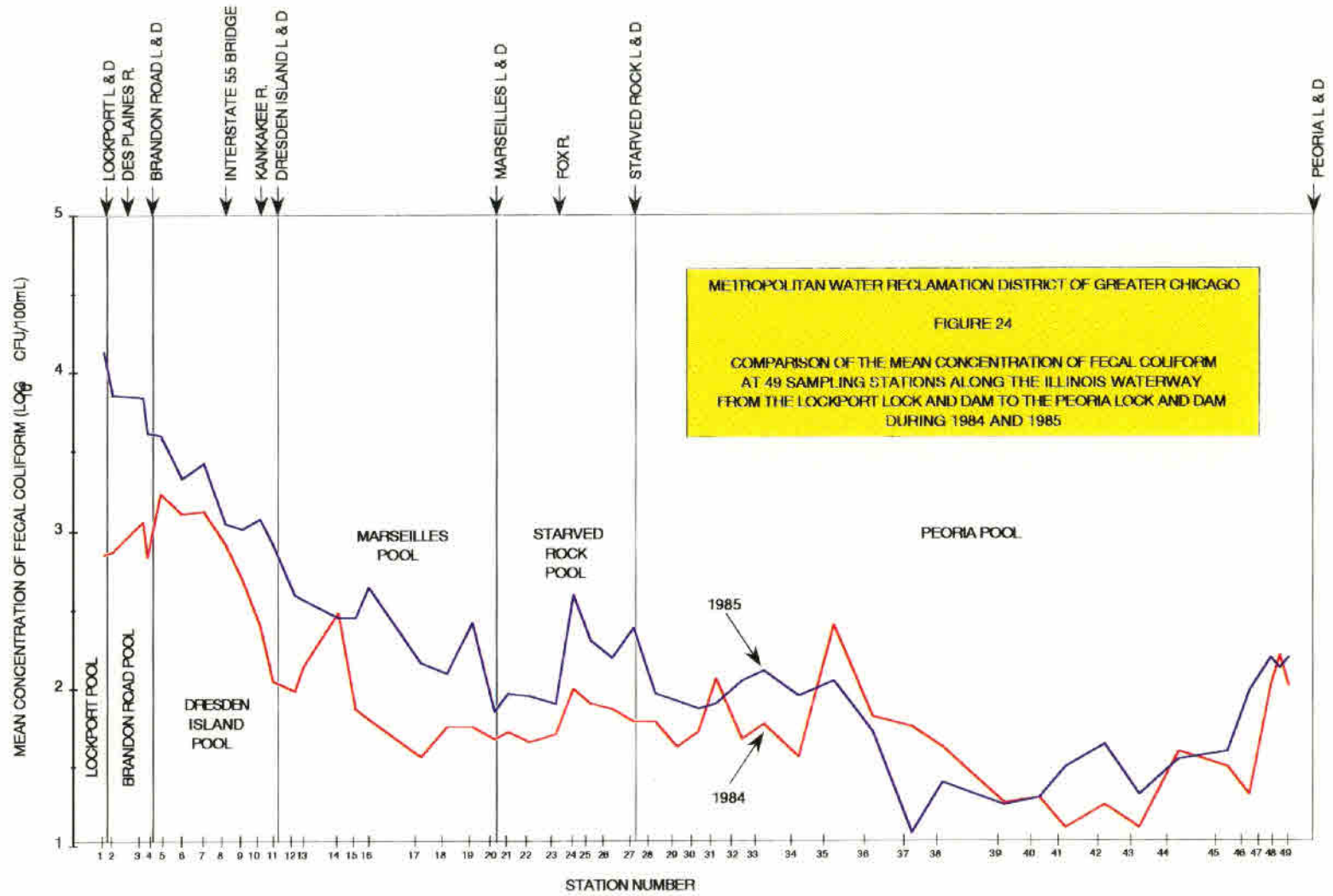


METROPOLITAN WATER RECALAMATION DISTRICT OF GREATER CHICAGO

FIGURE 23

COMPARISON OF THE MEAN CONCENTRATION OF TOTAL ZINC IN WATER ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT POOL TO THE PEORIA POOL DURING 1984 AND 1985





these materials are toxic to aquatic organisms when present in elevated concentrations. These wastes may include trace metals and man-made organic products such as pesticides, herbicides, polychlorinated biphenyls, polycyclic aromatic hydrocarbons, and many other industrial organic compounds. Even though such materials are discharged at subtoxic levels, many are capable of being concentrated in successive steps in aquatic food chains through a process called biological magnification.

1984

Total and Volatile Solids. In October of 1984, the total solids in sediments varied from a low of 46.1% at Station 38 in the Peoria pool to a high of 80.9% at Station 28, also in the Peoria pool. Volatile solids also varied considerably ranging from 0.9% at Station 32 in the Peoria pool to 16.4% at Station 1 in the Lockport pool. No clear trends were discernible in 1984 along the Illinois Waterway for total and volatile solids in sediment (Table 7).

Chemical Oxygen Demand. The concentration of COD in bottom sediments during the October 1984 survey was quite variable among the 14 sampling stations ranging from a low of 1,420 mg/kg at Station 23 in the Starved Rock pool to a high of 176,636 mg/kg at Station 1 in the Lockport pool. Generally, COD in sediments decreased from Station 1 (176,636 mg/kg) just above the Lockport Lock and Dam to Station 35 (14,762 mg/kg) in the middle portion of the Peoria pool, and then increased in

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 7

CHEMICAL CHARACTERISTICS OF SEDIMENT COLLECTED FROM THE LOCKPORT, BRANDON ROAD, DRESDEN ISLAND, MARSEILLES, STARVED ROCK, AND PEORIA POOLS OF THE ILLINOIS WATERWAY, OCTOBER 1984

Station Number	Navigational Pool	Constituents (Expressed on a dry weight basis)						
		Total Solids (%)	Total Volatile Solids (%)	Chemical Oxygen Demand (mg/kg)	Total Kjeldahl Nitrogen (mg/kg)	Total Cyanides (mg/kg)	Phenol (mg/kg)	Fats, Oils and Greases (mg/kg)
1	Lockport	52.3	16.4	176,636	NS	0.51	NS	6,012
2	Brandon Road	53.2	8.5	134,344	NS	0.91	NS	10,942
5	Dresden Island	75.2	3.5	24,686	NS	0.14	NS	10,341
8	Dresden Island	68.8	3.4	68,710	NS	0.15	NS	851
12	Marseilles	74.1	9.5	9,576	NS	0.08	NS	214
18	Marseilles	51.9	3.3	98,168	NS	0.55	NS	834
23	Starved Rock	77.6	6.1	1,420	NS	0.10	NS	59
28	Peoria	80.7	2.3	16,108	NS	0.06	NS	304
32	Peoria	76.6	0.9	8,379	NS	0.01	NS	99
35	Peoria	66.7	2.4	14,762	NS	0.04	NS	76
38	Peoria	46.1	7.2	68,418	NS	0.15	NS	362

Table continued on following page.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 7 (CONTINUED)

CHEMICAL CHARACTERISTICS OF SEDIMENT COLLECTED FROM THE LOCKPORT, BRANDON ROAD, DRESDEN ISLAND, MARSEILLES, STARVED ROCK, AND PEORIA POOLS OF THE ILLINOIS WATERWAY, OCTOBER 1984

Station Number	Navigational Pool	Constituents (Expressed on a dry weight basis)						
		Total Solids (%)	Total Volatile Solids (%)	Chemical Oxygen Demand (mg/kg)	Total Kjeldahl Nitrogen (mg/kg)	Total Cyanides (mg/kg)	Phenol (mg/kg)	Fats, Oils and Greases (mg/kg)
41	Peoria	74.6	1.5	54,760	NS	0.08	NS	115
44	Peoria	50.8	6.5	62,596	NS	0.09	NS	269
48	Peoria	80.7	2.5	54,019	NS	0.08	NS	470

NS = No sample.

concentration along the waterway to the Peoria Lock and Dam, Station 48 (54,019 mg/kg).

Total Kjeldahl Nitrogen. Total Kjeldahl nitrogen was not measured in sediments during the 1984 survey.

Total Cyanides. The range of values for total cyanides in sediments during the October 1984 survey were from 0.01 mg/kg at Station 32 in the Peoria pool to 0.91 mg/kg at Station 2 in the Brandon Road pool. Total cyanides decreased in concentration in bottom sediments down the Illinois Waterway from Station 1 in the Lockport pool (0.51 mg/kg) to Station 48 in the Peoria pool (0.08 mg/kg).

Phenols. Phenols were not measured in sediment during 1984.

Fats, Oils and Greases. The concentration of FOG in sediments was quite variable during October of 1984 among the 14 sampling stations ranging from a minimum value of 59 mg/kg at Station 23 in the Starved Rock pool to a maximum value of 10,942 mg/kg at Station 2 in the Brandon Road pool. FOG decreased in concentration in the sediments along the waterway from Station 2 in the Brandon Road pool (10,942 mg/kg) to Station 48 in the Peoria pool (470 mg/kg).

Trace Metals. Although many surface water quality surveys have included trace metal analysis, it is only recently that the distribution and concentration of trace metals in sediments has been investigated. A total of 11 trace metals were measured in

bottom sediments during the 1984 survey, including arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc.

While the concentration of trace metals in the sediments was quite variable among the 14 sampling stations, significantly higher levels of seven trace metals (cadmium, chromium, copper, lead, mercury, nickel, and zinc) were evident in the sediments collected during the 1984 survey from the Lockport (Station 1) and Brandon Road (Station 2) navigational pools compared to the Dresden Island, Marseilles, Starved Rock, and Peoria pool (Table 8). There was little variation in the concentration of arsenic and silver in sediments along the Illinois Waterway.

1985

Total and Volatile Solids. In October 1985, the total solids in sediments varied from a low of 48.2% at Station 41 in the Peoria pool to a high of 84.0% at Station 23 in the Starved Rock pool. Volatile solids also varied considerably ranging from 0.6% at Station 32 in the Peoria pool to 10.1% at Station 1 in the Lockport pool. No clear trends were discernible in 1985 along the Illinois Waterway for total and volatile solids in sediment (Table 9).

Chemical Oxygen Demand. The concentration of COD in bottom sediments during the October 1985 survey was quite variable among the 14 sampling stations ranging from a low of 5,179 mg/kg at Station 23 in the Starved Rock pool to a high of 180,979

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 8

TRACE METALS IN SEDIMENTS COLLECTED FROM THE LOCKPORT, BRANDON ROAD, DRESDEN ISLAND, MARSEILLES,
STARVED ROCK, AND PEORIA POOLS OF THE ILLINOIS WATERWAY,
OCTOBER 1984¹

Station Number	Navigational Pool	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Silver	Zinc
1	Lockport	<1	17	157	161	24,867	182	315	7.55	153	13	707
2	Brandon Road	<1	27	263	226	25,602	299	408	4.92	216	2	1,595
5	Dresden Island	<1	4	23	37	10,598	66	257	<0.02	66	3	199
8	Dresden Island	<1	4	28	38	10,654	38	237	<0.02	73	4	262
12	Marseilles	<1	4	9	14	6,221	16	181	<0.02	27	1	68
18	Marseilles	<1	5	48	50	8,555	52	328	1.22	347	2	218
23	Starved Rock	<1	1	5	4	3,273	5	95	0.09	13	<1	39
28	Peoria	<1	2	9	14	13,866	14	853	<0.02	50	5	87
32	Peoria	<1	1	5	5	5,300	9	162	<0.02	13	4	78
35	Peoria	<1	3	20	20	19,295	18	448	<0.02	45	5	105
38	Peoria	<1	6	43	54	22,603	56	642	0.34	65	4	304
41	Peoria	<1	3	7	7	6,300	2	332	<0.02	27	4	40
44	Peoria	<1	6	43	45	28,110	45	829	<0.02	59	10	236
48	Peoria	<1	2	6	7	6,580	40	328	<0.02	25	7	50

¹Expressed in mg/kg of dry sediments.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 9

CHEMICAL CHARACTERISTICS OF SEDIMENT COLLECTED FROM THE LOCKPORT, BRANDON ROAD, DRESDEN ISLAND, MARSEILLES, STARVED ROCK, AND PEORIA POOLS OF THE ILLINOIS WATERWAY, OCTOBER 1985

Station Number	Navigational Pool	Constituents (Expressed on a dry weight basis)						
		Total Solids (%)	Total Volatile Solids (%)	Chemical Oxygen Demand (mg/kg)	Total Kjeldahl Nitrogen (mg/kg)	Total Cyanides (mg/kg)	Phenol (mg/kg)	Fats, Oils and Greases (mg/kg)
1	Lockport	51.3	10.1	180,979	2,385	1.40	1.13	6,848
2	Brandon Road	NS	NS	NS	NS	NS	NS	NS
5	Dresden Island	73.9	2.9	19,147	260	0.37	<0.03	1,436
8	Dresden Island	75.2	2.9	30,677	360	0.27	<0.03	1,241
12	Marseilles	77.9	0.7	6,146	86	0.12	<0.03	603
18	Marseilles	83.4	0.8	6,148	88	0.11	<0.03	716
23	Starved Rock	84.0	1.4	5,179	35	0.07	<0.03	523
28	Peoria	72.7	3.0	22,489	166	0.11	<0.03	906
32	Peoria	81.5	0.6	6,873	37	0.05	<0.01	486
35	Peoria	78.0	2.0	20,368	174	0.17	<0.03	795
38	Peoria	61.9	5.5	84,956	978	0.55	<0.02	1,172

Table continued on following page.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 9 (CONTINUED)

CHEMICAL CHARACTERISTICS OF SEDIMENT COLLECTED FROM THE LOCKPORT, BRANDON ROAD, DRESDEN ISLAND, MARSEILLES, STARVED ROCK, AND PEORIA POOLS OF THE ILLINOIS WATERWAY, OCTOBER 1985

Station Number	Navigational Pool	Constituents (Expressed on a dry weight basis)						
		Total Solids (%)	Total Volatile Solids (%)	Chemical Oxygen Demand (mg/kg)	Total Kjeldahl Nitrogen (mg/kg)	Total Cyanides (mg/kg)	Phenol (mg/kg)	Fats, Oils and Greases (mg/kg)
41	Peoria	48.2	9.0	125,774	1,949	0.67	<0.02	1,495
44	Peoria	52.9	6.3	129,385	2,088	0.40	0.05	1,243
48	Peoria	72.2	2.7	101,596	1,043	0.24	0.02	839

NS = No sample.

mg/kg at Station 1 in the Lockport pool. Generally, COD in sediments decreased from Station 1 (180,975 mg/kg) just above the Lockport Lock and Dam to Station 35 (20,368 mg/kg) in the middle portion of the Peoria pool, and then increased in concentration along the waterway to the Peoria Lock and Dam, Station 48 (101,596 mg/kg).

Total Kjeldahl Nitrogen. The range of values of TKN in sediment for all 14 stations along the Illinois Waterway in 1985 were from 35 mg/kg at Station 23 in the Starved Rock pool to 2,385 mg/kg at Station 1 in the Lockport pool. The highest TKN values in sediment were found in the Lockport pool (Station 1) and lower portion of the Peoria pool (Stations 41, 44, and 48).

Total Cyanides. The range of values for total cyanides in sediments during the October 1985 survey were from 0.05 mg/kg at Station 32 in the Peoria pool to 1.40 mg/kg at Station 1 in the Lockport pool. Total cyanides decreased in concentration in bottom sediments down the Illinois Waterway from Station 1 in the Lockport pool (1.40 mg/kg) to Station 48 in the Peoria pool (0.24 mg/kg).

Phenols. During the 1985 survey, phenol concentrations in sediments were highest at Station 1 in the Lockport pool (1.13 mg/kg). All other sampling stations had concentrations of phenol less than 0.05 mg/kg (Table 9). Except for Station 1, there was little variation in the sediment phenol concentration along the Illinois Waterway.

Fats, Oils and Greases. The concentration of FOG in sediments was quite variable during October 1985 among the 14 sampling stations ranging from a minimum value of 486 mg/kg at Station 32 in the Peoria pool to a maximum value of 6,848 mg/kg at Station 1 in the Lockport pool. FOG decreased in concentration in the sediments along the waterway from Station 1 in the Lockport pool (6,848 mg/kg) to Station 48 in the Peoria pool (839 mg/kg).

Trace Metals. Eleven trace metals were measured in bottom sediments during the 1985 survey, including arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc.

While the concentration of trace metals in the sediments was quite variable among the 14 sampling stations, significantly higher levels of six trace metals (cadmium, chromium, copper, lead, nickel, and zinc) were evident in the sediments collected during the 1985 survey from the Lockport (Station 1) and Brandon Road (Station 2) navigational pools compared to the Dresden Island, Marseilles, Starved Rock, and Peoria pools (Table 10). The highest concentration of mercury was found in sediments from the middle and lower portions of the Peoria pool compared to navigational pools upstream. There was little variation in the concentration of arsenic and silver in sediments along the Illinois Waterway.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 10

TRACE METALS IN SEDIMENTS COLLECTED FROM THE LOCKPORT, BRANDON ROAD, DRESDEN ISLAND, MARSEILLES,
STARVED ROCK, AND PEORIA POOLS OF THE ILLINOIS WATERWAY,
OCTOBER 1985¹

Station Number	Navigational Pool	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Silver	Zinc
1	Lockport	<1	15	106	124	16862	90	322	0.20	94	<1	688
2	Brandon Road	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
5	Dresden Island	<1	7	37	39	9892	100	252	0.20	68	<1	311
8	Dresden Island	<1	3	23	20	10120	32	282	0.20	53	<1	253
12	Marseilles	<1	<1	8	<1	4660	14	136	0.24	13	<1	51
18	Marseilles	<1	<1	<1	<1	4089	<1	185	0.17	<1	<1	36
23	Starved Rock	<1	1	6	5	6060	1	194	0.09	24	<1	36
28	Peoria	<1	<1	7	36	6891	32	179	0.18	41	<1	69
32	Peoria	<1	<1	3	5	3558	9	122	0.13	12	<1	37
35	Peoria	<1	<1	4	3	7718	6	262	0.15	<1	<1	103
38	Peoria	<1	<1	23	26	15719	16	520	0.58	16	<1	226
41	Peoria	<1	2	27	31	20498	19	751	1.06	21	<1	311
44	Peoria	<1	<1	38	44	30435	8	756	0.76	38	<1	265
48	Peoria	<1	<1	14	14	13033	7	332	0.33	14	<1	97

¹Expressed in mg/kg of dry sediments.

COMPARISON OF THE SEDIMENT QUALITY BETWEEN 1984 AND 1985

Total Solids. Overall, the mean total solids values from the six navigational pools were similar both in 1984 and 1985 (Figure 25).

Total Volatile Solids. As shown in Figure 26, the mean percentage of total volatile solids in sediments was higher in 1984 (5.3 %) compared with 1985 (4.0 %).

Chemical Oxygen Demand. Between 1984 and 1985, COD in sediments was similar in concentration in the six navigational pools along the Illinois Waterway (Figure 27).

Total Cyanides. Compared to 1984 (0.21 mg/kg), the mean cyanide concentration increased slightly in the six navigational pools during 1985 (0.38 mg/kg) (Figure 28).

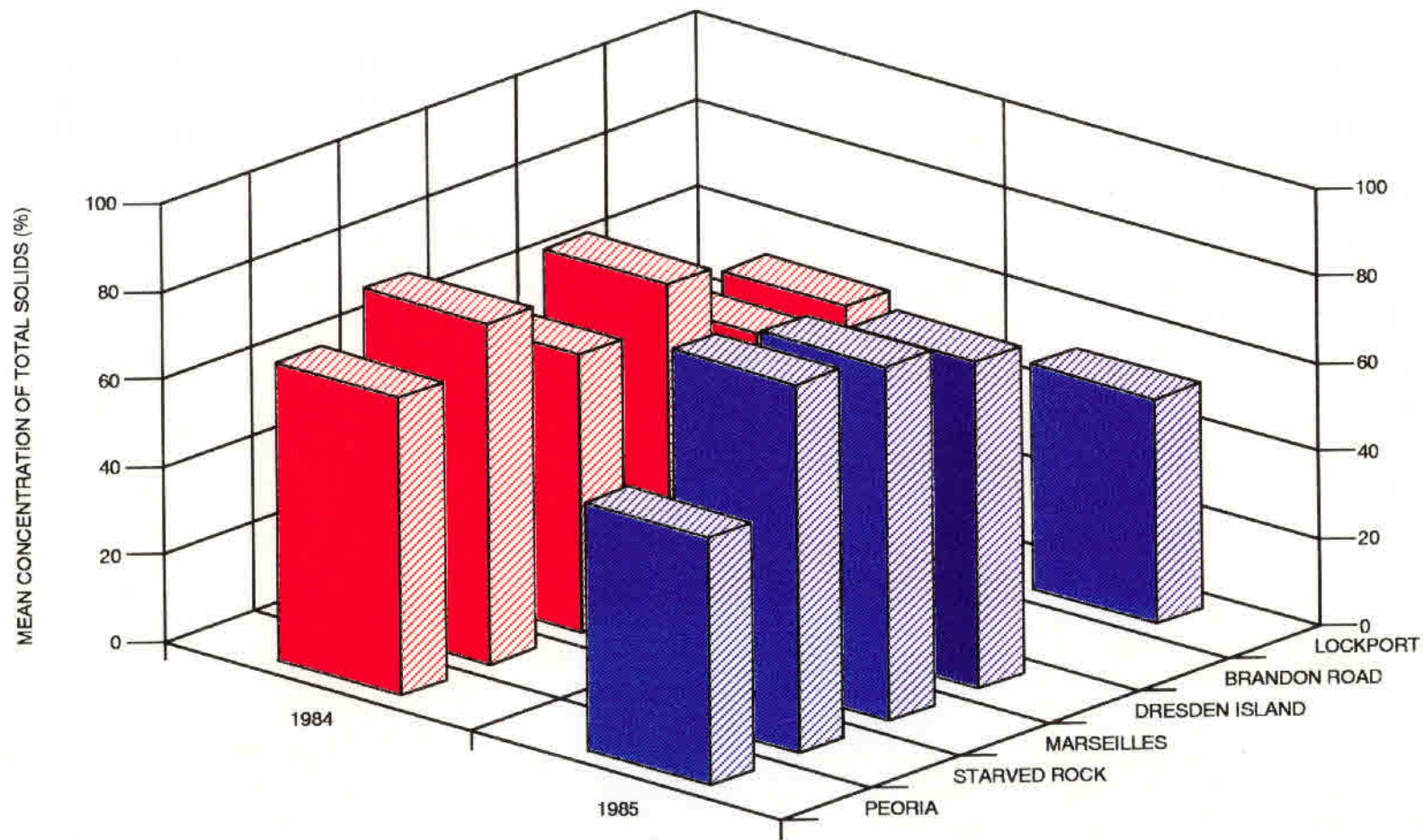
Fats, Oils and Greases. Between 1984 and 1985, there was little change in the mean value of FOG in sediments measured in the six navigational pools (Figure 29).

Trace Metals. Overall, the mean concentrations of the eleven trace metals in sediments surveyed at the 14 sampling stations along the Illinois Waterway were similar both in 1984 and 1985 (Figures 30-39).

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 25

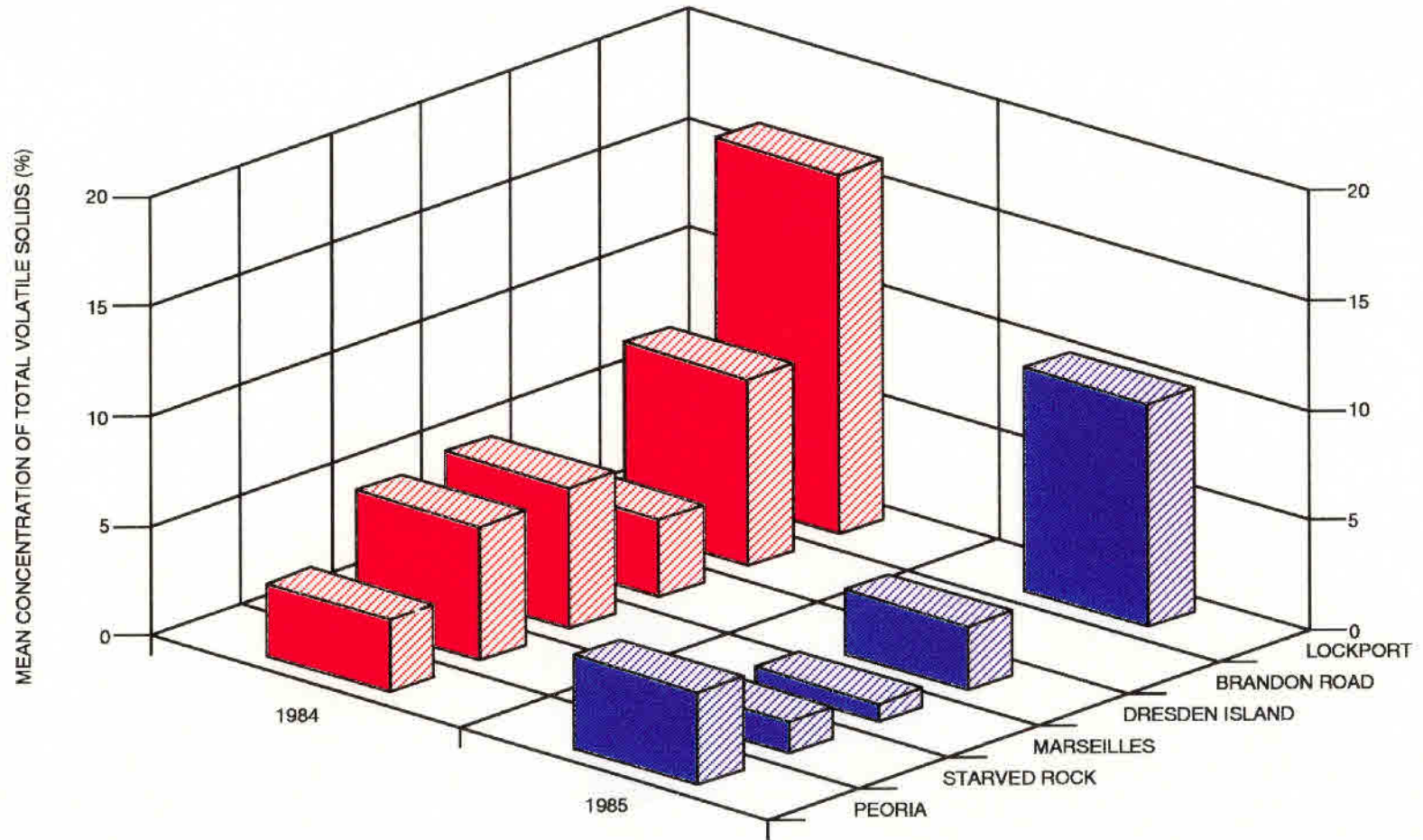
COMPARISON OF THE MEAN CONCENTRATION OF TOTAL SOLIDS IN SEDIMENT ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT POOL TO THE PEORIA POOL DURING 1984 AND 1985



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 26

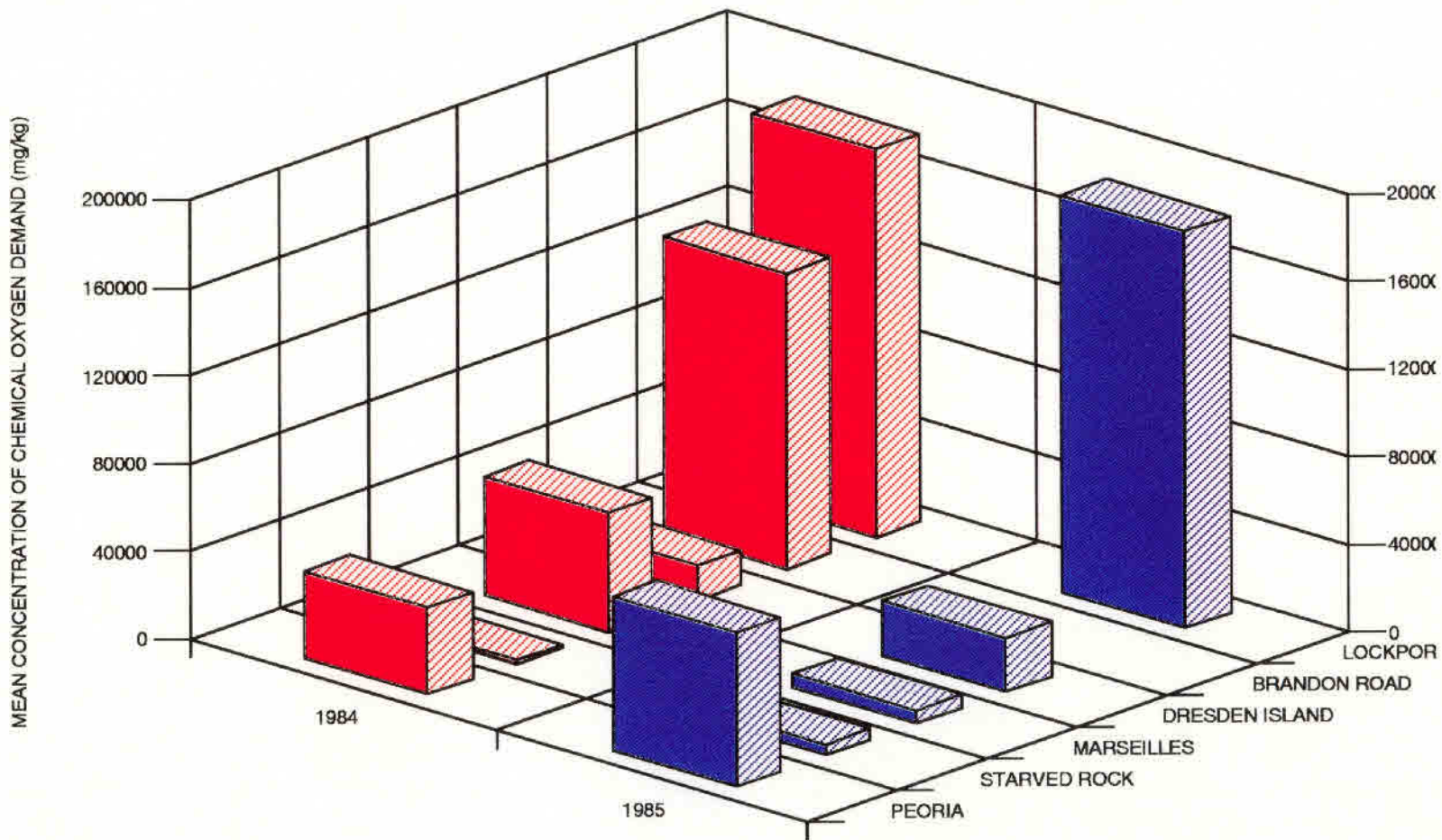
COMPARISON OF THE MEAN CONCENTRATION OF TOTAL VOLATILE SOLIDS IN SEDIMENT ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT POOL TO THE PEORIA POOL DURING 1984 AND 1985



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 27

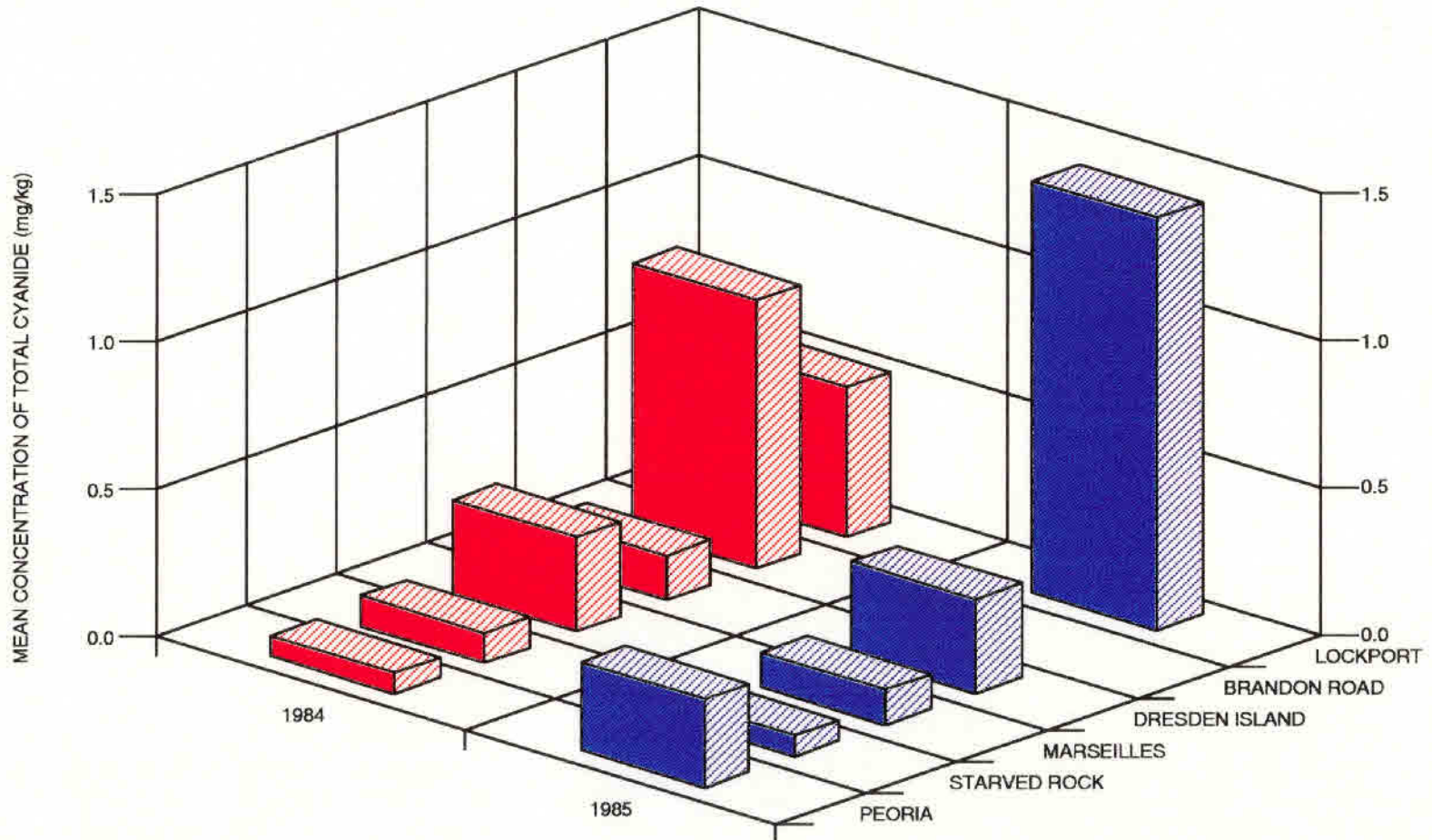
COMPARISON OF THE MEAN CONCENTRATION OF CHEMICAL OXYGEN DEMAND IN SEDIMENT ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT POOL TO THE PEORIA POOL DURING 1984 AND 1985



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 28

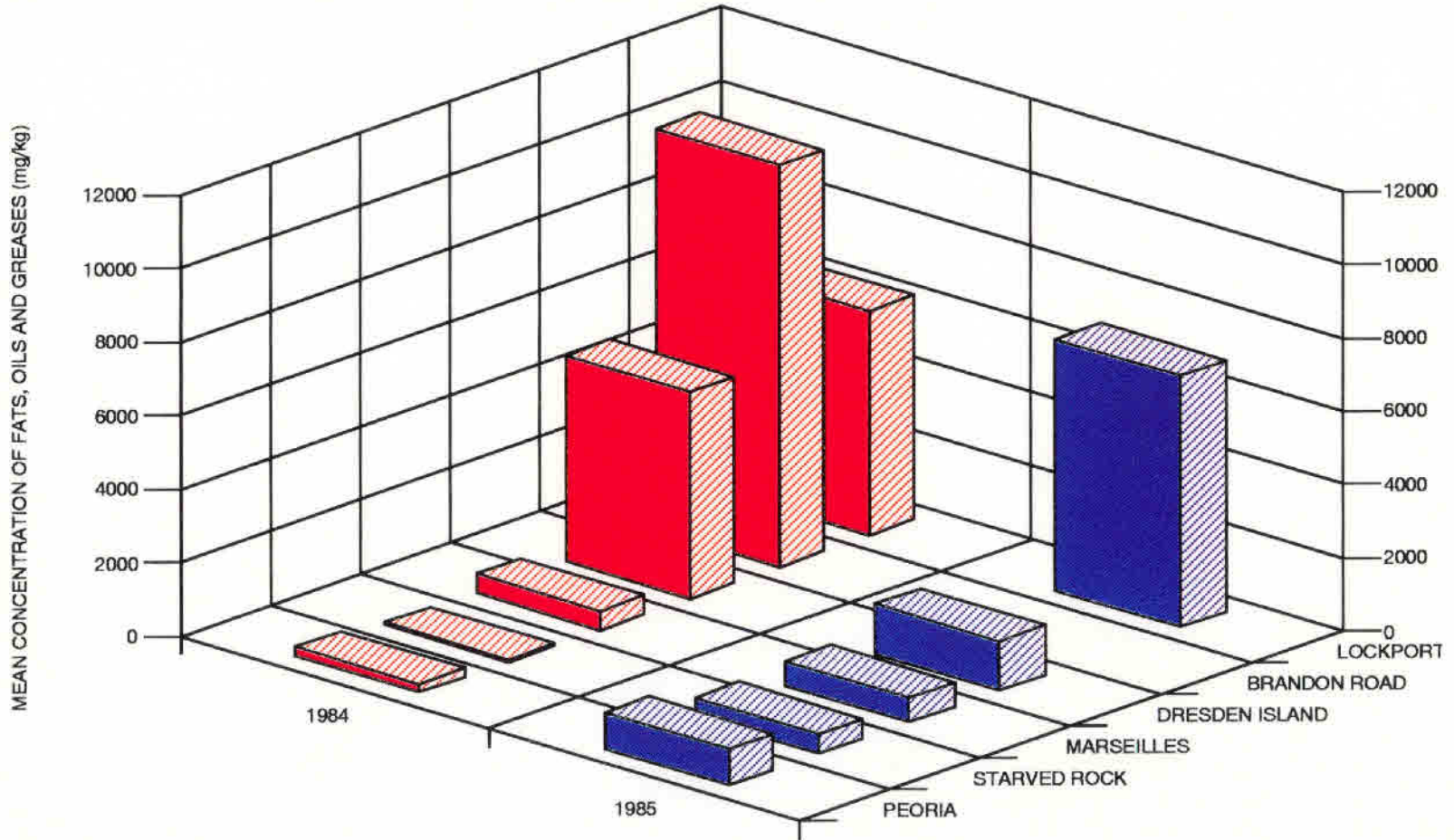
COMPARISON OF THE MEAN CONCENTRATION OF TOTAL CYANIDES IN SEDIMENT ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT POOL TO THE PEORIA POOL DURING 1984 AND 1985



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 29

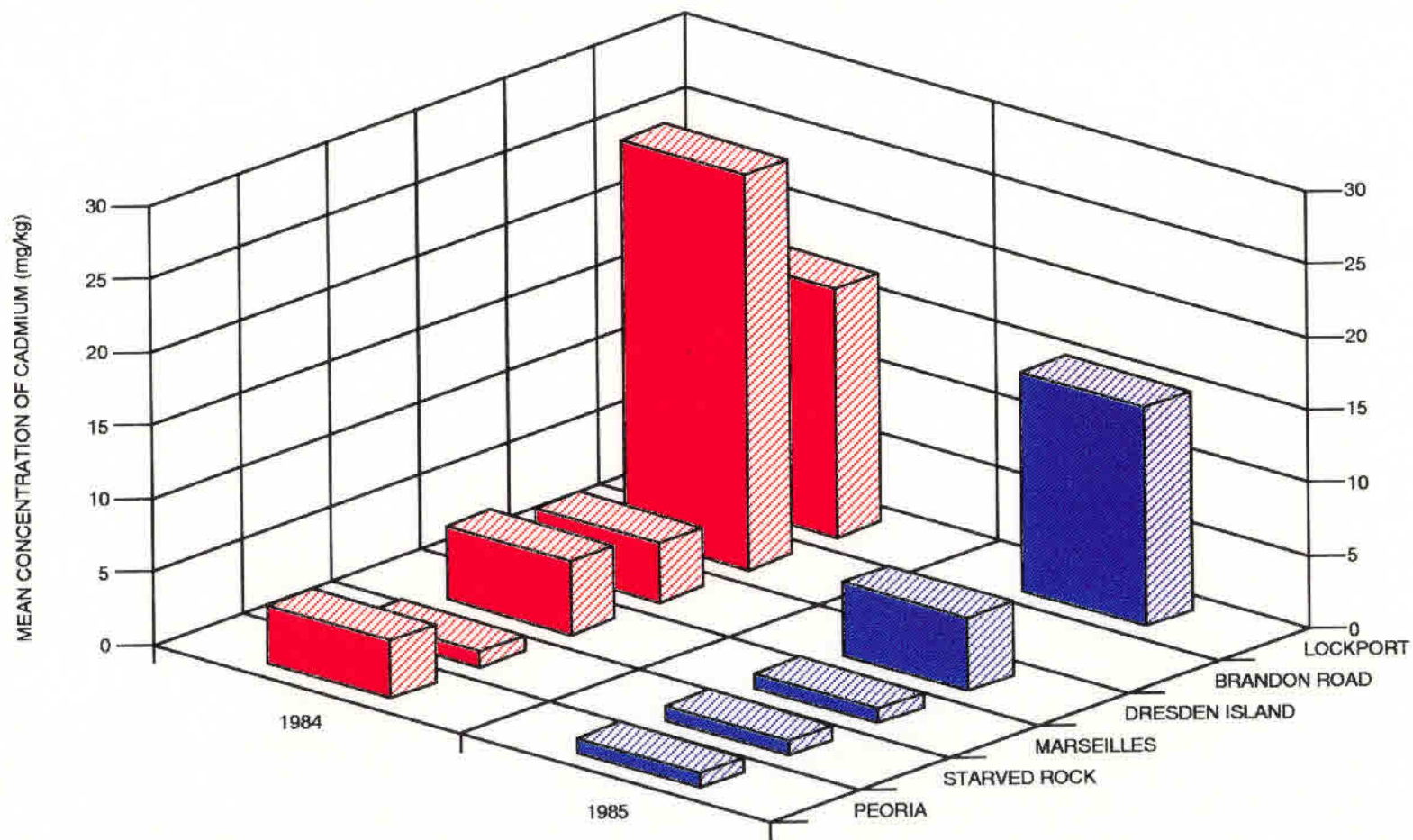
COMPARISON OF THE MEAN CONCENTRATION OF FATS, OILS AND GREASES IN SEDIMENT ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT POOL TO THE PEORIA POOL DURING 1984 AND 1985



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 30

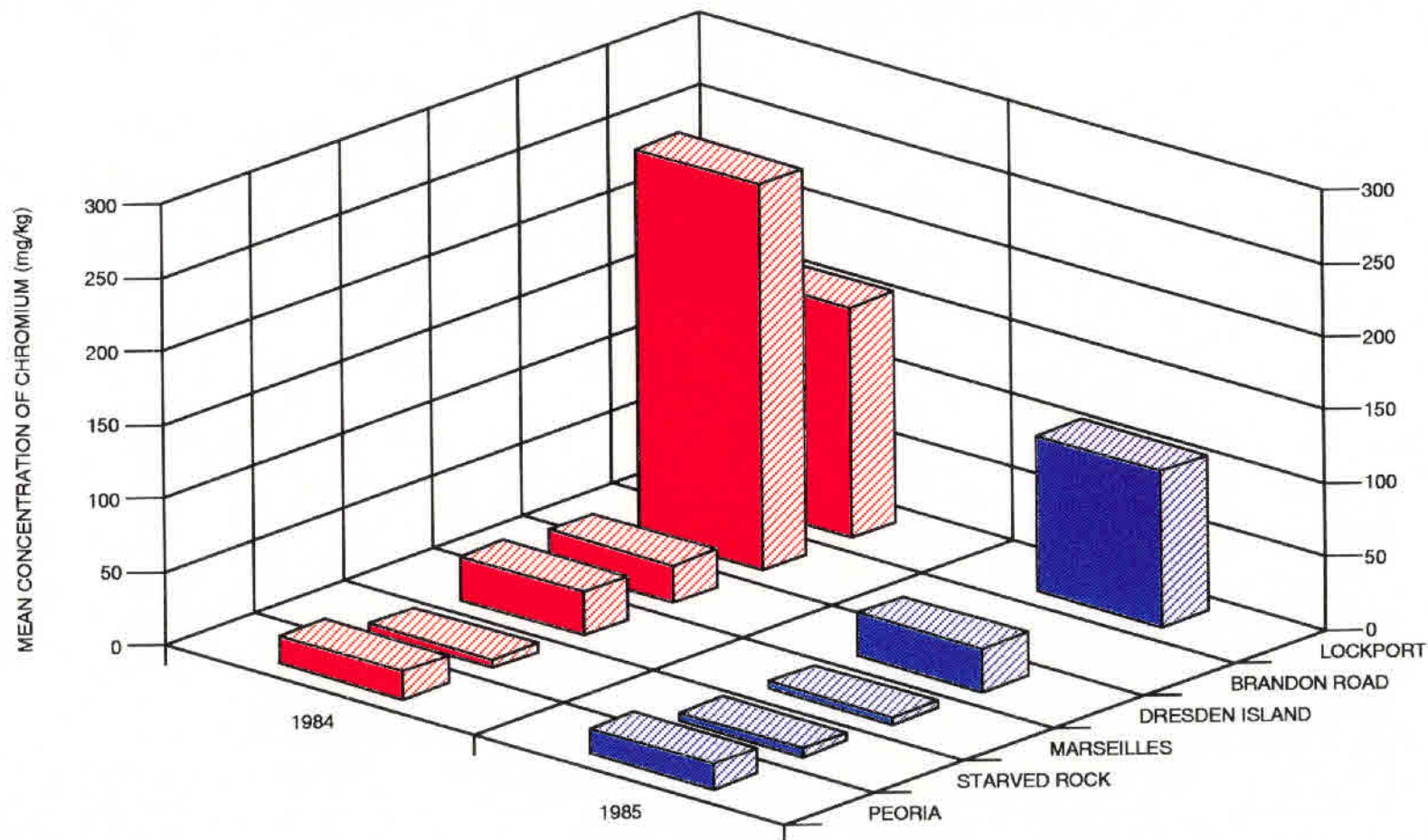
COMPARISON OF THE MEAN CONCENTRATION OF CADMIUM IN SEDIMENT ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT POOL TO THE PEORIA POOL DURING 1984 AND 1985



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 31

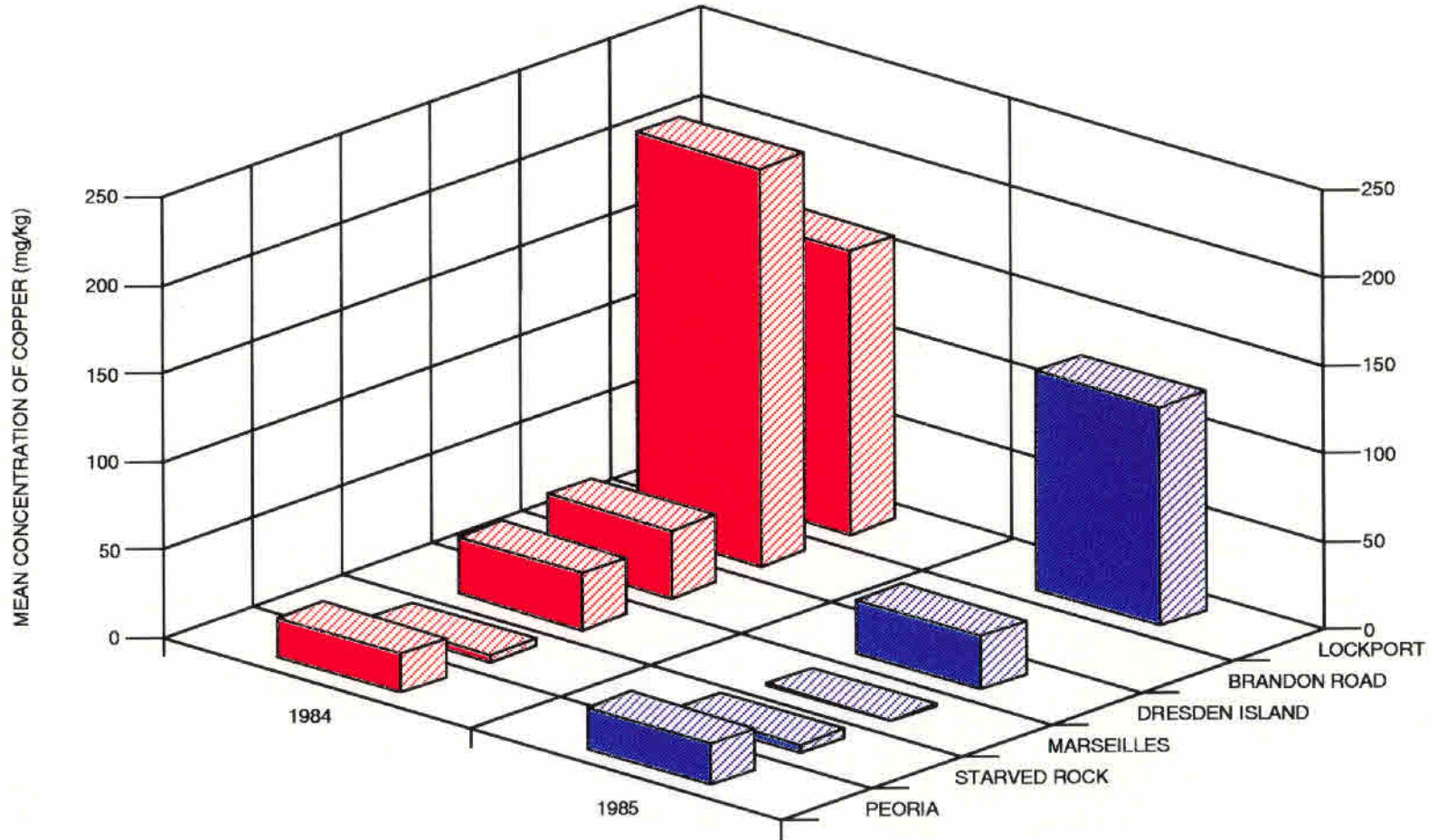
COMPARISON OF THE MEAN CONCENTRATION OF CHROMIUM IN SEDIMENT ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT POOL TO THE PEORIA POOL DURING 1984 AND 1985



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 32

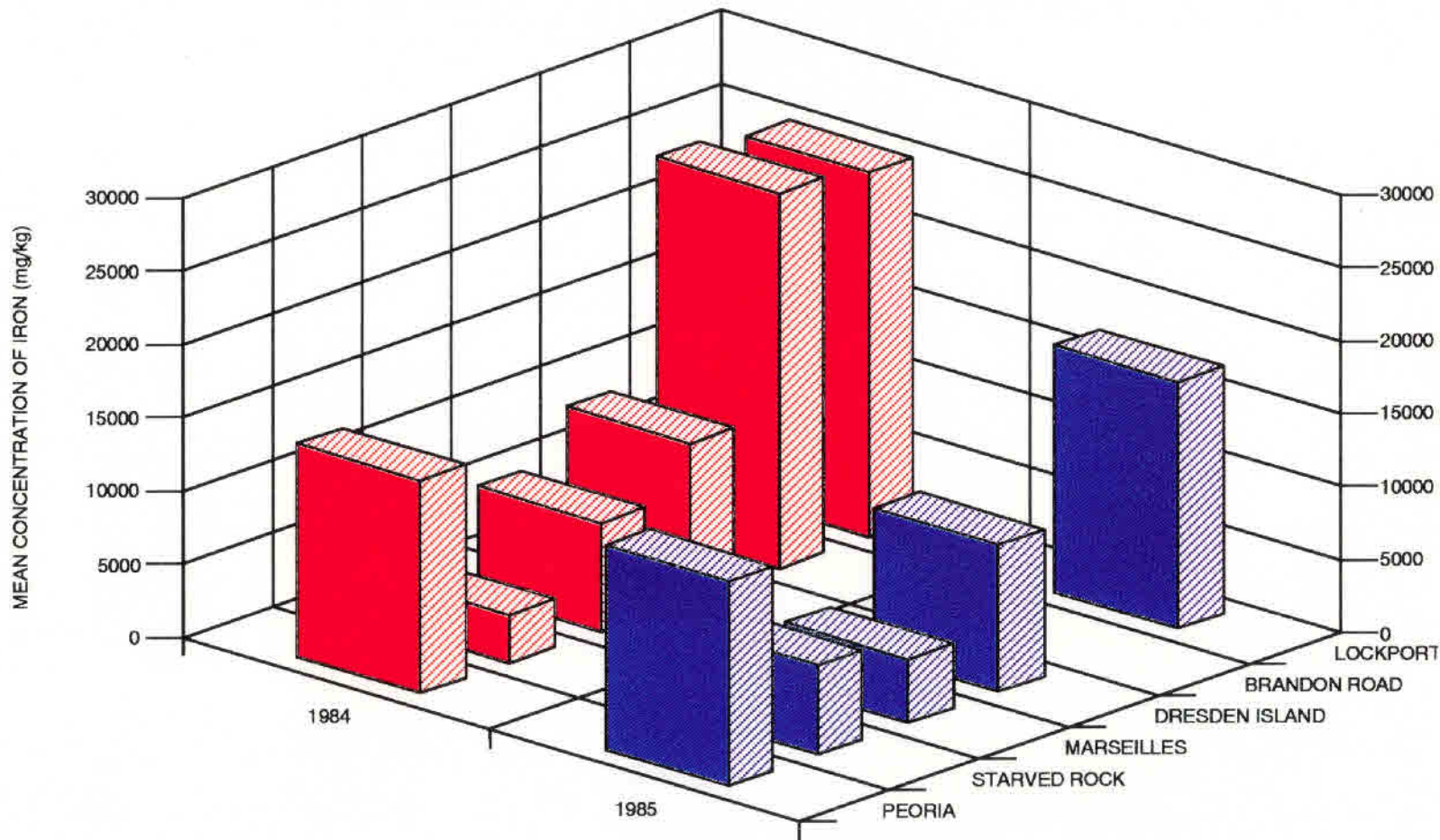
COMPARISON OF THE MEAN CONCENTRATION OF COPPER IN SEDIMENT ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT POOL TO THE PEORIA POOL DURING 1984 AND 1985



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 33

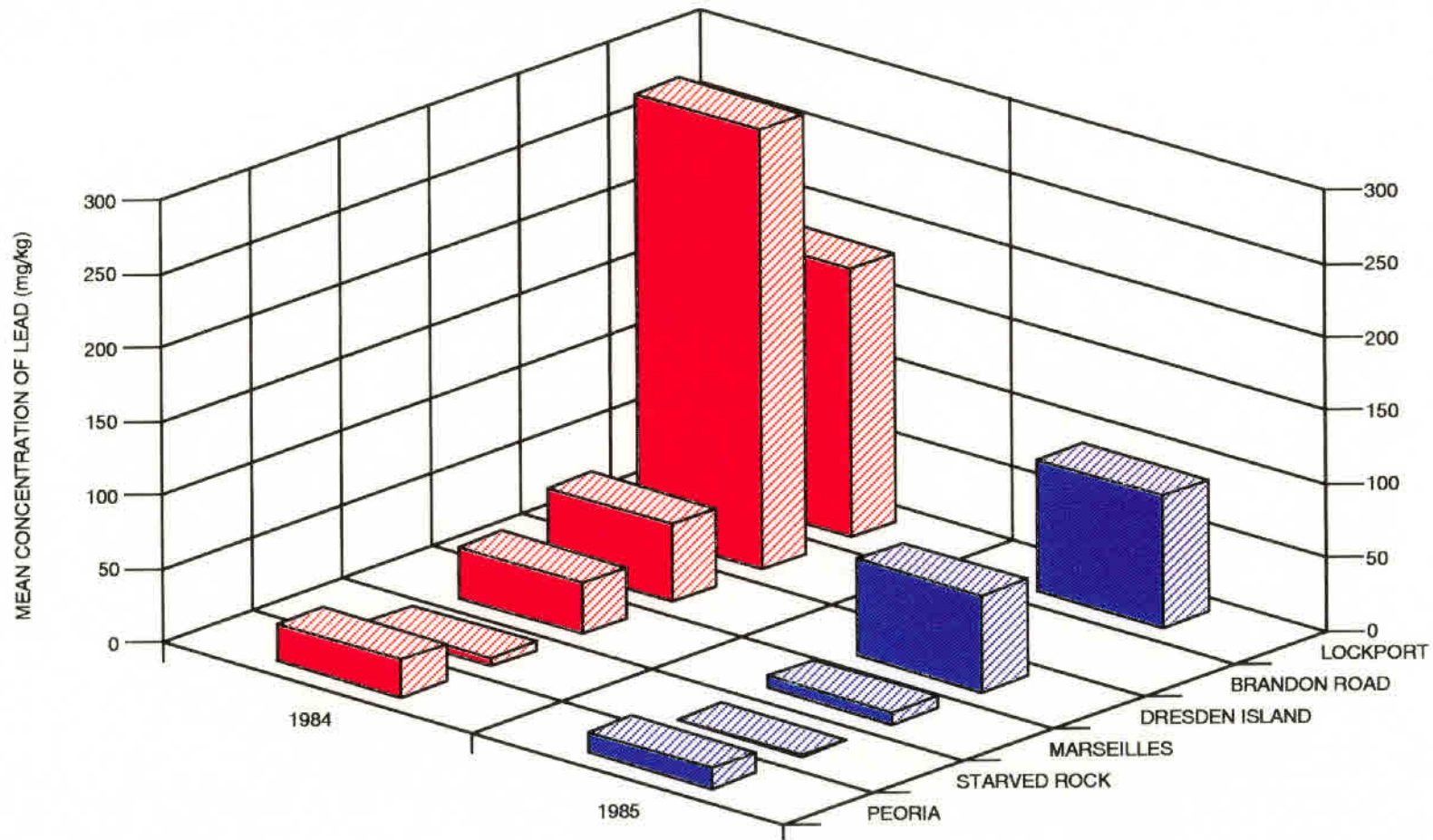
COMPARISON OF THE MEAN CONCENTRATION OF IRON IN SEDIMENT ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT POOL TO THE PEORIA POOL DURING 1984 AND 1985



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 34

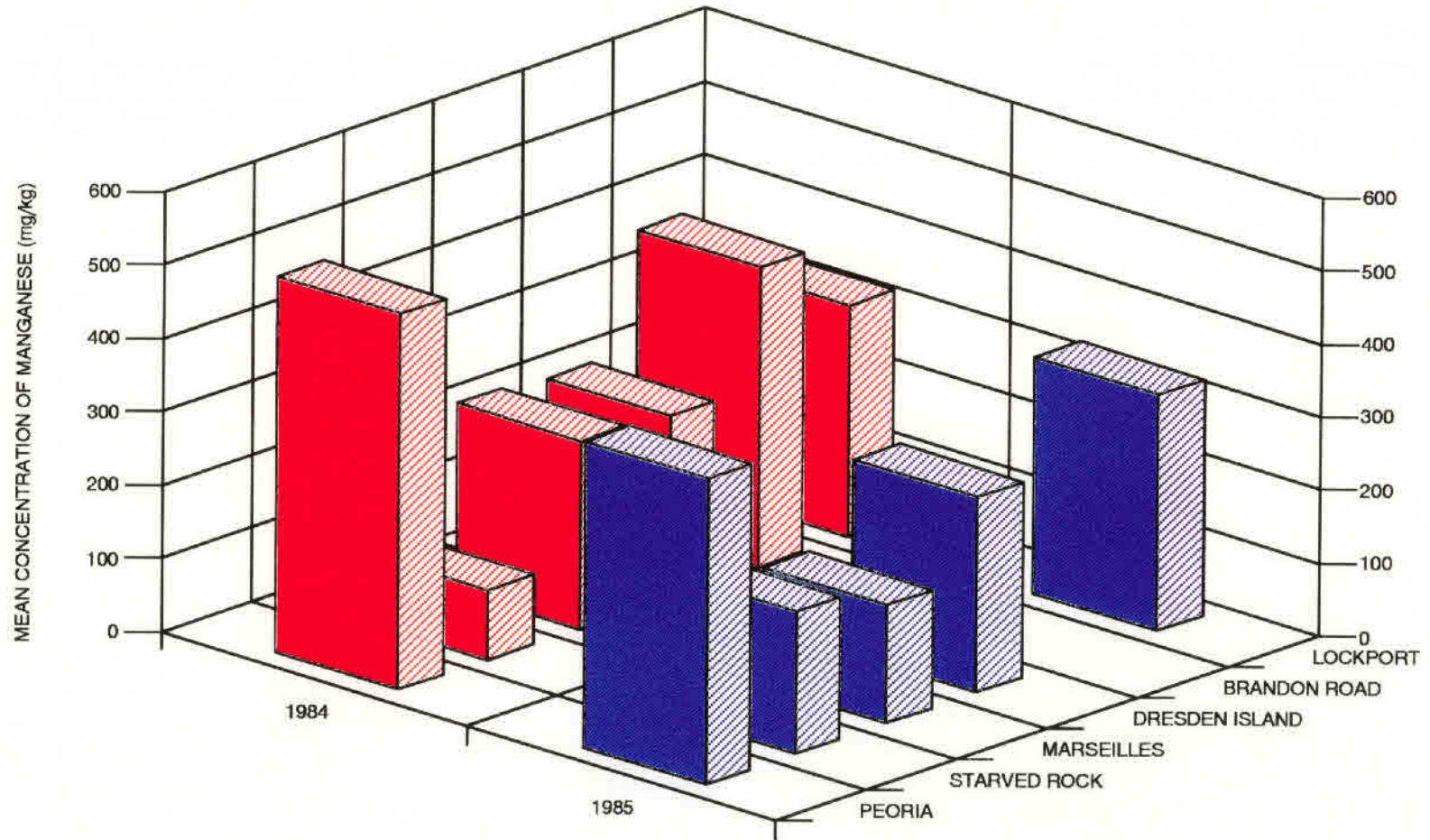
COMPARISON OF THE MEAN CONCENTRATION OF LEAD IN SEDIMENT ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT POOL TO THE PEORIA POOL DURING 1984 AND 1985



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 35

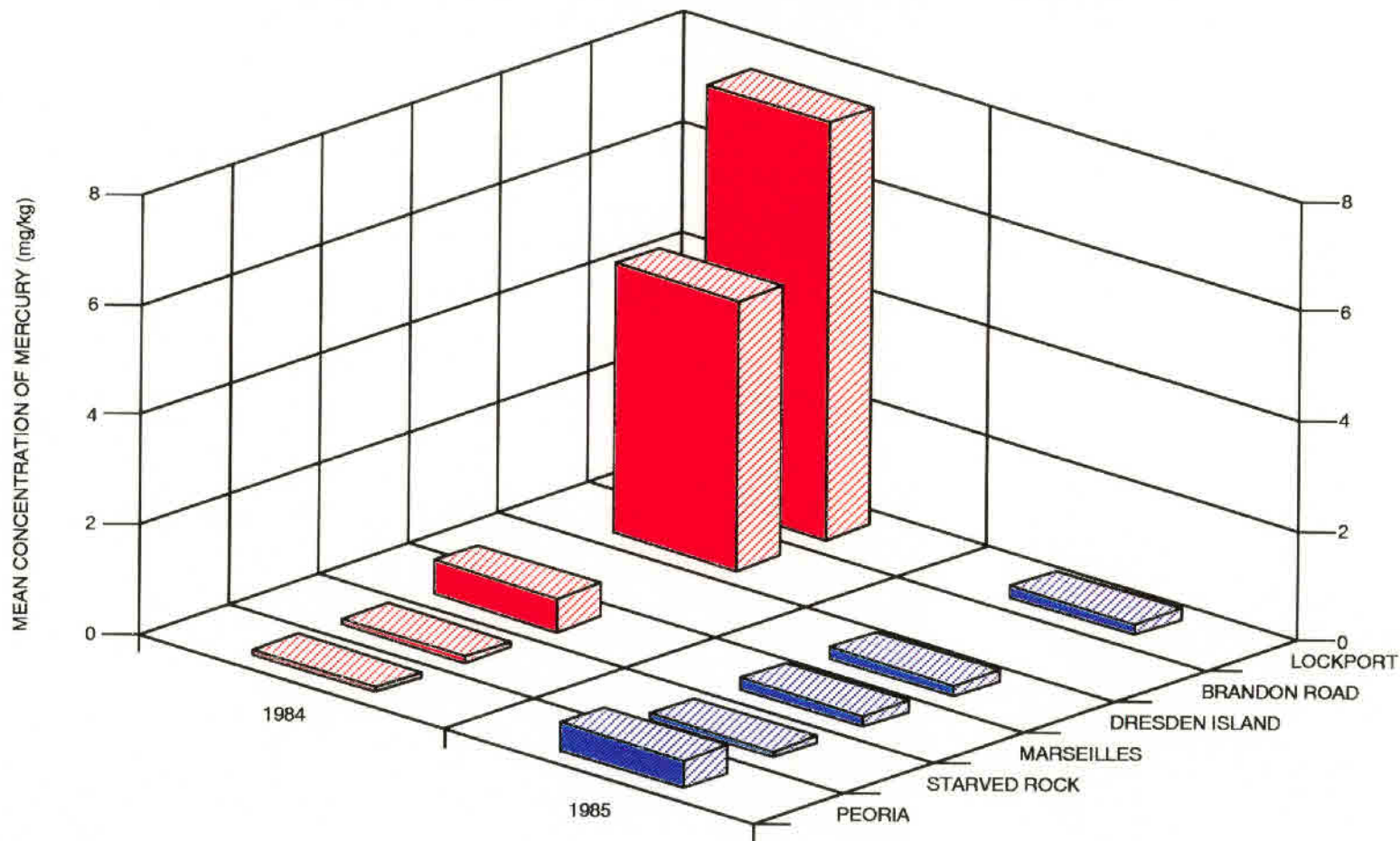
COMPARISON OF THE MEAN CONCENTRATION OF MANGANESE IN SEDIMENT ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT POOL TO THE PEORIA POOL DURING 1984 AND 1985



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 36

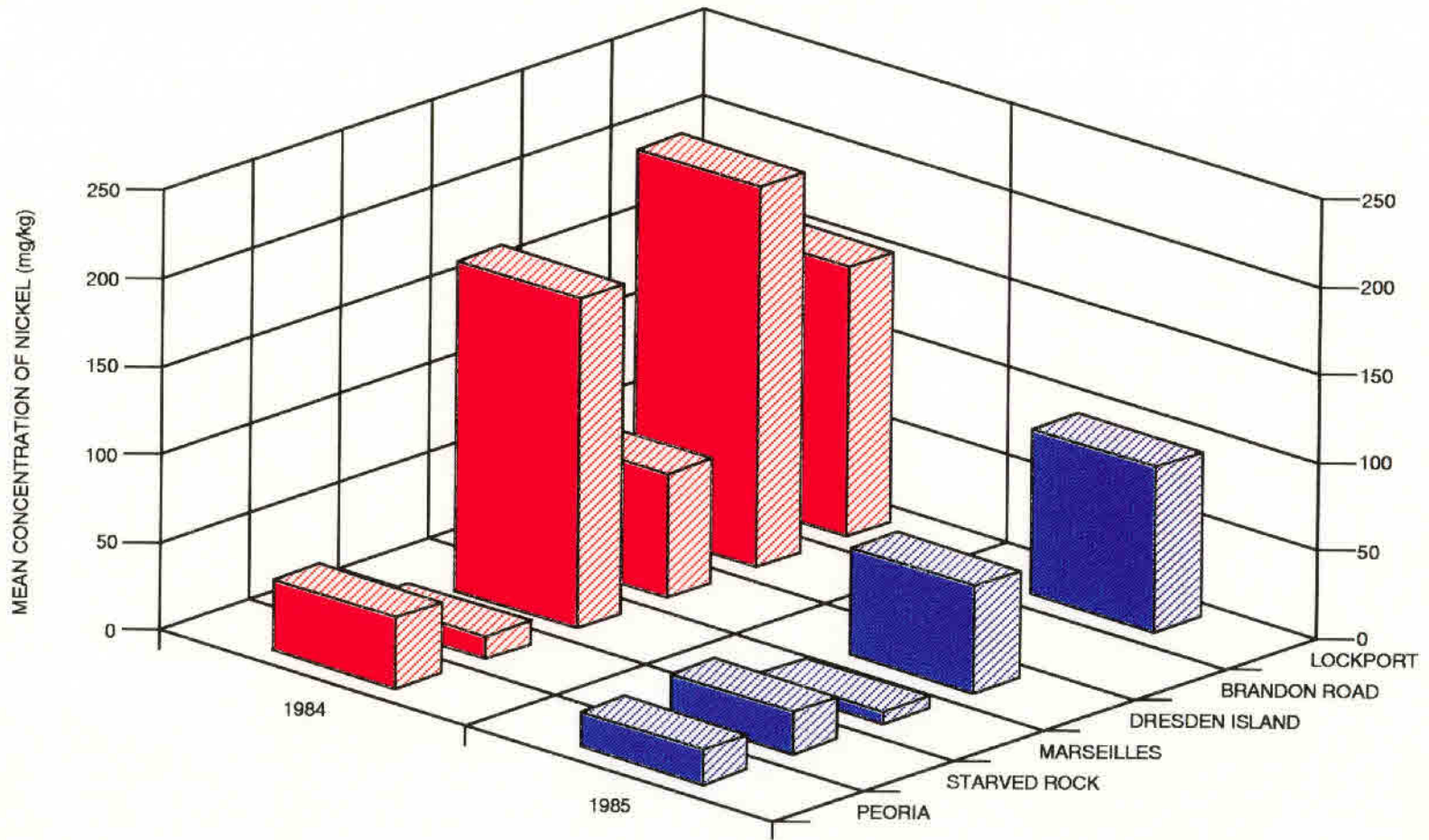
COMPARISON OF THE MEAN CONCENTRATION OF MERCURY IN SEDIMENT ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT POOL TO THE PEORIA POOL DURING 1984 AND 1985



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 37

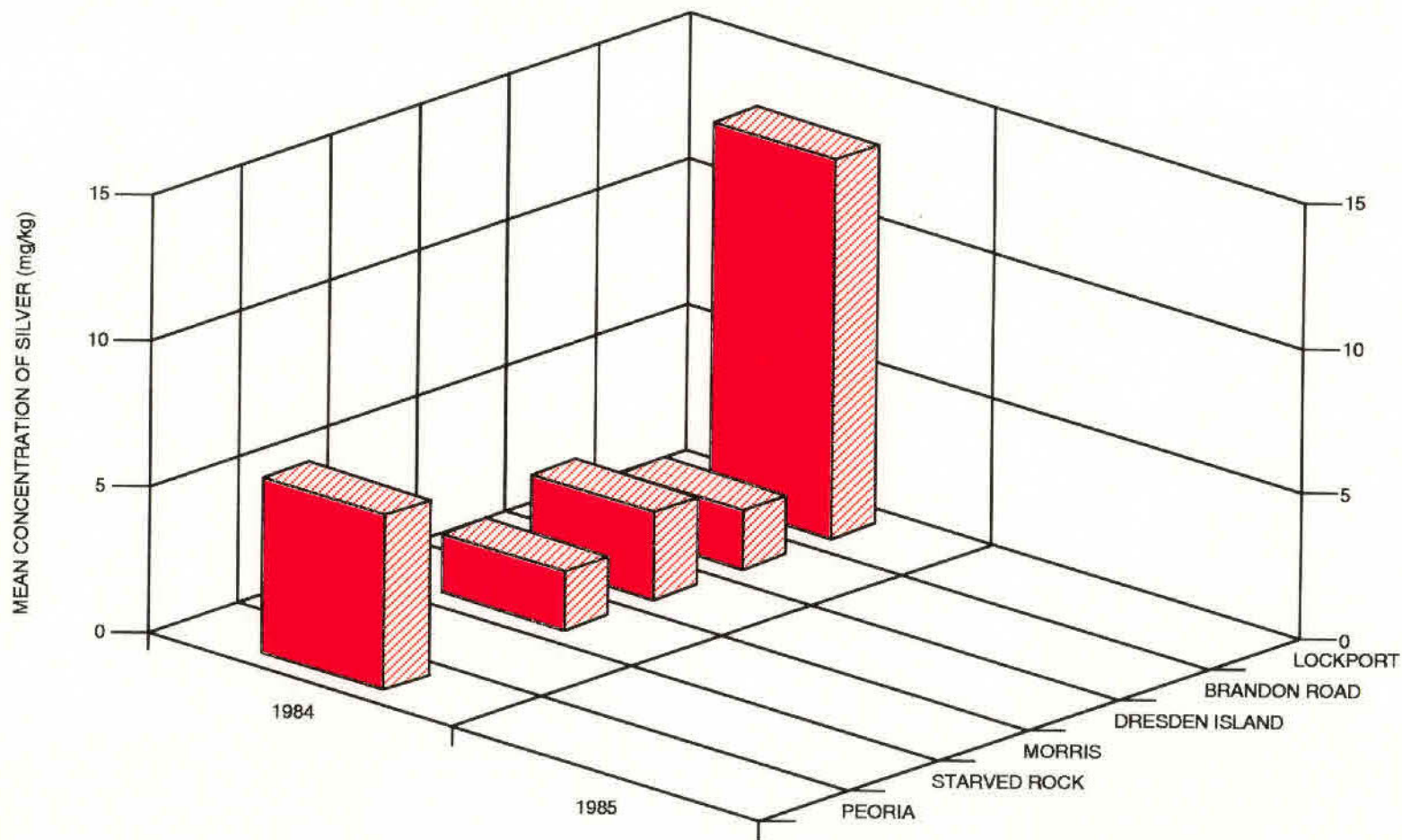
COMPARISON OF THE MEAN CONCENTRATION OF NICKEL IN SEDIMENT ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT POOL TO THE PEORIA POOL DURING 1984 AND 1985



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 38

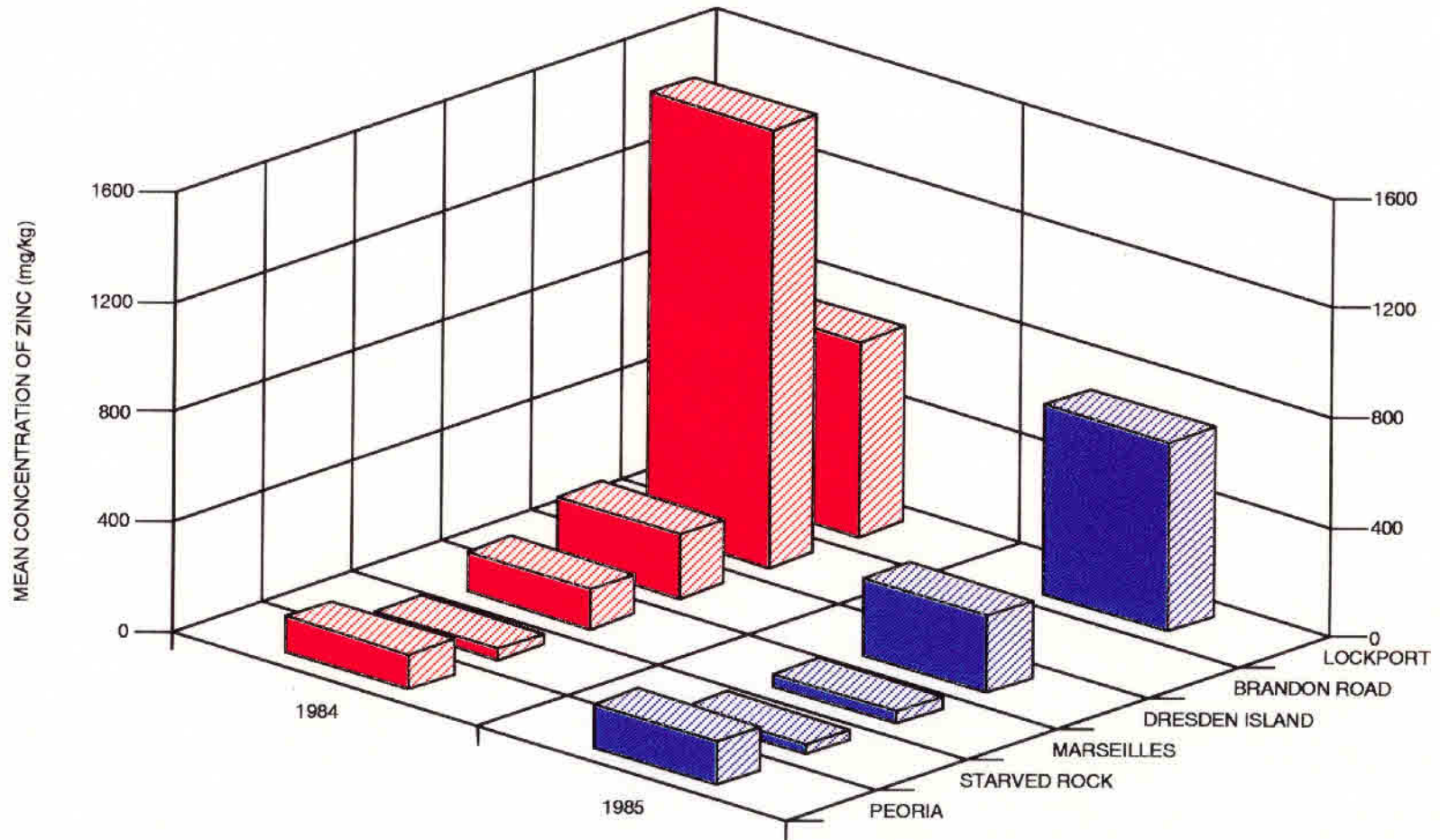
COMPARISON OF THE MEAN CONCENTRATION OF SILVER IN SEDIMENT ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT POOL TO THE PEORIA POOL DURING 1984 AND 1985



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 39

COMPARISON OF THE MEAN CONCENTRATION OF ZINC IN SEDIMENT ALONG THE ILLINOIS WATERWAY FROM THE LOCKPORT POOL TO THE PEORIA POOL DURING 1984 AND 1985



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