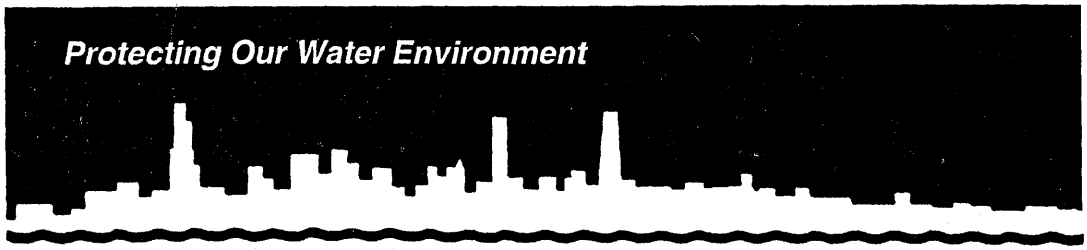

Metropolitan Water Reclamation District of Greater Chicago

RESEARCH AND DEVELOPMENT DEPARTMENT

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CONTINUOUS DISSOLVED OXYGEN MONITORING IN THE CHICAGO WATERWAY SYSTEM DURING 2004

August 2005

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CONTINUOUS DISSOLVED OXYGEN MONITORING IN THE CHCAGO WATERWAY SYSTEM DURING 2004

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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

Summary

More than 30 years ago, the Metropolitan Water Reclamation District of Greater Chicago (District) determined that applicable dissolved oxygen (DO) standards for deep draft navigable waterways in the Chicago area could not be maintained exclusively by improving the effluent quality from the three major District Water Reclamation Plants (WRPs) and by capturing and treating combined sewer overflows (CSOs).

In order to provide supplemental aeration, the District constructed and operated two diffused air instream aeration stations and five sidestream elevated pool aeration (SEPA) stations in Chicago area waterways. In August 1996, the District began planning a comprehensive DO monitoring study to identify reaches in the Chicago Waterway System where the DO concentration is less than the applicable Illinois Pollution Control Board (IPCB) water quality standards.

Initially, 20 stations were selected for monitoring from Wilmette, Illinois, on the North Shore Channel to the Lockport Powerhouse and Lock on the Chicago Sanitary and Ship Canal, using continuous water quality monitors, Models 6600 and 6920 manufactured by YSI Incorporated (YSI), Yellow Springs, Ohio. This monitoring was extended further downstream to Jefferson Street in Joliet, Illinois, on the Des Plaines River beginning in March 2000. Additional stations were added to the DO monitoring network in August 2001 in order to monitor the Calumet River System.
The present report includes hourly DO values at 21 stations from Wilmette to Lockport in the Chicago River System, 1 station in Joliet in the Des Plaines River System, and 13 stations in the Calumet River System.

In the Chicago River System, DO monitoring began at a new station at Foster Avenue on the North Shore Channel in September 2004. DO monitoring was discontinued in March 2004 at eight stations, including Linden Street and Simpson Street on the North Shore Channel, Division Street on the North Branch of the Chicago River, the Chicago River Controlling Works and Michigan Avenue on the Chicago River, Jackson Boulevard on the South Branch of the Chicago River, and River Mile 302.6 and Romeoville Road on the Chicago Sanitary and Ship Canal.

In the Calumet River System, DO monitoring was discontinued in March 2004 at six stations, including 130th Street on the Calumet River, Conrail Railroad on the Little Calumet River, and at Division Street, Kedzie Avenue, River Mile 311.7 and Southwest Highway on the Calumet-Sag Channel. The monitoring stations at Division Street and River Mile 311.7 were reactivated during September and October and were then returned to inactive status.

Conclusions

Chicago and Des Plaines River Systems. The results of the continuous DO monitoring conducted in the Chicago and Des Plaines River Systems during 2004 indicated the following.

1. DO supersaturation occurred at Main Street on the North Shore Channel, possibly due to oxygen produced by algae during daylight hours.

2. Hourly DO concentrations at or near zero were recorded numerous times at Simpson Street and Main Street on the North Shore Channel, 36th Street and

Interstate Highway 55 on Bubbly Creek, and at Route 83 on the Chicago Sanitary and Ship Canal.

3. Six monitoring stations recorded DO concentrations above the applicable IPCB standards at all times, including: Foster Avenue on the North Shore Channel, the Chicago River Controlling Works and Michigan Avenue on the Chicago River, Jackson Boulevard on the South Branch of the Chicago River, and River Mile 302.6 and Romeoville Road on the Chicago Sanitary and Ship Canal.

4. Three monitoring stations were above the applicable IPCB DO standard at least 99 percent of the time, including: Addison Street and Division Street on the North Branch of the Chicago River, and Loomis Street on the South Branch of the Chicago River.

5. The DO concentration was above the DO standard 90 to 98 percent of the time at five monitoring stations, including Fullerton Avenue and Kinzie Street on the North Branch of the Chicago River, Clark Street on the Chicago River, B&O Central Railroad on the Chicago Sanitary and Ship Canal, and Jefferson Street on the Des Plaines River.

6. Eight monitoring stations recorded DO levels above the applicable IPCB DO standards less than 90 percent of the time, including: Linden Street (71 percent), Simpson Street (48 percent), and Main Street (81 percent) on the North Shore Channel, 36th Street (71 percent) and Interstate Highway 55 (60 percent) on Bubbly Creek, and Cicero Avenue (77 percent), Route 83 (73 percent), and Lockport (73 percent) on the Chicago Sanitary and Ship Canal.

7. Based upon the results of this study, it appears that the North Shore Channel upstream of the North Side WRP and Bubbly Creek are the main areas, of those monitored, that are experiencing problems maintaining DO above the applicable DO standard. It also appears that the diffused air instream aeration stations on the North Shore Channel and North Branch are effective in maintaining compliance with DO standards in the waterways downstream of each station.

Calumet River System. The results of the continuous DO monitoring conducted in the Calumet River System during 2004 indicated the following.

1. DO supersaturation occurred at Torrence Avenue on the Grand Calumet River, possibly due to oxygen produced by algae during daylight hours.

2. Hourly DO concentrations at or near zero were recorded numerous times at Torrence Avenue on the Grand Calumet River, at Ashland Avenue on the Little Calumet River, and at 104th Avenue on the Calumet-Sag Channel.

3. Six monitoring stations recorded DO concentrations above the applicable IPCB standards at all times, including 130th Street on the Calumet River, Conrail Railroad on the Little Calumet River, and Division Street, Kedzie Avenue, River Mile 311.7, and Southwest Highway on the Calumet-Sag Channel.

4. Four monitoring stations were above the applicable IPCB DO standard at least 99 percent of the time, including: C&W Indiana Railroad and Halsted Street on the Little Calumet River, and Cicero Avenue and Route 83 on the Calumet-Sag Channel.

5. The DO concentration was above the DO standard 93 percent of the time at 104th Avenue on the Calumet-Sag Channel.

6. Two monitoring stations recorded DO concentrations above the applicable IPCB DO standard less than 90 percent of the time, including Torrence Avenue (78 percent) on the Grand Calumet River, and Ashland Avenue (57 percent) on the Little Calumet River.

7. Based upon the results of this study, it appears that the Grand Calumet River at Torrence Avenue and the Little Calumet River at Ashland Avenue are experiencing problems maintaining DO above the applicable DO standard. It also appears that the SEPA stations on the Calumet River, Little Calumet River, and Calumet-Sag Channel are effective in maintaining compliance with DO standards in the waterways downstream of these stations.

The database resulting from the operation of the continuous DO monitors has been an important source of information for determining the DO levels in a complex, urbanized waterway system. This information will be useful in the future for determining the need and location for additional supplemental aeration capacity, understanding the temporal and transient impacts of CSOs, assessing the effects of reduced discretionary diversion from Lake Michigan, and calibrating and verifying an unsteady-state water quality model for the Chicago, Calumet, and Des Plaines River Systems.

INTRODUCTION

The Chicago Waterway System (CWS) consists of 78 miles of canals, which serve the Chicago area for two principal purposes, the drainage of urban storm water runoff and treated municipal wastewater effluent and the support of commercial navigation. Approximately 75 percent of the length is composed of man-made canals where no waterway existed previously and the remainder is composed of natural streams that have been deepened, straightened and/or widened to such an extent that reversion to the natural state is not possible. The flow of water in the CWS is artificially controlled by hydraulic structures. The CWS has two river systems, the Calumet River System and the Chicago River System (Lanyon, 2002).

Over the years, increased pollutant loading from urbanization throughout the Chicago metropolitan area and low stream velocities in Chicago area deep-draft waterways have caused DO concentrations to fall below DO standards established by the IPCB. More than 30 years ago, the District determined that applicable IPCB DO standards for Chicago area waterways could not be met exclusively by advanced wastewater treatment at its three major regional WRPs (Calumet, North Side, and Stickney) and by the capture and treatment of CSOs. In order to increase the DO concentration in the Chicago and Calumet River Systems, the District designed and constructed artificial aeration systems (instream diffuser and sidestream elevated pool aeration [SEPA] stations) during the late 1970s and early 1990s, respectively.

From October 1994 through May 1996, the Research and Development (R&D) Department conducted weekly DO surveys in the Chicago River System. Water samples were collected manually, chemically fixed in the field, and returned to the laboratory for titration. The results from these surveys showed that DO concentrations in selected waterway reaches were less than IPCB DO standards applicable to these reaches.

In August 1996, R&D began developing a comprehensive field-monitoring program in order to locate and identify reaches in the Chicago River System where the DO concentration is less than the applicable IPCB DO standard. Initially, the program was to focus on the Chicago River System for a two-year period. Subsequently, the scope of the monitoring program was extended to four years, and the study area was expanded to include the Calumet River System for the latter two years. The resulting data have been used for the calibration and verification of a water quality model for the CWS.

Monitoring results for the CWS have been summarized by:

1. Polls (2002) from August 1998 through July 2000.

2. Dennison et al. (2004) from August 2000 through December 2001.

3. Dennison et al. (2004) from January 2002 through December 2002 (Chicago River System) and from August 2001 through December 2002 (Calumet River System).

4. Dennison et al. (2005) from January 2003 through December 2003.

This report covers the monitoring results for the period January 2004 through December 2004 for the Chicago River System, Des Plaines River System, and Calumet River System.

MONITORING STATIONS

Locations for 21 monitoring stations on the Chicago River System, 1 station on the Des Plaines River System, and 13 stations on the Calumet River System are shown in Figure 1. Chicago River System stations included: four stations on the North Shore Channel, four on the North Branch of the Chicago River, three on the Chicago River, one on the South Branch of the Chicago River, two on Bubbly Creek, and six on the Chicago Sanitary and Ship Canal. The one station on the Des Plaines River System was at Jefferson Street in Joliet. Calumet River System stations included one station on the Calumet River, one station on the Grand Calumet River, four stations on the Little Calumet River, and seven stations on the Calumet-Sag Channel. Table 1 describes the locations of all the monitoring stations. In March 2004, fourteen monitoring stations were taken out of service in order to use the monitors at other locations, primarily in relatively shallow streams. In August 2004, a new monitoring station was installed at Foster Avenue on the North Shore Channel in order to monitor the DO of the North Shore Channel before its confluence with the North Branch of the Chicago River.

Criteria used to select monitoring stations included the following: (1) history of low DO, (2) above and below confluence of waterways, (3) proximity to instream aeration stations or SEPA stations, (4) below North Branch and Racine Avenue pumping stations, (5) above and below the North Side, Stickney, and Calumet WRPs, (6) below discretionary diversion locations, and (7) minimal cross-sectional DO variability.

FIGURE 1: CONTINUOUS DISSOLVED OXYGEN MONITORING STATIONS IN THE CHICAGO WATERWAY SYSTEM

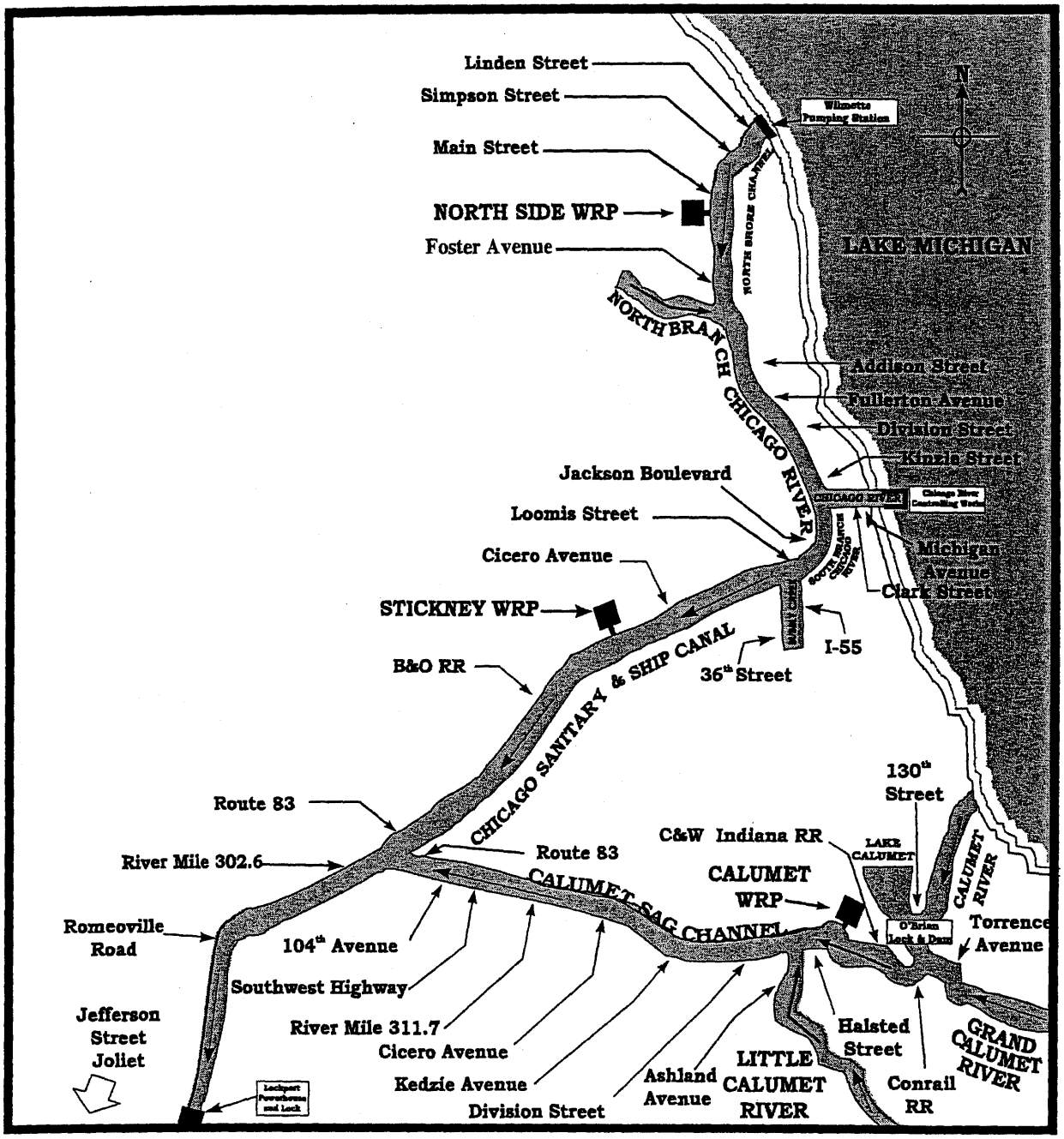

TABLE 1: CONTINUOUS DISSOLVED OXYGEN MONITORING STATIONS

Monitoring Station	Waterway	Description of Monitoring Station
		Chicago River System
Linden Street	North Shore Channel	0.1 mile below Wilmette Pumping Station; 7.1 miles above North Side WRP outfall; water quality monitor under Linden Street bridge, center of channel, one foot above bottom.
Simpson Street	North Shore Channel	1.6 miles below Wilmette Pumping Station; 5.6 miles above North Side WRP outfall; water quality monitor under Simpson Street bridge, center of channel, one foot above bottom.
Main Street	North Shore Channel	3.5 miles below Wilmette Pumping Station; 0.8 mile above North Side WRP outfall; water quality monitor under Main Street bridge, center of channel, one foot above bottom.
Foster Avenue	North Shore Channel	3.2 miles below North Side WRP outfall; 0.1 mile above junction with North Branch Chicago River; water quality monitor on northwest side Foster Avenue bridge, three feet below water surface.
Addison Street	North Branch Chicago River	5.2 miles below North Side WRP outfall; water quality monitor on northwest side Addison Street bridge; three feet below water surface.
Fullerton Avenue	North Branch Chicago River	7.2 miles below North Side WRP outfall; 0.4 mile above Webster Aeration Station; water quality monitor on northwest side Fullerton Avenue bridge, three feet below water surface.
Division Street	North Branch Chicago River	8.8 miles below North Side WRP outfall; 1.4 miles below Webster Aeration Station; water quality monitor on northeast side Division Street bridge, three feet below water surface.

TABLE 1 (Continued): CONTINUOUS DISSOLVED OXYGEN MONITORING STATIONS

Monitoring Station	Waterway	Description of Monitoring Station
	Chicago River System (Continued)	
Kinzie Street	North Branch Chicago River	9.9 miles below North Side WRP outfall; 0.2 mile above junction with Chicago River; water quality monitor on northeast side Kinzie Street bridge, three feet below water surface.
Chicago River Controlling Works	Chicago River	0.1 mile below Chicago River Controlling Works; 1.5 miles above junction with South Branch Chicago River; water quality monitor on south guidewall of lock, three feet below water surface.
Michigan Avenue	Chicago River	0.8 mile below Chicago River Controlling Works; 0.8 mile above junction with South Branch Chicago River; water quality monitor on northeast side Michigan Avenue bridge, three feet below water surface.
Clark Street	Chicago River	1.2 miles below Chicago River Controlling Works; 0.4 mile above junction with South Branch Chicago River; water quality monitor on northeast side Clark Street bridge, three feet below water surface.
Jackson Boulevard	South Branch Chicago River	4.0 miles below junction with Chicago River; 0.4 mile below Fisk Generating Station discharge; water quality monitor on northeast side Loomis Street bridge, three feet below water surface.
Loomis Street	South Branch Chicago River	3.6 miles below junction with Chicago River; water quality monitor on northeast side Loomis Street bridge; three feet below water surface.
36th Street	Bubbly Creek	0.2 mile below Racine Avenue Pumping Station; 1.2 miles above junction with South Branch of the Chicago River; water quality monitor attached to concrete wall on west side of river, three feet below water surface.

TABLE 1 (Continued): CONTINUOUS DISSOLVED OXYGEN MONITORING STATIONS

Monitoring Station	Waterway	Description of Monitoring Station
	Chicago River System (Continued)	
Interstate Highway 55	Bubbly Creek	1.0 mile below Racine Avenue Pumping Station; 0.4 mile above junction with South Branch of the Chicago River; water quality monitor on northeast side I-55 bridge, three feet below water surface.
Cicero Avenue	Chicago Sanitary and Ship Canal	1.5 miles above Stickney WRP outfall; 1.1 miles below Crawford Generating Canal Station cooling water discharge; water quality monitor on northeast side Cicero Avenue bridge, three feet below water surface.
B&O Central Railroad	Chicago Sanitary and Ship Canal	3.6 miles below Stickney WRP outfall; water quality monitor in center of canal, east side B&O Central RR bridge, three feet below water surface.
Route 83	Chicago Sanitary and Ship Canal	1.2 miles above junction with Calumet-Sag Channel; 1.1 miles above Canal Junction SEPA Station; water quality monitor 0.6 mile above Route 83 bridge, center of canal, one foot above bottom.
River Mile 302.6	Chicago Sanitary and Ship Canal	1.2 miles below junction with Calumet-Sag Channel; 1.3 miles below Canal Junction SEPA Station; water quality monitor in center of canal, one foot above bottom.
Romeoville Road	Chicago Sanitary and Ship Canal	7.1 miles below junction with Calumet-Sag Channel; 5.1 miles above Lockport Lock; water quality monitor on southeast side Romeoville Road bridge, three feet below water surface.
Lockport	Chicago Sanitary and Ship Canal	0.1 mile above Lockport Powerhouse; 1.1 miles above junction with Des Plaines River; water quality monitor on north side of canal, in forebay area on fender wall, three feet below water surface.