Metropolitan Water Reclamation District of Greater Chicago

MONITORING AND RESEARCH DEPARTMENT

REPORT NO. 14-19

CONTINUOUS DISSOLVED OXYGEN MONITORING

IN CHICAGO AREA WADEABLE STREAMS

DURING 2013

July 2014

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CONTINUOUS DISSOLVED OXYGEN MONITORING IN CHICAGO AREA WADEABLE STREAMS DURING 2013

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July 2014

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DISCLAIMER

Mention of proprietary equipment and chemicals in this report does not constitute endorsement by the District.

INTRODUCTION

The District began monitoring the Chicago Area Waterway System with continuous dissolved oxygen monitors in 1998. The initial project involved monitoring the Chicago River System and later expanded into the Calumet River System. The Continuous Dissolved Oxygen Monitoring (CDOM) Program was developed to identify reaches of the waterways where the dissolved oxygen (DO) concentrations were below the DO standards established by the Illinois Pollution Control Board (IPCB). In 2005 the CDOM Program expanded again and started monitoring the Chicago area wadeable streams.

Low DO levels can be caused by a multitude of factors including low gradient streams, dams, combined sewer overflow (CSO), stormwater runoff, wastewater effluents, thermal discharges, respiration, decomposition of organic material, and chemical reactions. Illinois streams that do not meet the state DO standards are placed on the 303(d) list of impaired waters by the Illinois Environmental Protection Agency (IEPA, 2012).

To better understand the DO concentrations in the wadeable streams within the Chicago area, monitoring locations were chosen to measure DO levels above and below discharges, impoundments, and major confluences. Wadeable sites were chosen within the Chicago River System, Upper Des Plaines River System, and Calumet River System.

One monitoring location is in the North Branch of the Chicago River. This location is upstream of the North Branch Dam. The North Branch watershed encompasses 113 square miles and is located both in Lake and Cook Counties (Ogata, 1975).

Four monitoring locations are in the Upper Des Plaines River System. One site is on the Upper Des Plaines River and three sites are in Salt Creek. The entire Des Plaines River watershed covers approximately 700 square miles and originates in Wisconsin. The river within the District's jurisdiction flows southward through a highly urbanized area from the Lake-Cook County line to Highway 171, at which point it flows southwestward, parallel and adjacent to the Chicago Sanitary and Ship Canal, to Lockport (Schmeelk, et al., 1979). Salt Creek is a tributary to the Des Plaines River and their confluence is located in the town of Lyons. The Salt Creek watershed encompasses approximately 150 square miles originating with the confluence of several small streams west of Palatine, Illinois (Polls et al., 1979).

One monitoring location is in the Calumet River System in the Little Calumet River. The Little Calumet River basin is located in northeastern Illinois and northwestern Indiana. The watershed drains an area of 242 square miles, 151.2 square miles of which are in Illinois (Northeastern Illinois Planning Commission, 1981).

This report covers the monitoring results for the period January 1, 2013, through December 31, 2013, for wadeable streams in the Chicago River System, Upper Des Plaines River System, and Calumet River System.

MONITORING LOCATIONS AND APPLICABLE DISSOLVED OXYGEN STANDARDS

Locations and Descriptions

The CDOM Program supplies the District with water quality data throughout the year for both the wadeable streams and deep-draft waterways within its jurisdiction. The CDOM stations are shown in Figure 1. Descriptions of the wadeable CDOM stations are listed in Table 1.

The monitor housing at Central Park Avenue on the North Branch Chicago River was damaged beyond repair after high flows in the spring of 2013. Continuous monitoring at this site was discontinued as of April 24, 2013.

Designated Uses

The IPCB has assigned water uses for specific water bodies within the state of Illinois. The waterways described in this wadeable CDOM report are all designated as General Use Waters.

Dissolved Oxygen Water Quality Standards

The IPCB has established water quality standards for DO in General Use Waters. In General Use Waters, the DO shall not be less than 3.5 mg/L at any time and shall meet a 4.0 mg/L daily minimum averaged over seven days and shall meet a 5.5 mg/L daily mean averaged over 30 days from August through February. During March through July, the DO shall not be less than 5.0 mg/L at any time and shall meet a 6.0 mg/L daily mean averaged over seven days.

FIGURE 1: 2013 CONTINUOUS DISSOLVED OXYGEN MONITORING STATIONS

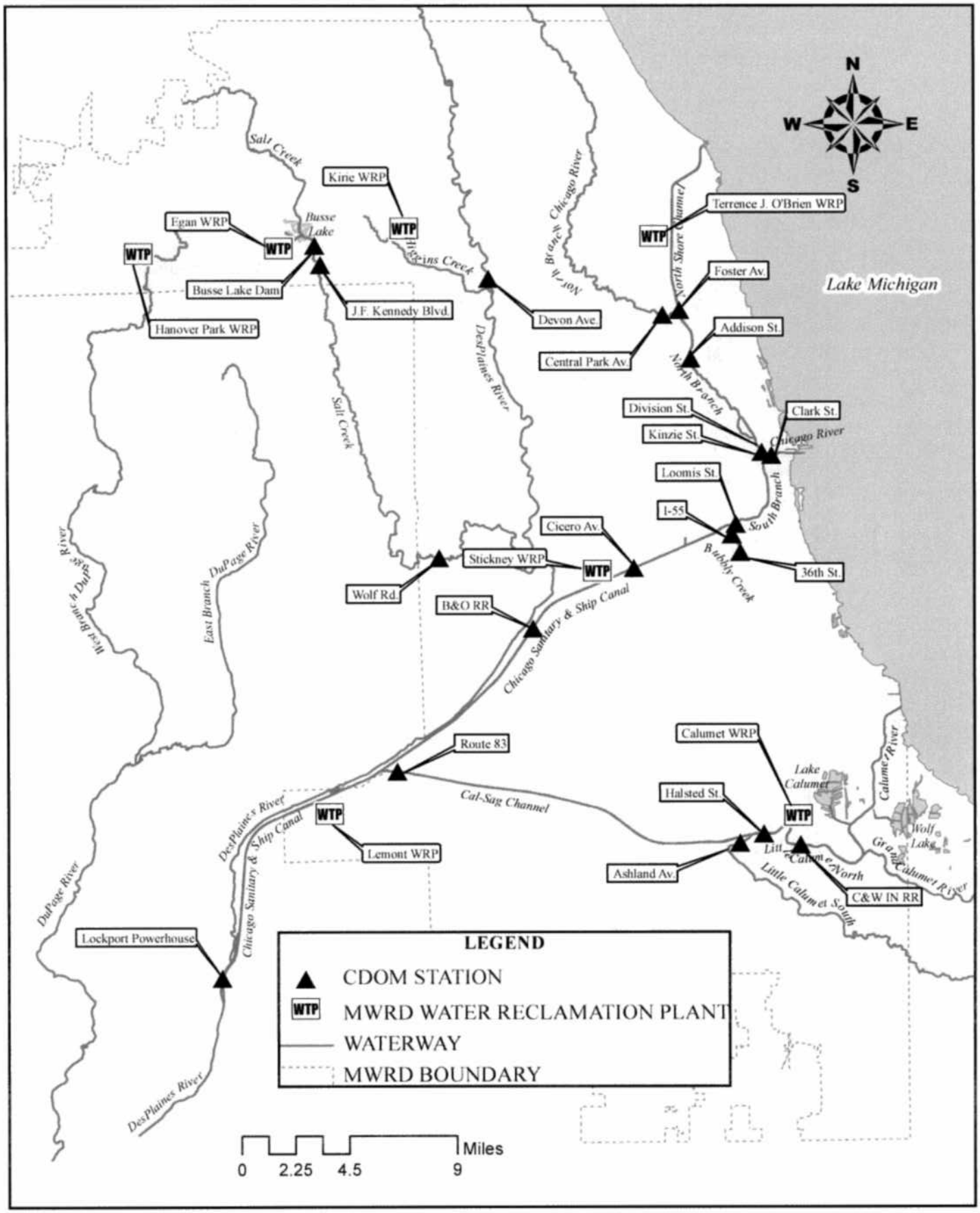


TABLE 1: WADEABLE STREAM CONTINUOUS DISSOLVED OXYGEN MONITORING STATIONS DURING 2013

Monitoring Station	Waterway	Description of Monitoring Station
	Chicago River System	
Central Park Avenue	North Branch Chicago River	0.8 mile above junction with North Shore Channel, water quality monitor on northeast side of Central Park Avenue bridge, 2-4 inches from stream bed.
	Des Plaines River System	
Devon Avenue	Des Plaines River	0.7 mile above junction with Willow Creek, water quality monitor on northwest side of Devon Avenue bridge, 2-4 inches from stream bed.
Busse Lake Dam	Salt Creek	0.1 mile above Egan WRP outfall, water quality monitor on bike path bridge support, downstream of Busse Woods South Dam, in center of creek, 2-4 inches from stream bed.
J.F. Kennedy Boulevard	Salt Creek	0.8 mile below Egan WRP outfall, water quality monitor on southeast side of J.F. Kennedy Boulevard bridge, 2-4 inches from stream bed.

TABLE 1 (Continued): WADEABLE STREAM CONTINUOUS DISSOLVED OXYGEN MONITORING STATIONS DURING 2013

Monitoring Station	Waterway	Description of Monitoring Station
	Des Plaines River System (Continued)	
Wolf Road	Salt Creek	8.0 miles above junction with Des Plaines River, water quality monitor on northwest side of Wolf Road bridge, 2-4 inches from stream bed.
	Calumet River System	
Ashland Avenue	Little Calumet River	0.5 mile above junction with Calumet-Sag Channel, water quality monitor attached to east side of Ashland Avenue bridge, 1 foot from stream bed

MATERIALS AND METHODS

Water Quality Monitor

The continuous water quality monitors (monitors) used to collect these data were manufactured by YSI Incorporated (YSI) of Yellow Springs, Ohio. The DO was measured hourly using the YSI Model 6920 or Model 6600 monitor. In order to protect the monitors from marine navigation and vandalism, the monitors were deployed in the field in stainless steel pipes. Installation designs resulted in a fixed length of pipe at each location with multiple 2-inch circular openings on the submerged end to allow sufficient flow of water through the pipe. Each monitor housing was vertically mounted on the side of a bridge abutment with an access hatch on the top end to allow for periodic monitor exchange.

The District personnel retrieved each monitor from the field following 14 days of continuous monitoring. Prior to retrieval, a water sample was collected next to the protective housing for DO analysis using the Winkler method for subsequent comparison with the monitor results. An additional monitor, that had been previously calibrated and serviced in the laboratory, was then deployed to replace the retrieved monitor. The retrieved monitors were returned to the laboratory for data downloading, exterior cleaning, servicing, and calibration of the DO sensors. The monitors were temporarily stored in holding tanks containing tap water for subsequent deployment during the following week.

Data Management and Review

Hourly DO data were directly exported electronically from individual monitors to a specially designed Oracle® database for data processing and storage. All DO data were carefully reviewed for accuracy.

The review process included the following:

1. Comparing the grab sample DO concentration measured in the field with the DO concentration recorded by the respective monitor retrieved in the field (DO rejection criteria = difference greater than 2.0 mg/L).

2. Comparing the last hourly DO concentration measured by the monitor retrieved in the field with the first hourly DO concentration recorded by a deployed monitor that replaced it. (DO rejection criteria = difference greater than 2.0 mg/L).

3. Comparing a DO concentration measured in a laboratory holding tank and a DO concentration recorded by a monitor after retrieval from the field (DO rejection criteria = difference greater than 1.0 mg/L).

Criterion 3 would result in rejection of all hourly readings; criteria 1 and 2 may or may not result in rejection of all readings. Incidents of equipment malfunction would also result in rejection of data. Only data that met the quality control criteria were used to to compile the results in this report.

A comprehensive description of methods is presented in revision 2.0 of the Continuous Dissolved Oxygen Monitoring Program Quality Assurance Project Plan, effective April 11, 2011.

Cross-Sectional Surveys

During the spring, summer, and fall of 2013, cross-sectional DO surveys were conducted in the Chicago River System, Calumet River System, and Des Plaines River System to determine if the DO concentration at a fixed continuous monitoring location represents the DO concentrations across the waterway. The DO concentrations were measured directly with a monitor at multiple locations and depths. The cross-sectional DO measurements were taken in the center of the waterway and at the right and left side of the flow from a bridge. DO measurements were recorded at up to three depths for each location including just above the bottom of the stream bed, three feet below the surface, and at the surface. If the overall depth was less than four feet, only a bottom and surface measurement was recorded, and if the overall depth was less than one foot, only a surface measurement was recorded.

RESULTS

The annual minimum, maximum, and mean DO concentrations measured at all six stations during 2013 are shown in Table 2.

The number and percent of measured DO concentrations rejected and removed from the Oracle® database following review during 2013 are summarized in Table 3.

Table 4 shows the percent distribution of DO concentrations in 1mg/L increments from <1.0 mg/L to >5.0 mg/L at the six monitoring stations during 2013. The current national one-day minimum dissolved oxygen criterion for adult life stages of fish is 3.0 mg/L (USEPA, 1986).

Hourly DO concentrations at each monitoring station are shown in Figures 2 through 7. The anytime DO standard is indicated on the graph for reference.

Weekly DO summary statistics during 2013 are presented for each monitoring station in Appendix A, Tables A-1 through A-6.

Summary statistics for DO measurements made during cross-sectional surveys are shown in Appendix Table A-7. The results from the cross-sectional surveys clearly showed that the differences across the waterway were generally minimal (coefficient of variation < 5 percent).

Dissolved Oxygen Fluctuations

DO concentrations fluctuate seasonally and daily in the aquatic environment. Oxygen is more soluble in cold water than warm water, a trend that can typically be seen in annual DO graphs where the colder months have higher mean DO concentrations than the warmer months. Daily DO fluctuation can be caused by aquatic plant and algae photosynthesis during daylight hours and respiration during the night. Photosynthesis results in higher DO, while plant respiration depletes DO. Slower moving canals absorb less oxygen from the atmosphere than faster moving streams and rivers. Thermal loads from sources such as used cooling water can increase the temperature of the waterway, thereby lowering DO. Other deficiencies of DO can occur when materials that exhibit an oxygen demand are introduced into a waterway. These materials enter a waterway most often through wastewater treatment effluents, CSOs, stormwater run-off, and directly from wildlife and plants. This is most evident during heavy rainstorms that result in CSO events containing untreated waste and stormwater. More information on CSOs can be found on the District website at www.mwrd.org.

TABLE 2: MINIMUM, MAXIMUM, AND MEAN HOURLY DISSOLVED OXYGEN CONCENTRATIONS DURING 2013[a]

Monitoring Station	Waterway	DO Concentration (mg/L) Minimum	Maximum	Mean
	Chicago River System			
Central Park Avenue[b]	North Branch Chicago River	8.7	18.6	12.3
	Des Plaines River System			
Devon Avenue	Des Plaines River	3.8	15.4	9.6
Busse Lake Dam	Salt Creek	0.0	15.4	10.0
J.F. Kennedy Boulevard	Salt Creek	2.8	13.2	8.7
Wolf Road	Salt Creek	3.8	17.7	10.1
	Calumet River System			
Ashland Avenue	Little Calumet River	0.4	19.2	8.7

[a]Dissolved oxygen was measured hourly using a YSI Model 6920 or Model 6600 continuous water quality monitor.
[b]Data collected through April 24, 2013.

TABLE 3: NUMBER AND PERCENT OF DISSOLVED OXYGEN VALUES NOT MEETING ACCEPTANCE CRITERIA DURING 2013[a]

Monitoring Station	Waterway	Number of DO Values Rejected	Percent of DO Values Rejected
	Chicago River System		
Central Park Avenue[b]	North Branch Chicago River	0	0
	Des Plaines River System		
Devon Avenue	Des Plaines River	2,041	23[c]
Busse Lake Dam	Salt Creek	697	8[d]
J.F. Kennedy Boulevard	Salt Creek	661	8[e]
Wolf Road	Salt Creek	2,298	26[f]
	Calumet River System		
Ashland Avenue	Little Calumet River	338	4[g]

[a]Dissolved oxygen was measured hourly using a YSI Model 6920 or Model 6600 continuous water quality monitor. DO values were rejected based on quality control checks and/or operational problems with the monitor.
[b]Data collected through April 24, 2013.
[c]1/1-16/13, 5/22-6/5/2013, 7/31-8/14/2013, 12/4-31/2013, monitor failed criteria 3. 7/3-17/2013, equipment failure.
[d]1/16-30/2013, monitor failed criteria 3. 10/9-24/2013, equipment failure.
[e]6/19-7/3/2013, 10/24-11/6/2013, monitor failed criteria 1 and 2. 12/31/2013, monitor failed criteria 3.
[f]1/3-30/2013, 9/25-10/9/2013, 10/24-11/6/2013, monitor failed criteria 1 and 2. 5/22-6/5/2013, 7/17-31/2013, 9/11-25/2013, monitor failed criteria 3.
[g]7/10-24/2013, monitor failed criteria 3.

TABLE 4: PERCENT OF DISSOLVED OXYGEN VALUES IN SELECTED RANGES DURING 2013

Monitoring Station	Waterway	Percent of DO Values in Range (mg/L)[a]					
		0-<1	1-<2	2-<3	3-<4	4-<5	≥5
	Chicago River System						
Central Park Avenue[b]	North Branch Chicago River	0	0	0	0	0	100
	Des Plaines River System						
Devon Avenue	Des Plaines River	0	0	0	<1	1	99
Busse Lake Dam	Salt Creek	1	1	1	1	2	95
J.F. Kennedy Boulevard	Salt Creek	0	0	<1	1	3	96
Wolf Road	Salt Creek	0	0	0	<1	1	99
	Calumet River System						
Ashland Avenue	Little Calumet River	<1	1	2	3	8	87

[a] Percentages greater than one are rounded to nearest whole number.
[b]Data collected through April 24, 2013.

FIGURE 2: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT CENTRAL PARK AVENUE ON THE NORTH BRANCH CHICAGO RIVER FROM JANUARY 1, 2013, THROUGH DECEMBER 31, 2013

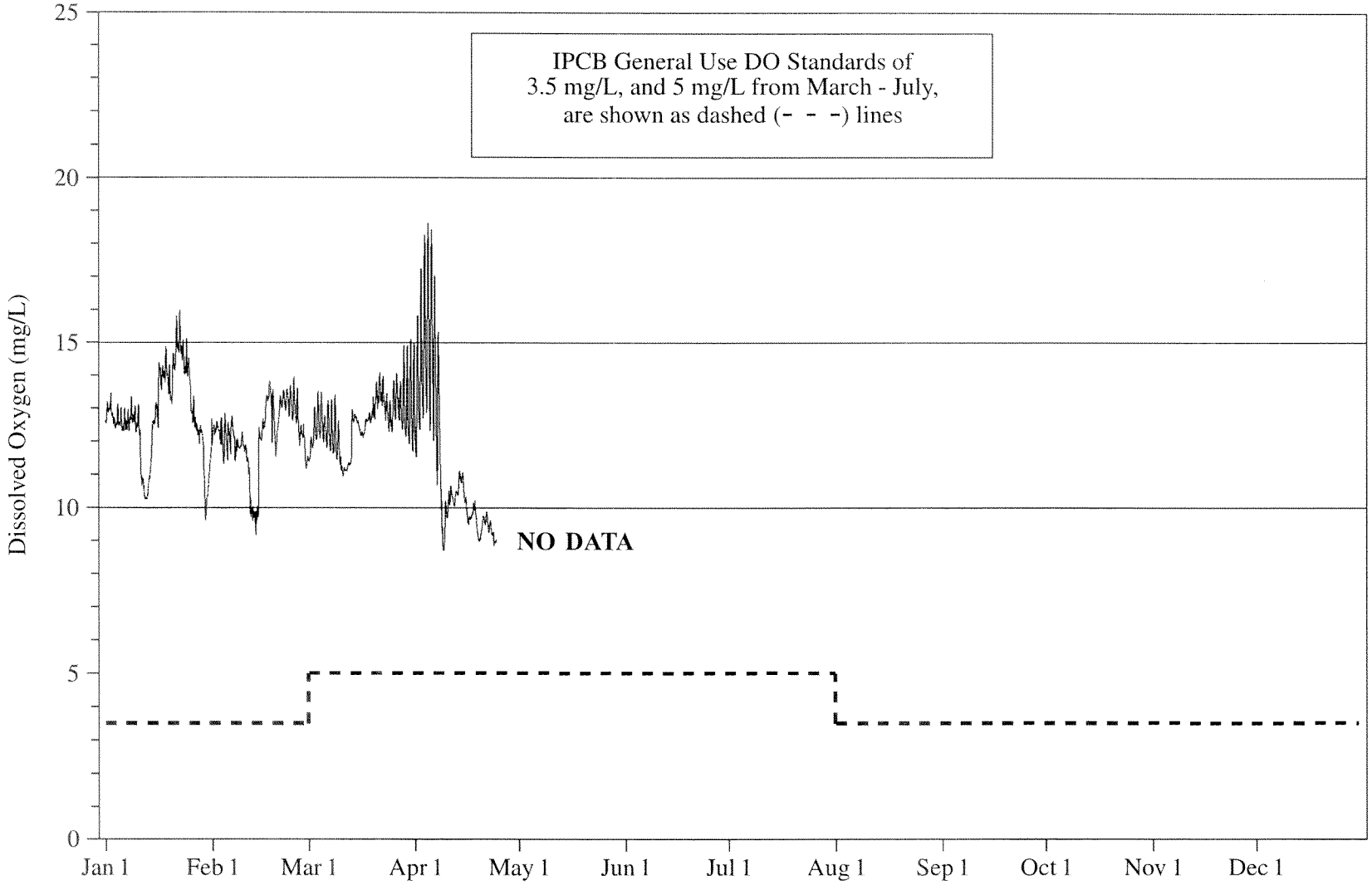


FIGURE 3: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT DEVON AVENUE ON THE DES PLAINES RIVER FROM JANUARY 1, 2013, THROUGH DECEMBER 31, 2013

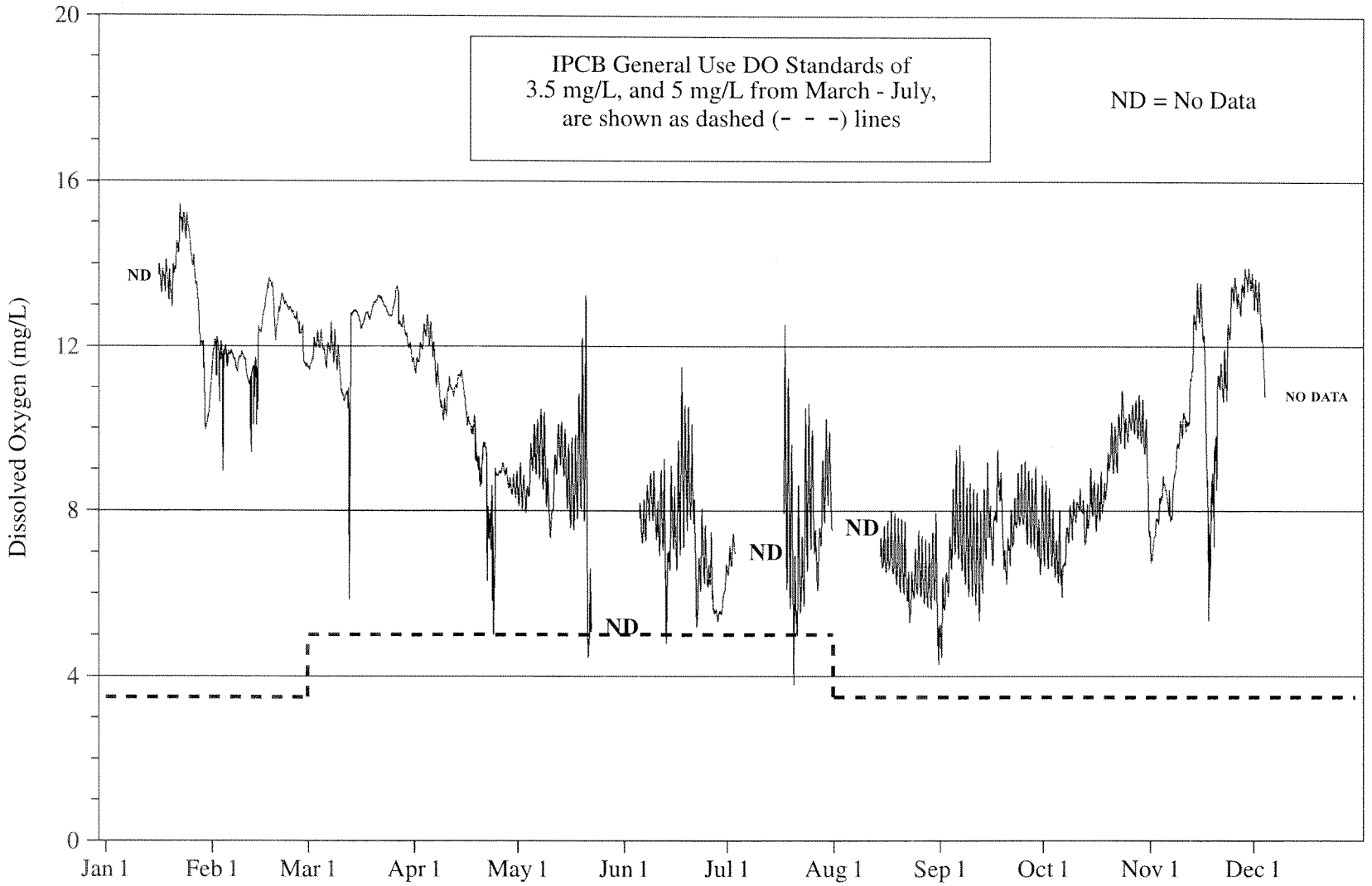


FIGURE 4: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT BUSSE LAKE DAM ON SALT CREEK FROM JANUARY 1, 2013, THROUGH DECEMBER 31, 2013

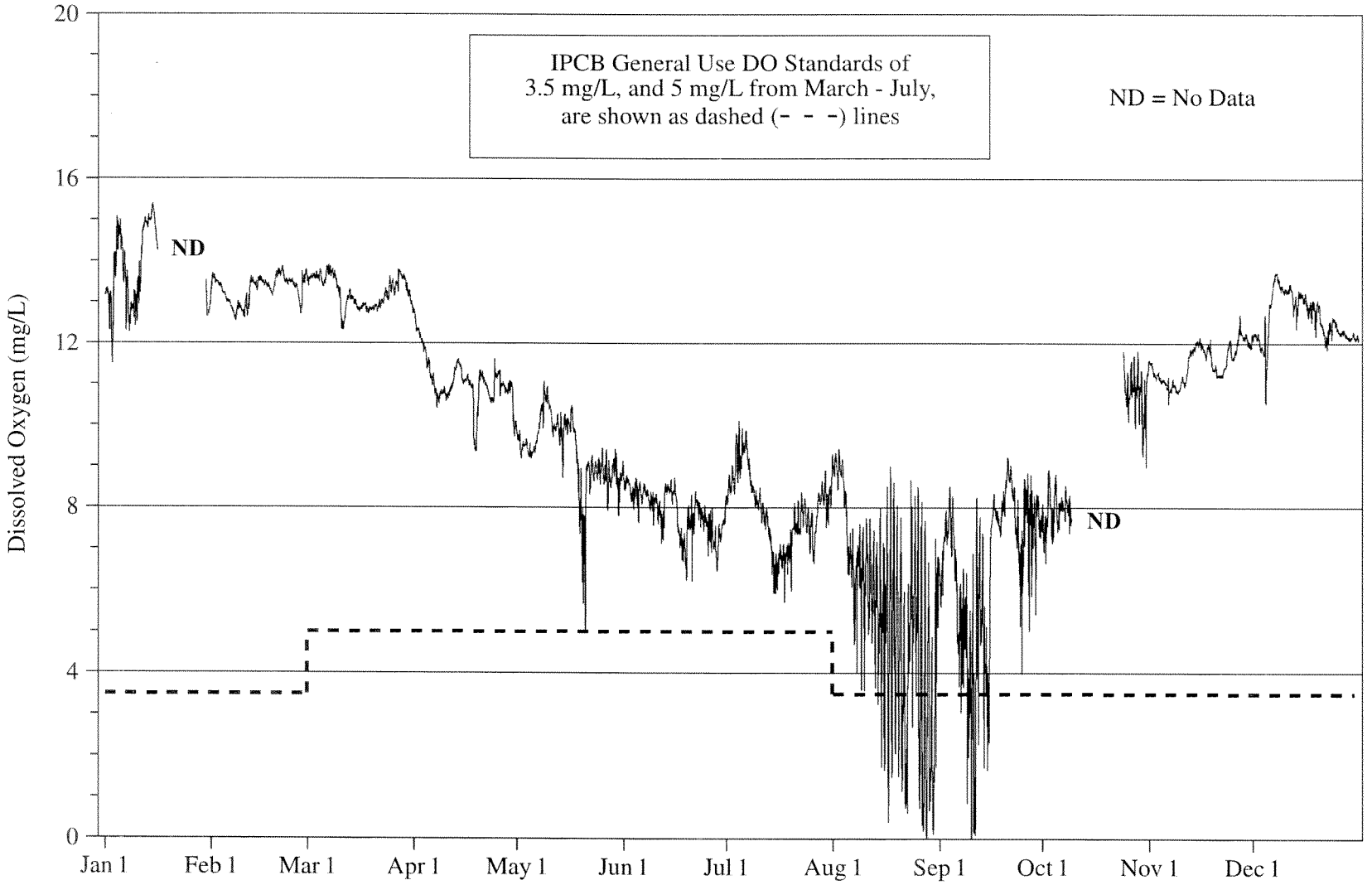


FIGURE 5: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT J. F. KENNEDY BOULEVARD ON SALT CREEK FROM JANUARY 1, 2013, THROUGH DECEMBER 31, 2013

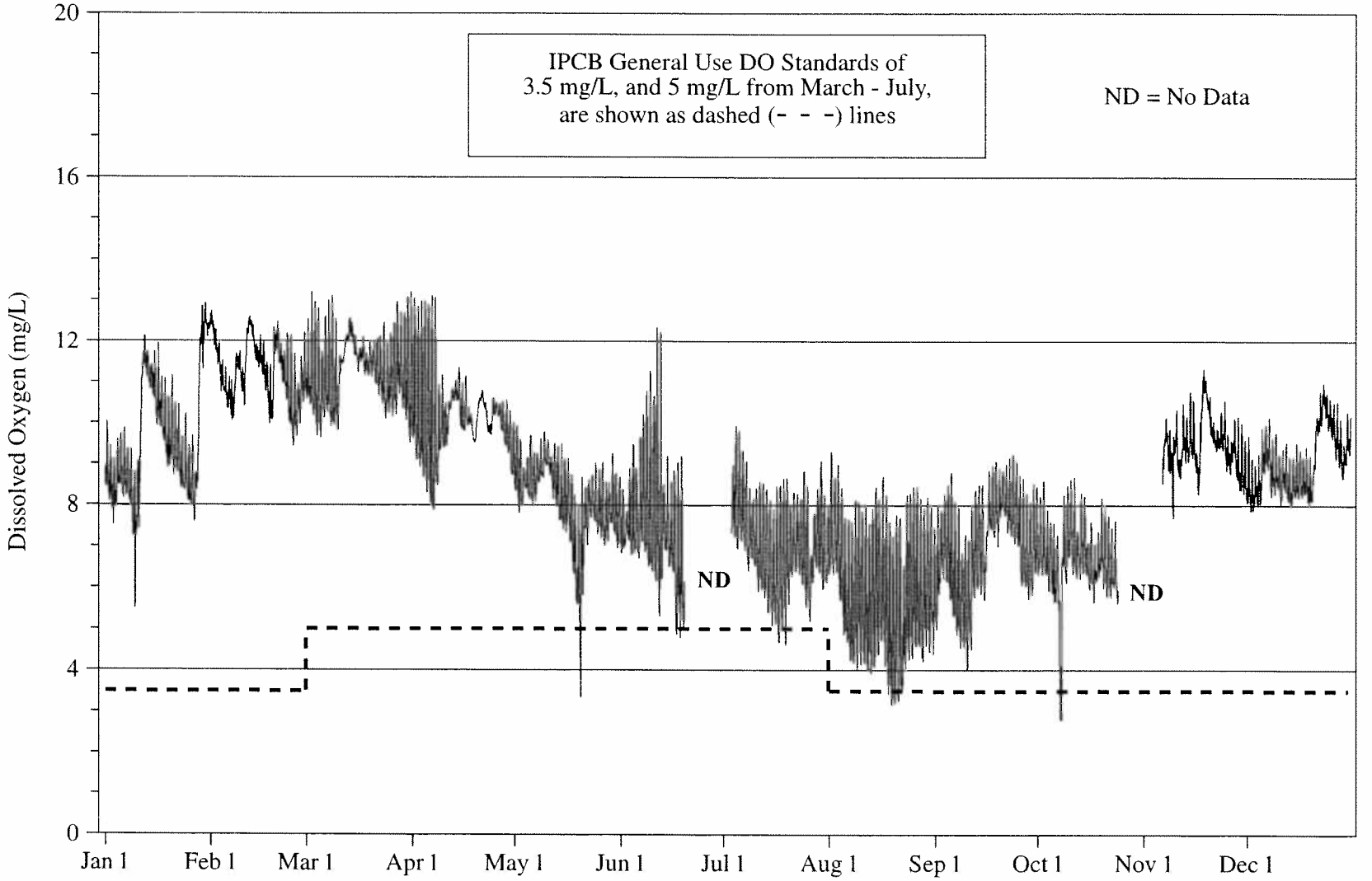


FIGURE 6: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT WOLF ROAD ON SALT CREEK FROM JANUARY 1, 2013, THROUGH DECEMBER 31, 2013

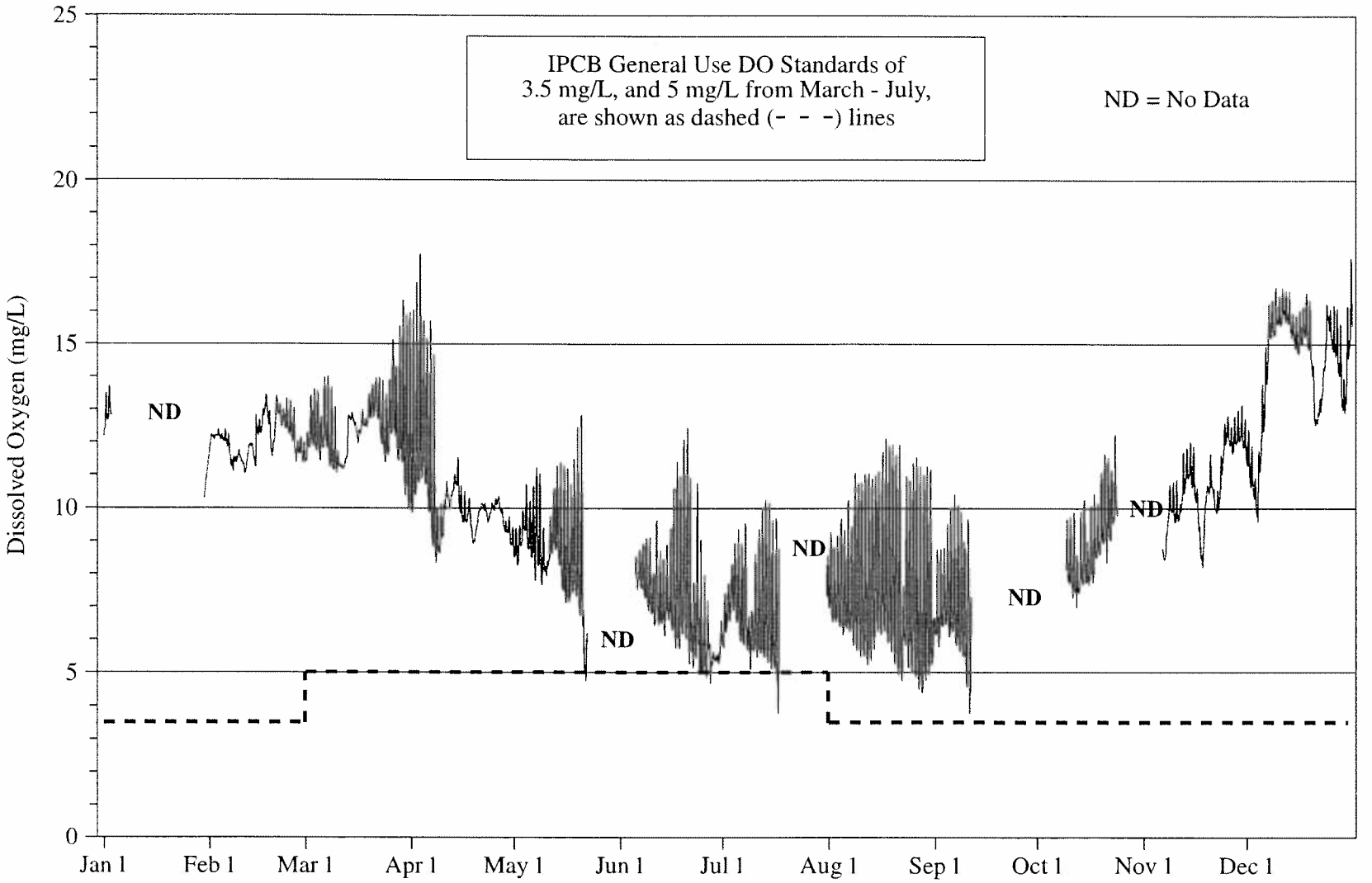
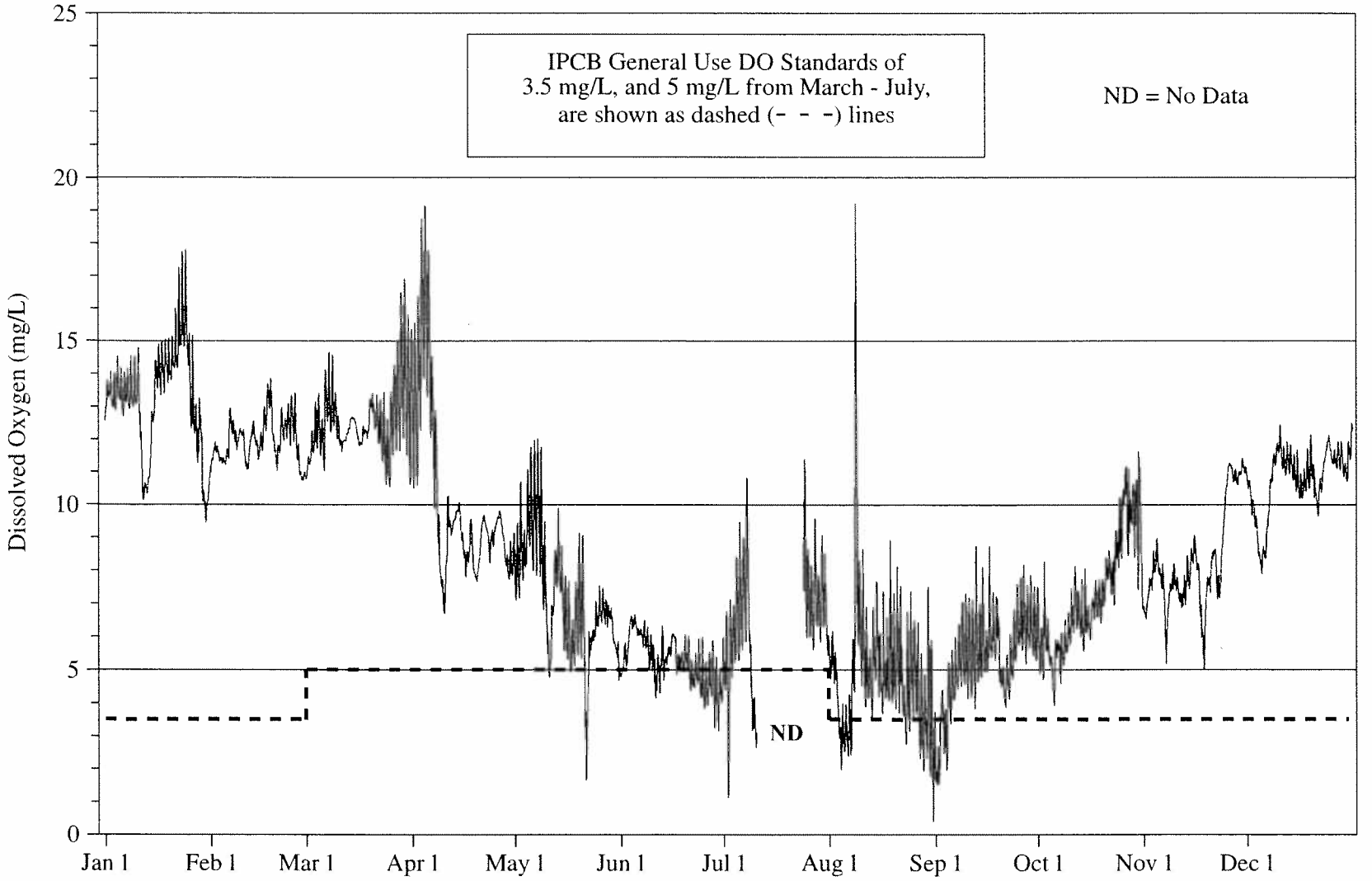


FIGURE 7: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT ASHLAND AVENUE ON THE LITTLE CALUMET RIVER FROM JANUARY 1, 2013, THROUGH DECEMBER 31, 2013



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APPENDIX A

WEEKLY DO SUMMARY STATISTICS AT ALL WADEABLE STREAM MONITORING STATIONS DURING 2013

TABLE A-1: WEEKLY DISSOLVED OXYGEN SUMMARY STATISTICS
AT CENTRAL PARK AVENUE ON THE
NORTH BRANCH CHICAGO RIVER DURING 2013

Monitoring Dates	Number of DO Values	DO Concentration (mg/L)		
		Minimum	Maximum	Mean
01/01/13 - 01/06/13	144	12.3	13.5	12.7
01/07/13 - 01/13/13	168	10.3	13.3	11.8
01/14/13 - 01/20/13	168	11.1	14.9	13.4
01/21/13 - 01/27/13	168	12.2	16.0	14.0
01/28/13 - 02/03/13	168	9.6	12.7	11.8
02/04/13 - 02/10/13	168	11.3	12.9	12.0
02/11/13 - 02/17/13	168	9.2	13.8	11.5
02/18/13 - 02/24/13	168	11.6	14.0	13.0
02/25/13 - 03/03/13	168	11.2	13.6	12.2
03/04/13 - 03/10/13	168	11.0	13.5	12.2
03/11/13 - 03/17/13	167	11.0	13.0	12.1
03/18/13 - 03/24/13	168	12.3	14.1	13.1
03/25/13 - 03/31/13	168	11.7	15.1	13.2
04/01/13 - 04/07/13	168	10.7	18.6	14.4
04/08/13 - 04/14/13	168	8.7	13.1	10.3
04/15/13 - 04/21/13	168	9.0	10.6	9.7
04/22/13 - 04/28/13	59	8.9	9.6	9.2
04/29/13 - 12/31/13		NO DATA		

TABLE A-2: WEEKLY DISSOLVED OXYGEN SUMMARY STATISTICS
AT DEVON AVENUE ON THE
DES PLAINES RIVER DURING 2013

Monitoring Dates	Number of DO Values	DO Concentration (mg/L)		
		Minimum	Maximum	Mean
01/01/13 - 01/13/13		NO DATA		
01/14/13 - 01/20/13	109	13.0	14.1	13.6
01/21/13 - 01/27/13	168	13.1	15.4	14.4
01/28/13 - 02/03/13	168	10.0	13.1	11.5
02/04/13 - 02/10/13	168	9.0	12.0	11.7
02/11/13 - 02/17/13	168	9.4	13.7	12.1
02/18/13 - 02/24/13	168	12.1	13.6	12.9
02/25/13 - 03/03/13	168	11.4	12.8	12.0
03/04/13 - 03/10/13	168	10.8	12.6	11.8
03/11/13 - 03/17/13	167	5.9	12.9	11.9
03/18/13 - 03/24/13	168	12.7	13.2	13.0
03/25/13 - 03/31/13	168	11.5	13.5	12.5
04/01/13 - 04/07/13	168	11.0	12.8	11.9
04/08/13 - 04/14/13	168	10.2	11.4	10.9
04/15/13 - 04/21/13	168	8.6	11.2	9.8
04/22/13 - 04/28/13	168	5.0	9.3	8.3
04/29/13 - 05/05/13	168	8.0	10.1	8.7
05/06/13 - 05/12/13	168	7.4	10.5	9.0
05/13/13 - 05/19/13	168	7.5	12.2	9.1
05/20/13 - 05/26/13	60	4.5	13.2	7.5
05/27/13 - 06/02/13		NO DATA		
06/03/13 - 06/09/13	109	7.2	9.0	8.0
06/10/13 - 06/16/13	168	4.8	9.7	7.5
06/17/13 - 06/23/13	168	5.2	11.5	8.0
06/24/13 - 06/30/13	168	5.3	7.7	6.1
07/01/13 - 07/07/13	58	6.5	7.4	6.9
07/08/13 - 07/14/13		NO DATA		
07/15/13 - 07/21/13	109	3.8	12.5	7.5
07/22/13 - 07/28/13	168	5.5	10.6	7.6
07/29/13 - 08/04/13	59	7.5	10.2	8.7
08/05/13 - 08/11/13		NO DATA		
08/12/13 - 08/18/13	109	6.5	8.0	7.0
08/19/13 - 08/25/13	168	5.3	7.8	6.5
08/26/13 - 09/01/13	168	4.3	7.9	6.1

TABLE A-2 (Continued): WEEKLY DISSOLVED OXYGEN SUMMARY STATISTICS
AT DEVON AVENUE ON THE
DES PLAINES RIVER DURING 2013

Monitoring Dates	Number of DO Values	DO Concentration (mg/L)		
		Minimum	Maximum	Mean
09/02/13 - 09/08/13	168	5.6	9.6	7.3
09/09/13 - 09/15/13	167	5.3	9.2	7.2
09/16/13 - 09/22/13	168	6.2	9.5	7.6
09/23/13 - 09/29/13	168	6.6	9.2	8.0
09/30/13 - 10/06/13	167	5.9	8.9	7.2
10/07/13 - 10/13/13	168	6.7	8.6	7.8
10/14/13 - 10/20/13	168	7.5	10.1	8.5
10/21/13 - 10/27/13	168	8.9	10.9	10.0
10/28/13 - 11/03/13	168	6.8	10.8	8.7
11/04/13 - 11/10/13	168	7.8	10.4	8.9
11/11/13 - 11/17/13	168	6.3	13.6	11.4
11/18/13 - 11/24/13	168	5.4	13.5	10.5
11/25/13 - 12/01/13	168	12.8	13.9	13.4
12/02/13 - 12/08/13	60	10.8	13.6	12.4
12/09/13 - 12/31/13		NO DATA		

TABLE A-3: WEEKLY DISSOLVED OXYGEN SUMMARY STATISTICS
AT BUSSE LAKE DAM ON
SALT CREEK DURING 2013

Monitoring Dates	Number of DO Values	DO Concentration (mg/L)		
		Minimum	Maximum	Mean
01/01/13 - 01/06/13	144	11.5	15.1	13.7
01/07/13 - 01/13/13	168	12.3	15.1	13.7
01/14/13 - 01/20/13	58	14.3	15.4	14.9
01/21/13 - 01/27/13		NO DATA		
01/28/13 - 02/03/13	109	12.7	13.7	13.3
02/04/13 - 02/10/13	168	12.6	13.4	12.9
02/11/13 - 02/17/13	168	12.7	13.6	13.4
02/18/13 - 02/24/13	168	13.1	13.9	13.5
02/25/13 - 03/03/13	168	12.7	13.8	13.5
03/04/13 - 03/10/13	168	12.4	13.9	13.5
03/11/13 - 03/17/13	167	12.3	13.3	12.9
03/18/13 - 03/24/13	168	12.7	13.6	13.0
03/25/13 - 03/31/13	168	12.7	13.8	13.4
04/01/13 - 04/07/13	168	10.4	12.8	11.7
04/08/13 - 04/14/13	168	10.5	11.6	11.0
04/15/13 - 04/21/13	168	9.4	11.3	10.8
04/22/13 - 04/28/13	168	10.5	11.6	10.9
04/29/13 - 05/05/13	168	9.2	11.1	9.7
05/06/13 - 05/12/13	168	9.3	11.1	10.2
05/13/13 - 05/19/13	168	6.2	10.5	9.5
05/20/13 - 05/26/13	168	5.0	9.4	8.6
05/27/13 - 06/02/13	168	7.8	9.4	8.7
06/03/13 - 06/09/13	168	7.6	8.7	8.3
06/10/13 - 06/16/13	168	7.1	8.7	8.1
06/17/13 - 06/23/13	168	6.2	8.4	7.6
06/24/13 - 06/30/13	168	6.5	8.3	7.5
07/01/13 - 07/07/13	168	8.1	10.1	9.0
07/08/13 - 07/14/13	168	5.9	8.7	7.8
07/15/13 - 07/21/13	168	5.7	8.2	7.0
07/22/13 - 07/28/13	168	6.7	8.6	7.7
07/29/13 - 08/04/13	168	7.5	9.4	8.6
08/05/13 - 08/11/13	168	3.6	7.7	6.5
08/12/13 - 08/18/13	168	0.4	9.0	5.4
08/19/13 - 08/25/13	168	0.6	8.7	4.6

TABLE A-3 (Continued): WEEKLY DISSOLVED OXYGEN SUMMARY STATISTICS AT BUSSE LAKE DAM ON SALT CREEK DURING 2013

Monitoring Dates	Number of DO Values	DO Concentration (mg/L)		
		Minimum	Maximum	Mean
08/26/13 - 09/01/13	168	0.0	8.1	3.9
09/02/13 - 09/08/13	168	0.9	8.5	6.3
09/09/13 - 09/15/13	168	0.0	8.2	4.4
09/16/13 - 09/22/13	168	7.3	9.2	8.2
09/23/13 - 09/29/13	168	4.0	8.8	7.4
09/30/13 - 10/06/13	168	6.7	8.9	7.9
10/07/13 - 10/13/13	58	7.4	8.5	8.0
10/14/13 - 10/20/13		NO DATA		
10/21/13 - 10/27/13	86	10.0	11.8	11.0
10/28/13 - 11/03/13	168	9.0	11.8	11.0
11/04/13 - 11/10/13	168	10.5	11.2	11.0
11/11/13 - 11/17/13	168	10.9	12.1	11.7
11/18/13 - 11/24/13	168	11.2	12.1	11.5
11/25/13 - 12/01/13	168	11.6	12.7	12.1
12/02/13 - 12/08/13	168	10.5	13.7	12.6
12/09/13 - 12/15/13	168	12.4	13.4	13.2
12/16/13 - 12/22/13	168	11.9	13.2	12.7
12/23/13 - 12/29/13	168	12.0	12.6	12.3
12/30/13 - 12/31/13	48	12.1	12.3	12.2

TABLE A-4: WEEKLY DISSOLVED OXYGEN SUMMARY STATISTICS
AT J. F. KENNEDY BOULEVARD ON
SALT CREEK DURING 2013

Monitoring Dates	Number of DO Values	DO Concentration (mg/L)		
		Minimum	Maximum	Mean
01/01/13 - 01/06/13	144	7.5	10.0	8.7
01/07/13 - 01/13/13	168	5.5	12.1	9.4
01/14/13 - 01/20/13	168	8.9	11.9	10.3
01/21/13 - 01/27/13	168	7.6	10.5	8.8
01/28/13 - 02/03/13	168	8.5	12.9	11.9
02/04/13 - 02/10/13	168	10.1	11.8	10.9
02/11/13 - 02/17/13	168	10.3	12.6	11.7
02/18/13 - 02/24/13	168	9.8	12.5	11.2
02/25/13 - 03/03/13	168	9.4	13.2	10.8
03/04/13 - 03/10/13	168	9.7	13.1	10.9
03/11/13 - 03/17/13	167	11.3	12.5	11.8
03/18/13 - 03/24/13	167	10.1	12.5	11.3
03/25/13 - 03/31/13	168	9.5	13.2	11.2
04/01/13 - 04/07/13	168	7.9	13.1	10.3
04/08/13 - 04/14/13	168	8.5	11.4	10.2
04/15/13 - 04/21/13	168	9.5	11.1	10.2
04/22/13 - 04/28/13	168	9.4	10.6	10.1
04/29/13 - 05/05/13	168	7.8	10.3	8.9
05/06/13 - 05/12/13	168	8.0	9.8	8.9
05/13/13 - 05/19/13	168	5.3	9.5	7.7
05/20/13 - 05/26/13	168	3.4	9.0	7.7
05/27/13 - 06/02/13	168	6.9	9.3	7.7
06/03/13 - 06/09/13	168	6.5	11.3	8.0
06/10/13 - 06/16/13	168	5.3	12.3	7.7
06/17/13 - 06/23/13	58	4.8	9.2	6.3
06/24/13 - 06/30/13		NO DATA		
07/01/13 - 07/07/13	111	6.8	9.9	8.1
07/08/13 - 07/14/13	167	5.4	8.6	7.0
07/15/13 - 07/21/13	168	4.6	8.7	6.6
07/22/13 - 07/28/13	168	5.2	8.8	6.9
07/29/13 - 08/04/13	168	5.7	9.3	7.1
08/05/13 - 08/11/13	168	4.1	8.1	5.7
08/12/13 - 08/18/13	168	3.4	8.7	5.8
08/19/13 - 08/25/13	168	3.2	8.4	5.3

TABLE A-4 (Continued): WEEKLY DISSOLVED OXYGEN SUMMARY STATISTICS AT J. F. KENNEDY BOULEVARD ON SALT CREEK DURING 2013

Monitoring Dates	Number of DO Values	DO Concentration (mg/L)		
		Minimum	Maximum	Mean
08/26/13 - 09/01/13	168	4.2	8.4	6.0
09/02/13 - 09/08/13	168	4.6	8.8	6.6
09/09/13 - 09/15/13	168	4.0	8.5	6.4
09/16/13 - 09/22/13	168	7.0	9.2	8.0
09/23/13 - 09/29/13	168	5.7	9.2	7.3
09/30/13 - 10/06/13	168	5.7	8.6	6.8
10/07/13 - 10/13/13	168	2.8	8.7	6.7
10/14/13 - 10/20/13	168	5.7	8.2	6.7
10/21/13 - 10/27/13	82	5.6	7.7	6.4
10/28/13 - 11/03/13		NO DATA		
11/04/13 - 11/10/13	109	7.7	10.3	9.4
11/11/13 - 11/17/13	168	8.3	10.8	9.4
11/18/13 - 11/24/13	168	9.2	11.3	10.0
11/25/13 - 12/01/13	168	8.1	10.2	9.0
12/02/13 - 12/08/13	168	7.9	10.1	8.8
12/09/13 - 12/15/13	168	8.0	9.8	8.6
12/16/13 - 12/22/13	168	8.0	10.8	9.0
12/23/13 - 12/29/13	168	8.7	11.0	9.8
12/30/13 - 12/31/13	36	9.0	10.3	9.5

TABLE A-5: WEEKLY DISSOLVED OXYGEN SUMMARY STATISTICS
AT WOLF ROAD ON
SALT CREEK DURING 2013

Monitoring Dates	Number of DO Values	DO Concentration (mg/L)		
		Minimum	Maximum	Mean
01/01/13 - 01/06/13	57	12.2	13.7	12.9
01/07/13 - 01/27/13		NO DATA		
01/28/13 - 02/03/13	110	10.3	12.4	11.8
02/04/13 - 02/10/13	168	11.1	12.4	11.7
02/11/13 - 02/17/13	168	11.0	13.4	12.1
02/18/13 - 02/24/13	168	11.6	13.4	12.6
02/25/13 - 03/03/13	168	11.4	13.6	12.0
03/04/13 - 03/10/13	168	11.1	14.0	12.1
03/11/13 - 03/17/13	167	11.2	13.0	12.1
03/18/13 - 03/24/13	168	11.4	14.0	12.8
03/25/13 - 03/31/13	168	10.0	16.3	12.8
04/01/13 - 04/07/13	168	8.9	17.7	12.2
04/08/13 - 04/14/13	168	8.4	11.5	10.0
04/15/13 - 04/21/13	168	8.9	10.7	9.7
04/22/13 - 04/28/13	168	9.3	10.4	9.9
04/29/13 - 05/05/13	168	8.3	10.7	9.2
05/06/13 - 05/12/13	168	7.7	11.2	8.9
05/13/13 - 05/19/13	168	7.1	12.5	8.9
05/20/13 - 05/26/13	58	4.8	12.8	7.0
05/27/13 - 06/02/13		NO DATA		
06/03/13 - 06/09/13	111	6.9	9.1	8.0
06/10/13 - 06/16/13	168	6.1	10.6	7.4
06/17/13 - 06/23/13	168	5.2	12.4	7.5
06/24/13 - 06/30/13	168	4.7	9.0	5.7
07/01/13 - 07/07/13	168	5.8	9.5	7.2
07/08/13 - 07/14/13	168	5.1	10.2	6.7
07/15/13 - 07/21/13	61	3.8	9.7	6.3
07/22/13 - 07/28/13		NO DATA		
07/29/13 - 08/04/13	111	6.4	9.7	7.6
08/05/13 - 08/11/13	168	5.5	11.0	7.6
08/12/13 - 08/18/13	168	5.2	12.1	8.0
08/19/13 - 08/25/13	168	4.8	11.9	7.4
08/26/13 - 09/01/13	168	4.4	11.5	6.9
09/02/13 - 09/08/13	168	5.6	10.4	7.3

TABLE A-5 (Continued): WEEKLY DISSOLVED OXYGEN SUMMARY STATISTICS
AT WOLF ROAD ON
SALT CREEK DURING 2013

Monitoring Dates	Number of DO Values	DO Concentration (mg/L)		
		Minimum	Maximum	Mean
09/09/13 - 09/15/13	60	3.8	9.7	6.4
09/16/13 - 10/06/13		NO DATA		
10/07/13 - 10/13/13	111	7.0	9.9	8.2
10/14/13 - 10/20/13	168	7.7	11.6	8.9
10/21/13 - 10/27/13	81	8.4	12.2	10.0
10/28/13 - 11/03/13		NO DATA		
11/04/13 - 11/10/13	110	8.4	10.8	9.6
11/11/13 - 11/17/13	168	8.5	12.0	10.4
11/18/13 - 11/24/13	168	8.2	12.6	10.5
11/25/13 - 12/01/13	168	10.9	13.1	12.1
12/02/13 - 12/08/13	167	9.6	16.3	12.7
12/09/13 - 12/15/13	168	14.9	16.7	15.8
12/16/13 - 12/22/13	168	12.5	16.5	14.5
12/23/13 - 12/29/13	168	12.9	16.2	14.7
12/30/13 - 12/31/13	48	13.2	17.6	15.2

TABLE A-6: WEEKLY DISSOLVED OXYGEN SUMMARY STATISTICS
AT ASHLAND AVENUE ON THE
LITTLE CALUMET RIVER DURING 2013

Monitoring Dates	Number of DO Values	DO Concentration (mg/L)		
		Minimum	Maximum	Mean
01/01/13 - 01/06/13	144	12.6	14.5	13.4
01/07/13 - 01/13/13	168	10.1	14.8	12.4
01/14/13 - 01/20/13	168	10.8	15.1	13.8
01/21/13 - 01/27/13	168	11.6	17.8	14.6
01/28/13 - 02/03/13	168	9.5	13.3	11.2
02/04/13 - 02/10/13	168	11.2	12.9	11.9
02/11/13 - 02/17/13	168	11.1	13.7	12.0
02/18/13 - 02/24/13	168	11.0	13.9	12.3
02/25/13 - 03/03/13	168	10.7	13.4	11.6
03/04/13 - 03/10/13	168	11.0	14.7	12.7
03/11/13 - 03/17/13	167	11.6	12.7	12.2
03/18/13 - 03/24/13	167	10.6	13.4	12.4
03/25/13 - 03/31/13	168	10.5	16.9	13.3
04/01/13 - 04/07/13	168	9.9	19.1	14.2
04/08/13 - 04/14/13	168	6.7	11.7	9.0
04/15/13 - 04/21/13	168	7.7	9.7	8.6
04/22/13 - 04/28/13	168	7.9	9.8	9.1
04/29/13 - 05/05/13	168	7.1	11.8	8.7
05/06/13 - 05/12/13	168	4.8	12.0	8.1
05/13/13 - 05/19/13	168	4.9	9.9	6.9
05/20/13 - 05/26/13	168	1.7	9.1	5.9
05/27/13 - 06/02/13	168	4.7	7.1	5.8
06/03/13 - 06/09/13	168	5.0	6.7	6.1
06/10/13 - 06/16/13	167	4.2	6.3	5.4
06/17/13 - 06/23/13	168	4.4	6.1	5.2
06/24/13 - 06/30/13	168	3.2	6.0	4.6
07/01/13 - 07/07/13	168	1.1	10.8	6.4
07/08/13 - 07/14/13	59	2.7	9.1	4.7
07/15/13 - 07/21/13		NO DATA		
07/22/13 - 07/28/13	110	5.6	11.4	7.5
07/29/13 - 08/04/13	168	2.0	9.1	5.3
08/05/13 - 08/11/13	168	2.4	19.2	5.6
08/12/13 - 08/18/13	168	3.5	8.9	5.2
08/19/13 - 08/25/13	168	2.8	8.1	4.8

TABLE A-6 (Continued): WEEKLY DISSOLVED OXYGEN SUMMARY STATISTICS AT ASHLAND AVENUE ON THE LITTLE CALUMET RIVER DURING 2013

Monitoring Dates	Number of DO Values	DO Concentration (mg/L)		
		Minimum	Maximum	Mean
08/26/13 - 09/01/13	168	0.4	7.5	3.4
09/02/13 - 09/08/13	168	1.8	7.0	4.3
09/09/13 - 09/15/13	168	3.8	8.7	5.7
09/16/13 - 09/22/13	167	3.9	8.7	5.4
09/23/13 - 09/29/13	168	4.7	8.2	6.2
09/30/13 - 10/06/13	168	3.9	8.3	5.6
10/07/13 - 10/13/13	168	4.6	8.1	6.3
10/14/13 - 10/20/13	168	5.6	8.4	6.9
10/21/13 - 10/27/13	168	7.0	11.2	9.0
10/28/13 - 11/03/13	168	6.5	11.6	8.6
11/04/13 - 11/10/13	168	5.2	9.0	7.5
11/11/13 - 11/17/13	168	6.0	9.1	7.7
11/18/13 - 11/24/13	168	5.0	10.5	7.9
11/25/13 - 12/01/13	168	10.4	11.4	10.9
12/02/13 - 12/08/13	168	7.9	11.6	9.5
12/09/13 - 12/15/13	168	10.4	12.4	11.4
12/16/13 - 12/22/13	168	9.7	12.1	10.6
12/23/13 - 12/29/13	168	10.7	12.1	11.4
12/30/13 - 12/31/13	48	10.7	12.5	11.5

TABLE A-7: SUMMARY STATISTICS FOR DISSOLVED OXYGEN MEASUREMENTS MADE DURING CROSS-SECTIONAL SURVEYS IN 2013

Waterway, Station, and Date	Water Depth[a] (ft.)			N[b]	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Standard Deviation (mg/L)	Coefficient of Variation (%)
	Left	Center	Right						
North Branch Chicago River									
Central Park Avenue									
05/20/2013	0.9	0.9	0.9	3	7.36	7.75	7.51	0.21	2.77
Des Plaines River									
Devon Avenue									
05/22/2013	4.2	5.6	4.0	9	5.79	6.30	5.99	0.16	2.61
08/15/2013	1.3	2.3	1.6	5	6.97	7.09	7.03	0.06	0.83
10/04/2013	1.9	2.7	1.7	6	6.40	6.44	6.43	0.02	0.27

TABLE A-7 (Continued): SUMMARY STATISTICS FOR DISSOLVED OXYGEN MEASUREMENTS MADE DURING CROSS-SECTIONAL SURVEYS IN 2013

Waterway, Station, and Date	Water Depth[a] (ft.)			N[b]	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Standard Deviation (mg/L)	Coefficient of Variation (%)
	Left	Center	Right						
Salt Creek									
Busse Lake Dam									
05/22/2013	1.0	4.1	1.3	6	8.55	8.65	8.59	0.04	0.51
	2.4	3.1	3.1	6	6.90	7.07	7.01	0.06	0.81
10/04/2013	2.0	2.8	2.0	6	8.32	8.40	8.37	0.03	0.37
J.F. Kennedy Boulevard									
05/22/2013	1.7	2.3	3.0	6	8.37	8.52	8.44	0.06	0.70
08/15/2013	1.1	1.7	2.6	5	7.18	7.91	7.44	0.30	4.03
10/04/2013	0.9	2.0	1.8	5	6.35	7.12	6.88	0.31	4.45
Wolf Road									
06/14/2013	3.1	3.8	3.0	7	8.90	9.03	8.98	0.06	0.63
08/15/2013	1.3	1.3	1.1	3	10.68	10.78	10.73	0.05	0.47
10/04/2013	1.6	2.1	1.5	6	8.18	8.45	8.35	0.13	1.54

TABLE A-7 (Continued): SUMMARY STATISTICS FOR DISSOLVED OXYGEN MEASUREMENTS MADE DURING CROSS-SECTIONAL SURVEYS IN 2013

Waterway, Station, and Date	Water Depth[a] (ft.)			N[b]	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Standard Deviation (mg/L)	Coefficient of Variation (%)
	Left	Center	Right						
Calumet River									
Ashland Avenue									
06/14/2013	4.5	4.3	3.6	8	5.64	5.68	5.66	0.02	0.27
08/09/2013	1.7	3.0	2.5	6	6.10	6.47	6.31	0.14	2.20
10/18/2013	2.1	2.7	3.1	6	7.16	7.38	7.26	0.09	1.29

[a]Water depth at the time of cross sectional survey. Exact measurement location may differ slightly during each event.
[b]Number of DO measurements across transects.