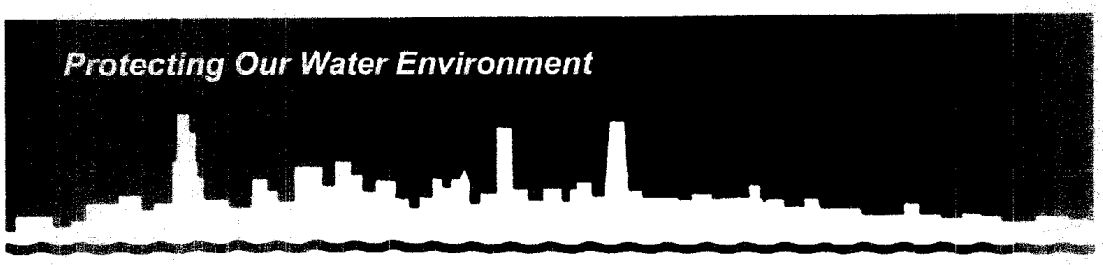

Metropolitan Water Reclamation District of Greater Chicago

RESEARCH AND DEVELOPMENT DEPARTMENT

REPORT NO. 03-1

BUBBLY CREEK WATER QUALITY IMPROVEMENT

A DEMONSTRATION PROJECT IN 2002

January 2003

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BUBBLY CREEK WATER QUALITY IMPROVEMENT

A Demonstration Project In 2002

By

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January 2003

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SUMMARY AND CONCLUSIONS

Bubbly Creek is the name commonly given to the South Fork of the South Branch of the Chicago River. Once the recipient of raw sewage and industrial waste, the creek now serves only to convey combined sewer overflow (CSO) and stormwater a few days each year to the South Branch. The Metropolitan Water Reclamation District of Greater Chicago's (District) Racine Avenue Pumping Station (RAPS) is the principal source of CSO. The City of Chicago owns several other CSO outfalls. In addition, storm water runoff enters directly from adjoining property.

Due to the periodic CSOs and the frequent appearance of floating debris, water quality in Bubbly Creek is generally considered to be poor. The Illinois Environmental Protection Agency (IEPA) has often brought this to the attention of the District. However, for several years there was little incentive to improve water quality. Recently, redevelopment of industrial properties for residential use has brought the condition of Bubbly Creek to the forefront. The District proposed a water quality improvement demonstration project to the IEPA on June 14, 2002. The project was implemented later that month by opening a gate at RAPS to allow water from the creek to discharge through the intercepting sewer system, thereby establishing a flow in the creek when otherwise it would be stagnant. The hypothesis for this demonstration project is that Bubbly Creek needs to flow to allow the natural processes of self-purification to occur. Introducing flow in this manner draws flow from the South Branch through the 1.25-mile long creek to RAPS on the many days when there would be no flow.

The demonstration project lasted for 105 days, from June 20 through October 2, 2002. Approximately 2.5 billion gallons (BG) were drawn through the creek. The handling of this added flow cost the District an estimated $625,000 in electrical energy, debris removal and equipment maintenance. Two storms occurred during the period, which caused the pumping of combined sewer overflow at RAPS and discharge to the creek. The volume of discharge totaled 1.48 BG, but occurred over two relatively short intervals. Normally, at least 6 storms would be expected to cause pumping to the creek during the June through September period. With only 2 CSO events, the demonstration project occurred during a period of relatively dry weather. The District monitored water quality in Bubbly Creek to assess the impact of the induced flow. The conclusions of this demonstration project will be used to guide future operations and perhaps to plan a capital improvement project to provide better water quality in Bubbly Creek.

The conclusions of the 2002 demonstration project in Bubbly Creek are as follows:

1. During prolonged periods of dry weather, the diurnal variation in dissolved oxygen (DO) caused by photosynthetic activity can produce daytime DO concentrations as high as 11 mg/L.

2. Nighttime DO concentrations during extended periods of dry weather can fall well below the Illinois Pollution Control Board standard of 4.0 mg/L due to algae respiration.

3. On some days, during extended periods of dry weather, the DO concentration does not fall below the standard. It is not understood what condition(s) cause this to happen.

4. At times there is a decrease in DO concentrations in Bubbly Creek, which cannot be attributed to a CSO event. The cause may be due to any one or a combination of conditions. These may include a transient current, diurnal variation or navigation traffic. Navigation traffic frequently causes resuspension of oxygen-demanding sediments.

5. It is possible to artificially create flow in Bubbly Creek during dry weather when capacity is available at the Stickney Water Reclamation Plant (WRP) by opening a discharge gate at RAPS and allowing creek water to flow by gravity through the intercepting sewer system to the Stickney WRP.

6. The incremental cost of energy for pumping the artificially created flow at the Stickney WRP is approximately $106 per million gallons (MG).

7. It is not possible to artificially create flow as soon as a CSO event ceases because capacity is not available at the Stickney WRP.

8. Artificial creation of flow in the creek during dry weather appears to provide a slightly higher and more stable level of DO concentrations generally in the range of 3 to 6 mg/L and to dampen diurnal variability, which may cause low nighttime DO concentrations to fall below the standard.

9. Creating artificial flow in Bubbly Creek shortly after a CSO event ceases, significantly decreases the length of the period of depressed DO concentrations from as long as 1 or 2 weeks to as short as 2 days.

10. The artificial creation of flow in Bubbly Creek following CSO events and during dry weather has been demonstrated to improve DO concentrations.

RECOMMENDATIONS

The Bubbly Creek Water Quality Improvement Project conducted in 2002 has provided valuable information and some insight into the dynamics of this little understood waterway. Based on what has been learned and the foregoing conclusions, recommendations for the future are:

1. Additional demonstration project operations should be undertaken in 2003.

2. Additional demonstration project operations should be conducted under a structured experimental plan to provide an opportunity to test improvements over a larger range of flow rates. This will increase our understanding of this little understood part of the waterway system.

3. The experimental plan should include the design of a more comprehensive monitoring program to gather additional information on water quality dynamics in Bubbly Creek.

4. Provide telemetering and real-time availability of continuous DO data to improve demonstration project controls.

5. The method of artificial creation of flow used in the demonstration project should not be looked upon as a long-term solution for water quality improvement in Bubbly Creek because it requires capacity at the Stickney WRP needed for treatment of CSO from the Tunnel and Reservoir Plan.

6. Conduct an engineering study of the feasibility and cost of a means to artificially create flow in Bubbly Creek by pumping water from the South Branch to 38th Street for discharge to the creek.

INTRODUCTION

Bubbly Creek is the name commonly given to the South Fork of the South Branch of the Chicago River. The current condition of Bubbly Creek is much different than a century ago when it served as the outlet for drainage from the infamous Union Stock Yards, a conglomeration of slaughterhouses and meat packing plants. Once the recipient of raw sewage and industrial waste, the creek now serves only to convey combined sewer overflow (CSO) and stormwater a few days each year. The Metropolitan Water Reclamation District of Greater Chicago's (District) Racine Avenue Pumping Station (RAPS) is the principal source of CSO. Other CSO outfalls are owned by the City of Chicago. See Figure 1. Direct storm water runoff enters from adjoining property.

Due to periodic CSOs, and the frequent appearance of floating debris, water quality in Bubbly Creek is generally considered to be poor. The Illinois Environmental Protection Agency (IEPA) has often brought this to the attention of the District. However, for several years there was little incentive to improve the condition of Bubbly Creek. Recently, redevelopment of industrial properties for residential use has brought the condition of Bubbly Creek to the forefront. The District proposed a water quality improvement demonstration project to the IEPA on June 14, 2002. See Appendix I. The project was implemented later that month.

Bubbly Creek has a colorful history and this is described in a book titled *The Chicago River: a natural and unnatural history*, (Hill, 2000). An historical account of the infrastructure affecting Bubbly Creek is found in Appendix II.

Description

The creek channel is approximately 6,600 feet long, originating near Racine Avenue and 38th Street, along the north side of RAPS, and flowing northward into a Turning Basin on the South Branch near 2700 South Ashland Avenue. The mouth of the creek at the Turning Basin is at Fuller Street extended. Bubbly Creek is rather straight and through much of its length it is lined with walls made of steel sheet piles, concrete or wood. Non-vertical stream banks are typically steep with rocky soils.

The channel is spanned by five crossings; namely, 35th Street, Archer Avenue, Interstate Route 55, the CTA Orange Line and the Illinois Central Railroad. Along the banks of Bubbly Creek are found a mix of land uses. Industrial plants, trucking terminals, rail yards and construction materials yards are giving way to commercial strip malls and residences. Examples of newer developments are Riverside Mall on Ashland Avenue, conversion of the former Harry Alter warehouse at 35th Street and Racine Avenue to public storage and present construction of single family housing on former railroad property at 33rd Street west of Racine Avenue.

Channel depths vary from approximately 6 feet near the upstream end to 14 feet at its mouth. At its upstream end and next to the north wall of RAPS, Bubbly Creek begins in a wide area approximately 200 by 400 feet. From this wide area north to 33rd Street, the channel is 150 to 200 feet wide. Between 33rd and 31st Streets, the channel narrows to approximately 120 feet. The

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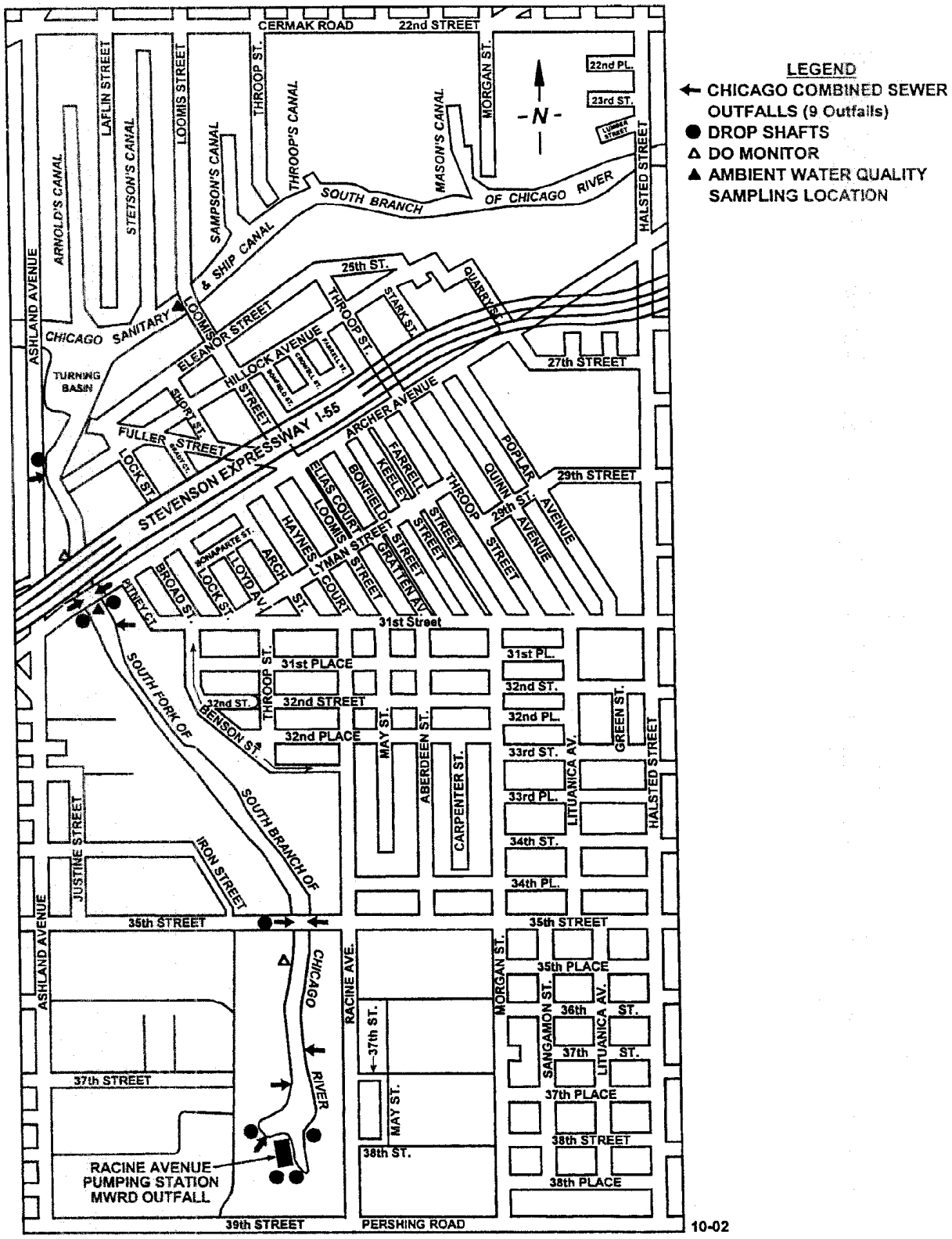
Figure 1

SOUTH FORK OF SOUTH BRANCH OF CHICAGO RIVER

(BUBBLY CREEK)



channel widens again, being 160 to 200 feet wide from 31st Street to its mouth. In addition to RAPS, there are City of Chicago CSO outfalls at 29th, 31st, 35th, 37th and 38th Streets. See Figure 1.

The channel widths above were scaled from an April 1995 aerial photographic map. The depths were determined from centerline soundings between the mouth and 33rd Street made with a recording sonic depth indicator on-board PC1 operated by the Research and Development Department.

Hydraulic Conditions

During dry weather periods Bubbly Creek is stagnant, except for the occasional shifting of water caused by a passing boat or surge from the South Branch. Following light rainstorms, flow in Bubbly Creek is not noticeably changed since most rainfall runoff is captured in the sewer system and conveyed to the Stickney Water Reclamation Plant (WRP). Heavier rainstorms will cause flow to occur in Bubbly Creek when the capacity of the sewer system is reached and pumps at RAPS are turned on to discharge CSO to the creek. During excessively heavy rainfall events, several CSO pumps may be turned on and other CSO outfalls along the creek may also discharge. When this occurs, the water level in the creek rises, increasing the creek's depth and forcing the CSO to flow towards the South Branch. Based on the above physical conditions of the creek, it is estimated that the channel has a volume of 10,000,000 cubic feet or 75 million gallons (MG) below normal water level from its mouth to RAPS. Normal water level is at or slightly below -2.0 feet, Chicago City Datum. Typical channel cross-section area ranges from approximately 900 square feet south of 35th Street to 2,500 square feet near the mouth.

With a flow of 100 cfs, the drop in water level from one end of the creek to the other end is estimated to be less than 0.1 feet. This is based on the application of the Manning Formula assuming a channel roughness of 0.03 for the most restrictive cross-section. Thus, at normal water levels in the Chicago Waterway System, the water level at RAPS would be slightly above or below the water level in the South Branch, depending on the direction of flow. At a discharge rate of 100 cubic feet per second (cfs) or 65 million gallons per day (mgd), the flow-through or residence-time of the creek would be approximately 1.2 days. At 50 cfs (32.5 mgd) and 150 cfs (97.5 mgd), the flow-through time would be 2.4 and 0.6 days, respectively. These flow-through times are comparable to conditions in other District waterways. At a discharge rate of 100 cfs, velocities in the creek would approximately range from 0.11 to 0.04 feet per second (fps). At these velocities, solids would settle and re-suspension of sediments would not occur.

At maximum capacity, RAPS can discharge approximately 6,000 cubic feet per second, raising the water level at 38th Street about 3 feet and increasing the channel water velocity to as much as 5 feet per second. At this rate of discharge from RAPS, the 10,000,000-cubic foot volume of Bubbly Creek would be completely displaced in less than 30 minutes.

Use of Bubbly Creek for Flood Relief

During intense storms with excessive rainfall amounts, it is likely that all 14 pumps at RAPS will be operated and discharge to the creek to prevent local flooding and basement backup. RAPS can also serve as a relief for the Stickney WRP by pulling back from the interceptor running west on 39th Street. At the 6,000 cubic feet per second maximum pumping capacity, Bubbly Creek will rise approximately three feet adjacent to RAPS in order to develop the gradient needed to move the water through the creek to the South Branch. If the South Branch also rises due to increased flow, the creek at RAPS will rise by a similar amount. Maximum water level increases in the creek of 5 to 6 feet at RAPS have been observed by operating personnel. The velocity of water in Bubbly Creek under this condition will be from three to five feet per second.

In the ten-year period 1992 through 2001, pumping to the creek at RAPS has occurred 17 times per year on average. The highest was 27 times in 1993 and the lowest was 10 times in 1997. The duration of pumping varies from a few hours to as long as a day or more, depending on the amount and duration of rainfall. Even with the increased flood storage capacity provided by the TARP McCook Reservoir, expected to be in service in 2014, pumping to the creek at RAPS will continue to occur when intense storms with large rainfall amounts hit the south side of Chicago. There is no other practical and environmentally acceptable way to economically provide for the drainage of this part of the city.

Water Quality Monitoring

The District began monitoring the water quality of Bubbly Creek at the Archer Avenue Bridge in 2001. This is one sampling location in the District's Ambient Water Quality Monitoring (AWQM) Program, which includes waterways throughout the Chicago area. Samples are collected from the creek once per month at the center of the channel and are analyzed at the District's laboratory for over 50 parameters. In addition, the District also performs continuous dissolved oxygen monitoring (CDOM) along the main waterways, including Bubbly Creek. The CDOM program began in 1998 and one location is on the west bank of Bubbly Creek under the Interstate Route 55 Bridge. An additional CDOM location was installed in June 2002 on the west bank of Bubbly Creek at 36th Street. Both AWQM and CDOM on the South Branch near Bubbly Creek afford an opportunity to compare the water quality of the South Branch and Bubbly Creek.

CDOM provides hourly observations using an in-situ automatic water quality monitor. The monitor is located in a protective housing at one side of the waterway cross-section. To determine if the data provided by the monitor is representative of the average DO in the waterway cross-section, measurements of DO are obtained in the cross-section and compared with the observation obtained by the monitor. The observations obtained by the monitor are considered representative of the cross-section if the monitor observation is within 1.0 mg/L of the cross-sectional average. Table 1 shows the results of such a test conducted on August 20, 2002, at the I-55 Bridge and at 36th Street on Bubbly Creek. In both cases, the results show that the monitor is representative of the cross-sectional average. However, the cross-sectional data also show a pattern of point DO measurements that are not typical of those found in other District waterways.

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TABLE 1

CROSS-SECTIONAL DO VALUES MEASURED IN BUBBLY CREEK
ON AUGUST 20, 2002

Monitoring Station	Depth	Cross-Sectional DO Values				
		Left	Center	Right	Mean	Monitor
I-55[1]	surface	4.2	4.1	4.1	4.6	3.5
	3 feet	4.3	4.1	4.2		
	bottom	5.3	6.1	5.7		
36th Street[2]	surface	3.6	4.3	4.7	3.6	3.3
	3 feet	3.1	3.1	4.5		
	bottom	2.9	3.6	2.9		

[1]Cross-sectional survey conducted between 10:50 and 11:10 AM.
[2]Cross-sectional survey conducted between 8:50 and 9:25 AM.

Typically, the point DO measurements are lower near the bottom of the cross-section. However, in Bubbly Creek, the bottom DO measurements are higher in all vertical profiles at the I-55 Bridge and at one vertical profile at 36th Street. The reasons for this are not understood, but it is believed that it may be due to either a transient density current or to a latent effect of photosynthetic activity.

WATER QUALITY CONDITIONS

The range of results for selected parameters in the South Branch at Loomis Street and in Bubbly Creek at Archer Avenue in 2001 and 2002 are compared in the following table. Also shown is the number of results that do not comply (NNIC) with Illinois water quality standards, where such standards exist. NS means that no standards exist. There are only 7 results for chlorophyll, since analysis for this parameter began in 2002.

	Bubbly Creek at Archer Avenue, range of 17 samples except chlorophyll			South Branch at Loomis Street, range of 16 samples except chlorophyll		
Parameter	Min	Max	NNIC	Min	Max	NNIC
Dissolved Oxygen, mg/L	0.0	8.0	10	4.2	7.5	0
Biochemical Oxygen Demand, mg/L	0.0	22.0	NS	0.0	8.0	NS
Suspended Solids, mg/L	9.0	38.0	NS	9.0	37.0	NS
Temperature, degrees C	9.9	28.4	0	9.0	28.2	0
pH, units	5.1	8.4	1	6.2	8.1	0
Turbidity, NTU	6.9	24.8	NS	7.9	20.9	NS
Fecal Coliform, cts/100ml	130	$1.3x10^6$	NS	40	$.13x10^6$	NS
Chlorophyll a, µg/L	0.0	13.5	NS	1.0	9.0	NS

Generally, water quality is more consistent in the South Branch as compared to Bubbly Creek, as shown by the narrower range of results for DO, BOD_5, Fecal Coliform and Chlorophyll a. The higher variability of water quality in Bubbly Creek may be due to the long periods of stagnant flow. The greater variability in DO concentrations in Bubbly Creek may be due to the diurnal variation caused by photosynthetic activity. While the range of chlorophyll appears to be similar, it should be noted that in Bubbly Creek at Archer Avenue, 4 of the 7 results were at or above 11.0 µg/L. The relatively short period of time over which water quality data is available for Bubbly Creek does not allow for conclusions to be drawn regarding seasonal variations.

The results of CDOM in Bubbly Creek at the I-55 Bridge and in the South Branch at Loomis Street for the August 1998 through July 2000 period provides a comparison of DO concentrations in these two water bodies. For this period, approximately 11 percent of the hourly values were rejected for Bubbly Creek because of the application of QA/QC data validation protocols. For the acceptable data, Bubbly Creek was above the Secondary Contact DO water quality standard of 4.0 mg/L only 53 percent of the time. DO concentrations ranged from 0.0 to 18.7 mg/L, with a mean of 4.2 mg/L. Conditions were better in the South Branch during this period. Only 8 percent of the hourly values were rejected and the DO exceeded the standard 98 percent of the time. The DO concentrations ranged from 0.4 to 12.6 mg/L with a mean of 6.6 mg/L. (Polls, 2002)

For the June through September period in the years 1998, 1999 and 2000, CDOM data at the I-55 Bridge exhibited considerable variability as shown in Table 2. The DO ranged from 0.0 to 11.8 mg/L. The portion of monthly DO measurements at or above the standard of 4.0 mg/L varied

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TABLE 2

Dissolved Oxygen Conditions in Bubbly Creek
For August and September 1998 and June through September 1999, 2000 and 2002

Month And Year	Data Available Percent	Data Above Standards Percent	DO Concentration Min	Max	Mean
			mg/L		
At Interstate 55 Bridge					
August 1998	63*	3.2	0.0	5.0	1.6
September 1998	100	52.0	0.2	6.4	3.9
June 1999	91*	12.3	0.0	10.4	1.8
July 1999	100	35.6	0.4	10.7	3.4
August 1999	100	39.5	0.4	9.6	3.4
September 1999	100	54.4	0.2	6.3	3.8
June 2000	100	11.0	0.2	10.6	1.8
July 2000	100	21.2	0.2	11.8	2.7
August 2000	100	21.7	0.1	9.1	2.7
September 2000	100	39.4	0.2	8.5	3.6
June 2002	100	5.7	0.0	10.3	1.3
July 2002	100	30.9	0.2	5.9	3.1
August 2002	100	41.2	0.3	7.1	3.5
September 2002	100	51.3	1.3	5.9	3.9
At 36th Street					
June 2002	15	0.0	0.2	1.2	0.3
July 2002	100	20.7	0.0	10.7	2.3
August 2002	66*	50.3	0.0	7.9	3.8
September 2002	65*	42.5	0.7	8.4	3.7

Notes: No data available at the I-55 Bridge for June and July 1998 and for June through September 2001.
Monitor at 36th Street placed in service on June 25, 2002.
* = Data for part of the period did not pass quality control checks and was rejected. Only valid data used.

from 3.2 to 54.4 percent. Typically, the portion above the standard was lowest in June and highest in September. These conditions will be examined in more depth and compared with conditions in the year 2002 in later discussion. The DO monitor was not in service in 2001.

Sediment Quality Conditions

The District, IEPA, USEPA and The Wetlands Initiative have sampled sediments in Bubbly Creek at various times in the past decade. The District collected samples in January 1995 at three locations: Station 1 at 37th Street, Station 2 at 33rd Street and Station 3 in the Turning Basin. Sediment chemical contaminant concentrations were generally higher at Stations 2 and 3 as compared to Station 1. Results of organic priority pollutant analysis were mixed, showing no station with consistently higher concentrations of these contaminants. (Polls, 2001.) Aged organic sediments lie on the bottom of Bubbly Creek. Clumps of sediment frequently come to the surface when made buoyant by entrapped gas bubbles. These clumps eventually sink when the gas vents to the atmosphere. Although intermittent, the appearance of these clumps is unsightly.

Intake Screens at RAPS

In order to protect the pumps from damage caused by large solid objects, incoming sewage and CSO to RAPS is passed through large screens. There are 10 sets of screens and the screens have an opening of 3 inches between bars. Mechanical rakes are passed over the screens periodically to remove accumulated solids. The solids are collected and disposed as non-hazardous municipal waste. The mechanical raking and removal of solids is automated for optimal performance of the screens.

In early 2001, the District replaced two of the screens at RAPS with new screens having an opening of 1.5 inches. These new screens have operated well without problems. With the narrower opening, it is presumed that an additional amount of solids are collected, thereby reducing the amount of solids discharged to Bubbly Creek during periods when pumping to Bubbly Creek is occurring. Unfortunately, it is not possible to segregate the amount of screenings removed from each set of screens; therefore, the improvement in the removal of solids due to the narrower screen opening cannot be quantified.

WATER QUALITY IMPROVEMENT DEMONSTRATION PROJECT

With the on-off character of Bubbly Creek, from short intervals conveying CSO discharges to the South Branch to longer periods of stagnation, maintaining water quality standards is challenging. In addition, significant depths of aged contaminated sediments lie on the bottom, having a negative impact on water quality. Water quality in Bubbly Creek undoubtedly suffers for a large part of the time because of the lack of flow. During warm summer weather, elevated temperatures of the stagnant water contribute to potential aesthetic and odor nuisance conditions. The DO content of water is one of the principal measures of water quality. Sufficient DO is essential to support aquatic life and to prevent odors released from sediments. Extremely low or zero DO cause septic conditions to occur and stresses all aquatic organisms. Thus, DO is one of the principal water quality indicators.

During CSO pumping episodes at RAPS, a significant quantity of fresh sewage and street runoff solids and some floatable materials are discharged to Bubbly Creek. Following the pumping episode, some of the floatable materials are found either hanging on branches above the water level or collected in pockets near bridge abutments and other shoreline irregularities. Some of the solids from sewage and street runoff settle to the bottom of Bubbly Creek. Water flow is essential to maintain acceptable water quality in any waterway, because flowing water supplies oxygen and increases natural reaeration. The District initiated a project in 2002 to demonstrate how water quality of Bubbly Creek could be improved by providing flow in the creek during dry weather periods.

As shown previously, water quality in other District waterways generally meet standards during dry weather periods. Therefore, if it were possible to induce flow in Bubbly Creek, water quality during these periods would be expected to improve. The most expedient way to accomplish this would be to open a gate at RAPS and allow water from Bubbly Creek to flow into the station and on to the Stickney WRP through the intercepting sewer system. This would cause flow throughout Bubbly Creek to occur, drawing water from the South Branch. In essence, the flow in Bubbly Creek would be reversed. Rather than flow from south to north, it would flow from north to south. Such an operation would also tend to draw back into RAPS, the water that is discharged to the creek during periods when pumping to the creek occurs.

The demonstration project began on June 20 and concluded on October 2, 2002, a total of 105 days. It was interrupted on five occasions due to rainfall. On July 9 and August 22 and 23, rainfall was sufficient to cause CSO pumping to the creek. On June 25, August 13, September 2 and September 23 rain warnings occurred. As a precaution, intake of creek water at RAPS was temporarily curtailed. See Table 3.

There are two options for taking creek water into RAPS, through Gate 21 or through any one of Gates 1, 2 or 3. The former would have required additional pumping at RAPS and the latter would not. The latter method was used for the demonstration project. However, pumping of the additional flow would have to occur at the Stickney WRP. Since the additional flow has a weak waste strength, there would be little treatment or solids handling. It is assumed that the incremental cost of electrical energy would be representative of the additional operational cost. Based on the estimated cost of electrical energy at the Stickney WRP, it was determined that the

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TABLE 3

Racine Avenue Pumping Station
Bubbly Creek Intake Gate Operation in 2002

Date	Time h:m	Gate Position Open	Close	Reason
6-20	7:00 a.m.	X		Begin creek intake
6-24	12:05 p.m.		X	Maintenance
6-24	2:30 p.m.	X		Resume intake
6-25	9:50 a.m.		X	Maintenance and rain warning
6-26	3:20 p.m.	X		Resume intake
7-09	1:40 a.m.		X	Rain warning
7-10	1:45 p.m.	X		Resume intake
7-17	12:45 p.m.		X	Maintenance
7-17	1:10 p.m.	X		Resume intake
7-24	8:00 a.m.		X	Maintenance
7-24	12:00 p.m.	X		Resume intake
8-13	2:50 p.m.		X	Rain warning
8-14	1:30 p.m.	X		Resume intake
8-22	3:00 a.m.		X	Rain warning
8-26	9:25 a.m.	X		Resume intake
9-02	9:20 a.m.		X	Rain warning
9-03	7:20 a.m.	X		Resume intake
9-18	4:55 a.m.		X	Rain warning
9-23	5:30 a.m.	X		Resume intake
10-02	3:50 p.m.		X	Rain warning

105-day demonstration project incurred an additional operating cost of approximately $125,000, exclusive of monitoring activities.

Initially, there was concern for the potential adverse impact this operation would have on the sewer system and the Stickney WRP. First, would the quality of the creek water cause interference with the treatment processes at the Stickney WRP? Second, would sediments in the creek be re-suspended and be drawn into RAPS to cause problems with blockages in the intercepting sewers or process units at the Stickney WRP? The first concern was somewhat allayed by review of the water quality data which showed that the creek water was considerably lower in strength than raw sewage. The second concern was allayed by review of the hydraulic data, which showed that velocities in the creek were sufficiently low and would not cause re-suspension of sediments. Nevertheless, it was decided that the quality of the creek water would be closely monitored during intake and if problems were detected, the intake of creek water would be suspended. Samples were collected at the point of intake at RAPS. After two weeks of monitoring, no adverse impact was found and this additional monitoring was discontinued. To guide the operations staff at the Stickney WRP during the demonstration project, operating guidelines were prepared. These guidelines are found in Appendix III.

Monitoring to determine the impact on water quality in Bubbly Creek was continued throughout the period of the demonstration project. The DO monitors at the Interstate 55 Bridge and at 36th Street were used as the primary source of data to assess the impact on water quality of the intake of creek water at RAPS. The continuous data is superior to intermittent observations or sampling. The DO monitor at 36th Street was not operational until June 26 and did not appear to be operating reliably until the following week. In addition and as a back-up for the CDOM data, twice-daily observations of air and water temperatures and DO concentrations were made in the morning between 9:00 and 10:00 a.m. and in the afternoon between 4:00 and 5:00 p.m. Air temperature was measured at the 35th Street Bridge. Water temperature and DO concentration were measured at Archer Avenue, 35th Street Bridge and at the north wall of RAPS near the point of intake. These observations began on June 18, 2002, and continued through September 30, 2002, and were conducted because of the delay in installing and testing of the new DO monitor at 36th Street. The daily observations are included in Table 4. The table also shows the daily average intake flow and the volume of CSO pumped to the creek on two occasions.

Because of the concern for the impact on the sewer system and treatment plant processes, the initial rates of intake flow were modest. After the first week, the intake flow rate was approximately 27 mgd, except for periods when rainfall was expected. This rate of flow would result in a flow-through time in Bubbly Creek of approximately 2.8 days. The highest rate of intake flow was 38.5 mgd, occurring September 4 through 7. This rate results in a flow-through time of 1.9 days. The lowest creek intake flow was 18.5 mgd on June 21 with a flow-through time of 4.1 days.

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TABLE 4

Bubbly Creek Water Quality Improvement Demonstration Project
Atmosphere and Water Condition Observations

			Water Temperature[5]			Dissolved Oxygen[5]			Discharge[6]	
Date	Time[1] Period	Air Temp.	Archer[2]	35th[3]	RAPS[4]	Archer[2]	35th[3]	RAPS[4]	Intake[7]	CSO[8]
6/18/02	a.m.	26	21	20	22	0.3	0.4	0.7		
6/18/02	p.m.	ND	ND	ND	ND	ND	ND	ND		
6/19/02	a.m.	21	22	22	21	0.7	0.2	0.4		
6/19/02	p.m.	24	23	23	22	4.6	3.2	0.03		
6/20/02	a.m.	28	22	22	22	2.3	0.3	0.3	15.0	
6/20/02	p.m.	28	24	ND	ND	6.0	2.1	0.2		
6/21/02	a.m.	28	24	24	23	10.9	7.1	0.7	18.5	
6/21/02	p.m.	29	25	25	25	11.2	11.3	6.3		
6/22/02	a.m.	24	25	25	24	4.5	2.4	2.4	27.0	
6/22/02	p.m.	25	24	25	26	1.3	0.5	4.4		
6/23/02	a.m.	27	26	26	25	3.8	4.2	1.0	26.7	
6/23/02	p.m.	33	27	27	26	5.3	3.9	3.4		
6/24/02	a.m.	26	26	26	26	1.8	2.3	2.6	30.6	
6/24/02	p.m.	40	27	27	28	3.6	4.8	11.1		
6/25/02	a.m.	28	26	26	26	2.6	1.4	2.0	17.7	
6/25/02	p.m.	32	26	27	27	3.3	2.4	3.0		
6/26/02	a.m.	24	25	26	26	1.8	0.3	0.9	11.6	
6/26/02	p.m.	35	27	27	27	5.1	3.1	5.9		
6/27/02	a.m.	24	26	26	26	4.3	0.3	1.7	32.7	
6/27/02	p.m.	29	27	26	27	5.0	0.3	4.0		
6/28/02	a.m.	24	26	26	26	3.5	0.8	0.5	28.7	
6/28/02	p.m.	38	28	26	29	1.9	0.7	2.3		
6/29/02	a.m.	23	26	26	26	2.1	0.3	0.3	27.0	
6/29/02	p.m.	29	27	26	27	2.7	0.6	1.3		
6/30/02	a.m.	29	25	26	26	3.5	0.6	0.6	27.0	
6/30/02	p.m.	30	28	28	28	4.0	0.7	2.0		
7/01/02	a.m.	29	26	26	27	3.8	2.4	1.6	27.0	
7/01/02	p.m.	40	27	28	28	5.8	4.5	5.7		
7/02/02	a.m.	27	26	26	26	4.9	1.8	1.8	27.0	
7/02/02	p.m.	39	27	28	30	6.1	6.3	6.4		
7/03/02	a.m.	29	27	27	27	4.5	2.6	3.2	27.0	
7/03/02	p.m.	41	28	29	29	5.0	6.2	6.3		
7/04/02	-	ND	ND	ND	ND	ND	ND	ND	27.0	

Metropolitan Water Reclamation District of Greater Chicago

TABLE 4 (Continued)

Bubbly Creek Water Quality Improvement Demonstration Project
Atmosphere and Water Condition Observations

			Water Temperature[5]			Dissolved Oxygen[5]			Discharge[6]	
Date	Time[1] Period	Air Temp.	Archer[2]	35th[3]	RAPS[4]	Archer[2]	35th[3]	RAPS[4]	Intake[7]	CSO[8]
7/05/02	a.m.	19	24	26	26	6.3	3.0	2.5	26.6	
7/05/02	p.m.	32	27	27	28	5.6	4.1	4.5		
7/06/02	-	ND	ND	ND	ND	ND	ND	ND	27.0	
7/07/02	-	ND	ND	ND	ND	ND	ND	ND	27.0	
7/08/02	a.m.	23	25	25	25	4.5	2.8	1.9	26.6	
7/08/02	p.m.	28	25	25	26	5.4	2.5	3.4		
7/09/02	a.m.	24	24	23	23	0.4	0.3	0.5	15.2	90.6
7/09/02	p.m.	31	27	25	24	3.0	0.3	0.3		
7/10/02	a.m.	22	26	25	24	0.5	0.3	0.5	11.5	
7/10/02	p.m.	26	27	26	27	1.1	0.4	0.3		
7/11/02	a.m.	19	25	24	24	0.5	0.4	0.4	27.0	
7/11/02	p.m.	25	26	25	26	0.4	0.3	0.3		
7/12/02	a.m.	18	25	24	24	0.3	0.3	0.4	27.0	
7/12/02	p.m.	27	26	25	27	1.0	0.8	0.5		
7/13/02	-	ND	ND	ND	ND	ND	ND	ND	27.0	
7/14/02	-	ND	ND	ND	ND	ND	ND	ND	27.0	
7/15/02	a.m.	29	26	25	25	4.0	2.0	1.4	27.0	
7/15/02	p.m.	31	28	26	2	5.9	6.2	16.1		
7/16/02	a.m.	28	27	26	26	4.1	3.8	5.4	27.0	
7/16/02	p.m.	33	29	28	29	5.2	7.6	15.6		
7/17/02	a.m.	28	28	27	27	3.7	2.8	6.7	25.0	
7/17/02	p.m.	23	28	28	28	3.3	4.6	7.9		
7/18/02	a.m.	22	28	27	27	2.3	2.5	5.3	27.0	
7/18/02	p.m.	32	31	28	30	5.6	8.5	12.8		
7/19/02	a.m.	23	28	28	28	0.5	4.1	9.2	27.0	
7/19/02	p.m.	33	29	29	29	4.2	8.0	16.4		
7/20/02	-	ND	ND	ND	ND	ND	ND	ND	27.0	
7/21/02	-	ND	ND	ND	ND	ND	ND	ND	27.0	
7/22/02	a.m.	28	29	29	28	3.3	3.7	3.4	27.0	
7/22/02	p.m.	39	30	29	29	5.4	7.0	6.0		
7/23/02	a.m.	21	29	28	27	1.9	2.3	2.2	27.0	
7/23/02	p.m.	29	29	29	28	2.6	6.4	8.0		

Metropolitan Water Reclamation District of Greater Chicago

TABLE 4 (Continued)

Bubbly Creek Water Quality Improvement Demonstration Project
Atmosphere and Water Condition Observations

			Water Temperature[5]			Dissolved Oxygen[5]			Discharge[6]	
Date	Time[1] Period	Air Temp.	Archer[2]	35th[3]	RAPS[4]	Archer[2]	35th[3]	RAPS[4]	Intake[7]	CSO[8]
7/24/02	a.m.	21	28	27	26	2.7	2.5	4.0	22.5	
7/24/02	p.m.	16	28	28	28	2.6	2.8	7.7		
7/25/02	a.m.	22	27	27	26	2.5	2.4	3.0	27.0	
7/25/02	p.m.	25	27	27	26	2.6	2.6	5.0		
7/26/02	a.m.	27	27	26	26	2.5	1.5	2.4	27.0	
7/26/02	p.m.	32	27	27	27	2.2	3.6	6.5		
7/27/02	-	ND	ND	ND	ND	ND	ND	ND	27.0	
7/28/02	-	ND	ND	ND	ND	ND	ND	ND	27.0	
7/29/02	a.m.	26	28	27	27	3.1	3.8	2.6	27.0	
7/29/02	p.m.	30	28	27	27	4.1	6.2	4.7		
7/30/02	a.m.	26	27	27	26	2.0	3.3	3.6	27.0	
7/30/02	p.m.	33	29	29	27	4.8	11.5	14.5		
7/31/02	a.m.	28	28	28	27	2.7	4.4	5.6	27.0	
7/31/02	p.m.	35	2	29	29	5.2	14.0	11.2		
8/01/02	a.m.	28	28	28	28	3.3	5.5	4.4	27.0	
8/01/02	p.m.	40	29	29	29	6.3	9.7	10.4		
8/02/02	a.m.	23	29	28	28	4.3	3.8	3.9	27.0	
8/02/02	p.m.	28	30	29	30	5.4	7.7	9.5		
8/03/02	-	ND	ND	ND	ND	ND	ND	ND	27.0	
8/04/02	-	ND	ND	ND	ND	ND	ND	ND	27.0	
8/05/02	a.m.	23	28	28	28	4.3	2.3	3.0	27.0	
8/05/02	p.m.	30	30	29	30	5.6	4.1	8.8		
8/06/02	a.m.	21	27	27	27	3.3	2.5	3.1	27.0	
8/06/02	p.m.	ND	ND	ND	ND	ND	ND	ND		
8/07/02	a.m.	22	26	26	26	4.2	2.7	2.4	27.0	
8/07/02	p.m.	23	27	27	28	5.5	6.4	10.4		
8/08/02	a.m.	22	26	26	25	3.7	2.6	3.3	27.0	
8/08/02	p.m.	25	28	27	28	6.1	4.8	10.4		
8/09/02	a.m.	22	26	26	25	3.7	2.5	3.3	27.0	
8/09/02	p.m.	28	27	27	28	5.5	5.2	11.2		
8/10/02	-	ND	ND	ND	ND	ND	ND	ND	27.0	
8/11/02	-	ND	ND	ND	ND	ND	ND	ND	27.0	

Metropolitan Water Reclamation District of Greater Chicago

TABLE 4 (Continued)

Bubbly Creek Water Quality Improvement Demonstration Project
Atmosphere and Water Condition Observations

			Water Temperature[5]			Dissolved Oxygen[5]			Discharge[6]	
Date	Time[1] Period	Air Temp.	Archer[2]	35th[3]	RAPS[4]	Archer[2]	35th[3]	RAPS[4]	Intake[7]	CSO[8]
8/12/02	a.m.	22	28	27	26	4.5	4.3	4.6	31.0	
8/12/02	p.m.	33	28	28	28	6.5	9.5	10.9		
8/13/02	a.m.	23	28	27	26	4.4	4.6	5.1	20.0	
8/13/02	p.m.	25	28	28	28	6.1	7.3	7.2		
8/14/02	a.m.	21	27	27	26	4.1	4.0	3.2	11.8	
8/14/02	p.m.	22	27	27	26	3/7	3/0	2.7		
8/15/02	a.m.	23	26	26	25	3.5	2.9	2.9	27.0	
8/15/02	p.m.	31	27	27	26	4.7	6.6	7.8		
8/16/02	a.m.	24	27	26	26	3.7	3.5	3.9	27.0	
8/16/02	p.m.	23	27	26	26	4.2	4.2	10.0		
8/17/02	-	ND	ND	ND	ND	ND	ND	ND	27.0	
8/18/02	-	ND	ND	ND	ND	ND	ND	ND	27.0	
8/19/02	a.m.	18	26	25	25	2.8	3.2	2.5	29.5	
8/19/02	p.m.	24	26	25	25	2.8	3.8	6.2		
8/20/02	a.m.	18	24	25	24	6.1	2.2	2.2	32.7	
8/20/02	p.m.	25	25	25	26	4.6	4.6	9.9		
8/21/02	a.m.	23	24	24	24	3.5	3.0	3.3	32.7	
8/21/02	p.m.	25	24	25	25	6.3	3.7	4.5		
8/22/02	a.m.	22	22	22	22	6.1	6.8	5.0	6.8	
8/22/02	p.m.	23	23	23	23	4.7	5.3	4.9		1,390
8/23/02	a.m.	22	22	22	22	0.1	0.2	0.2	0	
8/23/02	p.m.	22	23	22	23	0.3	0.3	0.2		
8/24/02	-	ND	ND	ND	ND	ND	ND	ND	0	
8/25/02	-	ND	ND	ND	ND	ND	ND	ND	0	
8/26/02	a.m.	19	23	24	24	2.7	0.3	0.4	19.8	
8/26/02	p.m.	30	25	24	26	0.3	0.2	0.2		
8/27/02	a.m.	22	23	24	24	3.1	0.3	0.6	32.7	
8/27/02	p.m.	22	23	24	27	2.8	0.4	0.5		
8/28/02	a.m.	27	23	24	24	2.7	0.3	0.3	32.7	
8/28/02	p.m.	30	24	24	26	5.3	0.4	0.5		
8/29/02	a.m.	23	23	23	24	3.7	1.3	0.3	32.7	
8/29/02	p.m.	32	26	24	26	6.8	1.0	7.6		

Metropolitan Water Reclamation District of Greater Chicago

TABLE 4 (Continued)

Bubbly Creek Water Quality Improvement Demonstration Project
Atmosphere and Water Condition Observations

			Water Temperature[5]			Dissolved Oxygen[5]			Discharge[6]	
Date	Time[1] Period	Air Temp.	Archer[2]	35th[3]	RAPS[4]	Archer[2]	35th[3]	RAPS[4]	Intake[7]	CSO[8]
8/30/02	a.m.	23	25	24	24	4.6	3.3	3.1	32.7	
8/30/02	p.m.	33	27	26	26	6.3	6.3	10.2		
8/31/02	-	ND	ND	ND	ND	ND	ND	ND	32.7	
9/01/02	-	ND	ND	ND	ND	ND	ND	ND	32.7	
9/02/02	-	ND	ND	ND	ND	ND	ND	ND	13.5	
9/03/02	a.m.	17	25	25	24	3.0	2.6	3.1	26.4	
9/03/02	p.m.	28	27	26	27	5.4	6.6	12.2		
9/04/02	a.m.	22	27	25	25	2.6	2.4	4.0	38.5	
9/04/02	p.m.	26	27	26	27	3.6	4.8	6.4		
9/05/02	a.m.	22	27	26	25	3.3	2.3	1.7	38.5	
9/05/02	p.m.	26	28	27	28	5.3	3.1	4.4		
9/06/02	a.m.	29	27	26	26	4.4	2.6	1.8	38.5	
9/06/02	p.m.	29	28	28	28	5.0	3.0	5.2		
9/07/02	-	ND	ND	ND	ND	ND	ND	ND	38.5	
9/08/02	-	ND	ND	ND	ND	ND	ND	ND	38.1	
9/09/02	a.m.	24	28	28	28	4.7	2.5	2.7	26.3	
9/09/02	p.m.	30	29	29	30	5.7	3.5	8.4		
9/10/02	a.m.	28	29	28	28	3.5	3.4	2.6	21.2	
9/10/02	p.m.	29	30	29	29	5.2	5.9	6.5		
9/11/02	a.m.	18	28	27	26	3.9	2.8	2.8	21.2	
9/11/02	p.m.	23	27	27	27	4.6	4.4	5.3		
9/12/02	a.m.	18	28	26	26	3.8	1.6	2.5	21.2	
9/12/02	p.m.	27	28	27	27	5.4	1.5	4.2		
9/13/02	a.m.	18	28	26	25	4.3	2.6	1.9	21.2	
9/13/02	p.m.	25	28	27	27	4.4	3.1	3.5		
9/14/02	-	ND	ND	ND	ND	ND	ND	ND	21.2	
9/15/02	-	ND	ND	ND	ND	ND	ND	ND	21.0	
9/16/02	a.m.	19	24	23	23	3.5	2.3	0.8	21.0	
9/16/02	p.m.	22	24	24	24	3.9	2.8	3.4		
9/17/02	a.m.	19	25	23	23	4.8	3.3	1.0	21.0	
9/17/02	p.m.	25	27	24	25	5.4	3.7	4.8		

Metropolitan Water Reclamation District of Greater Chicago

TABLE 4 (Continued)

Bubbly Creek Water Quality Improvement Demonstration Project
Atmosphere and Water Condition Observations

			Water Temperature[5]			Dissolved Oxygen[5]			Discharge[6]	
Date	Time[1] Period	Air Temp.	Archer[2]	35th[3]	RAPS[4]	Archer[2]	35th[3]	RAPS[4]	Intake[7]	CSO[8]
9/18/02	a.m.	19	26	24	23	4.0	3.8	2.8	4.4	
9/18/02	p.m.	30	26	25	24	4.3	4.1	3.5		
9/19/02	a.m.	24	26	24	23	3.7	3.3	1.9	0	
9/19/02	p.m.	ND	ND	ND	ND	ND	ND	ND		
9/20/02	a.m.	24	25	24	24	2.8	3.5	1.9	0	
9/20/02	p.m.	20	26	24	23	3.9	4.0	2.9		
9/21/02	-	ND	ND	ND	ND	ND	ND	ND	0	
9/22/02	-	ND	ND	ND	ND	ND	ND	ND	0	
9/23/02	a.m.	11	23	22	21	2.8	4.7	3.6	16.3	
9/23/02	p.m.	21	24	23	22	3.7	8.4	11.0		
9/24/02	a.m.	8	23	21	20	4.3	3.7	5.6	21.2	
9/24/02	p.m.	19	24	22	21	5.4	4.4	8.4		
9/25/02	a.m.	15	23	21	20	4.4	3.9	4.2	20.9	
9/25/02	p.m.	22	24	22	22	5.2	3.9	6.8		
9/26/02	a.m.	16	23	22	21	4.8	4.2	4.3	21.2	
9/26/02	p.m.	24	26	22	23	5.9	4.1	5.5		
9/27/02	a.m.	16	24	23	22	4.6	3.8	3.3	20.9	
9/27/02	p.m.	ND	ND	ND	ND	ND	ND	ND		
9/28/02	-	ND	ND	ND	ND	ND	ND	ND	21.2	
9/29/02	-	ND	ND	ND	ND	ND	ND	ND	21.2	
9/30/02	a.m.	19	22	23	22	5.6	3.4	3.4	24.9	
9/30/02	p.m.	27	23	23	24	4.7	3.9	4.7		
10/01/02	-	ND	ND	ND	ND	ND	ND	ND	26.7	
10/0202	-	ND	ND	ND	ND	ND	ND	ND	17.7	

ND = No data.

Notes:

1. Observations generally made between 9:00 and 10:00 a.m. and between 4:00 and 5:00 p.m. Beginning 7/4/02, observations on holidays and weekend days were discontinued.

2. From 6/18/02 through 6/24/02 a.m., observations made on the east bank at 33rd Street. Thereafter, observations made from the Archer Avenue Bridge.

Metropolitan Water Reclamation District of Greater Chicago

TABLE 4 (Continued)

Bubbly Creek Water Quality Improvement Demonstration Project
Atmosphere and Water Condition Observations

3. Observations made from the 35th Street Bridge.

4. Observations made from the north wall near the northwest corner of the Racine Avenue Pumping Station (RAPS).

5. Observation of dissolved oxygen in mg/L and of temperature in °C made with a portable field meter calibrated in the laboratory.

6. Discharge in millions of gallons per day based on M&O Department records.

7. Average daily flow withdrawn from Bubbly Creek through Gate No. 3 at RAPS.

8. Combined sewer overflow volume in millions of gallons pumped to Bubbly Creek from RAPS.

DEMONSTRATION PROJECT ASSESSMENT

For purposes of this assessment, conditions during the summer of 2002 will be compared to the summer of 1999 and 2000. Unfortunately, as a cost reduction measure, the DO monitor at the I-55 Bridge was taken out of service and was not available for the summer of 2001, a period of remarkably frequent and intense rainfall activity. Conditions during the summer of 2002 were relatively dry as compared to 1999 and 2000, as shown by the following table.

Month and Year	**Monthly Total Rainfall in inches**	**Number of Events Pumping to the Creek Occurred**
June 1999	6.16	3
July 1999	2.83	1
August 1999	3.13	1
September 1999	1.94	1
June 2000	3.68	2
July 2000	3.09	2
August 2000	2.71	2
September 2000	3.22	1
June 2002	2.76	2
July 2002	1.10	1
August 2002	3.34	1
September 2002	1.67	0

Rainfall for the four months in 2002 totaled 8.87 inches compared to 14.06 and 12.70 inches for 1999 and 2000, respectively. Similarly, pumping to the creek occurred on 4 events in 2002, as compared to 6 events in 1999 and 7 events in 2000. Because of the less frequent CSOs, it would be expected that water quality in Bubbly Creek in 2002 would be better than the other years. The number of times that pumping to the creek occurs in any month is related to the portion of time in the month that the creek complies with the DO standard. As shown in Table 2, the month of June in all three years met the standard less than 12 percent of the time at I-55. These months also had two or more CSO pumping events. Note that the demonstration project did not begin until June 20. Months with no or only one CSO pumping event had at least 31 percent, and as high as 54 percent compliance.

DO Conditions in 1998, 1999 and 2000

The amount of rainfall and volume of CSO pumped to the river at RAPS for each storm event during the month of August 1998 and during the months of June through September in 1999 and 2000 are as follows:

Date of Storm	Amount of rainfall in inches	Volume of CSO pumped in MG
1998		
August 4 and 5	2.20	814
August 7	0.73	259
1999		
June 2	1.33	859
June 10 and 11	2.93	92
June 13	0.74	357
July 21	0.85	340
August 19	0.93	238
September 28	1.53	402
2000		
June 13 and 14	0.76	476
June 24	1.00 (est.)	280
July 3	1.34 (est.)	648
July 10	1.11 (est.)	354
August 6	1.17	153
August 17	0.91	61
September 11 and 12	2.32	1,320

It should be noted that the RAPS rain gage was out of service for three storms in 2000. For these events, estimated rainfall was calculated from three nearby rain gages.

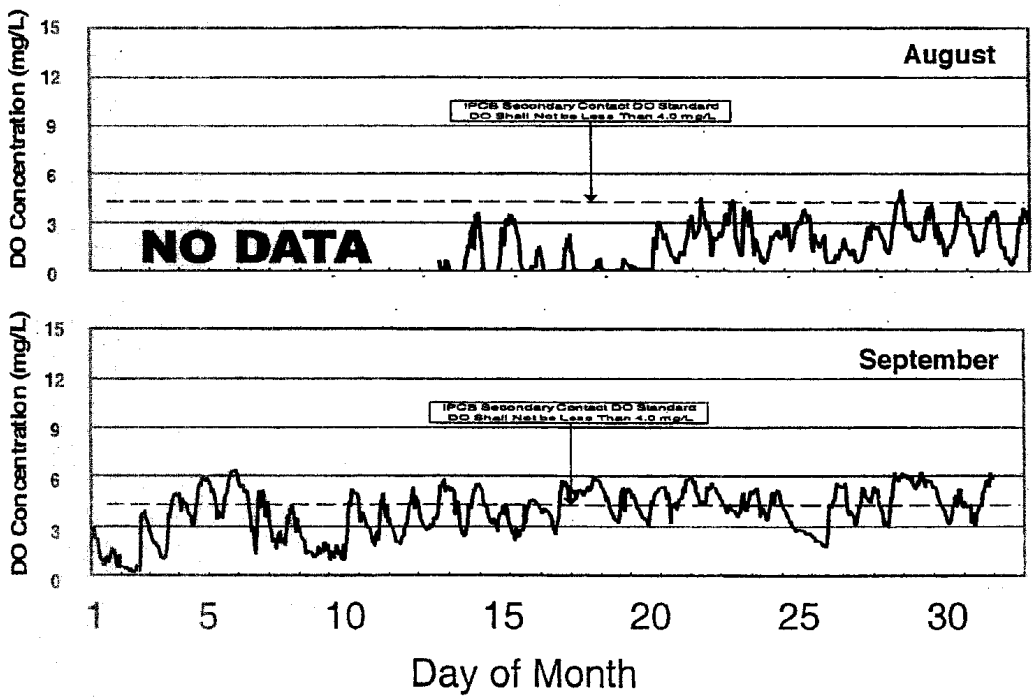
August and September 1998. The data from the DO monitor at the I-55 Bridge was not available for the two events in early August 1998. However, as shown in Figure 2 the DO in mid-August 1998 varied from 0 to 3 mg/L. No CSO events occurred in the latter part of August or in September and DO concentrations improved. In the latter part of August, DO concentrations varied from 1 to 4 mg/L. Improvement continued through September with the DO concentration varying from 2 to 6 mg/L. Diurnal variation occurred throughout this period.

June through September 1999. In June 1999, the DO was above the standard prior to the first CSO event of the month, as shown in Figure 3. As a result of the three events in the early part of June, the DO remained below the standard, except for a brief peak of 9 mg/L on June 9. The three CSO events discharged a total of 1,300 MG, approximately 17.5 times the volume of Bubbly Creek. It wasn't until June 19, that the DO showed significant improvement, remaining below the standard most of the time, but peaking daily above the standard. However, beginning on June 25 and extending through July 2, the DO concentration was depressed even though there were no CSO events. The DO concentration improved on July 3 and remained slightly below the standard until July 14 when it rose above the standard for several days. The CSO event on July 21 caused a marked reduction in the DO concentration, which lasted until July 29. This single

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 2

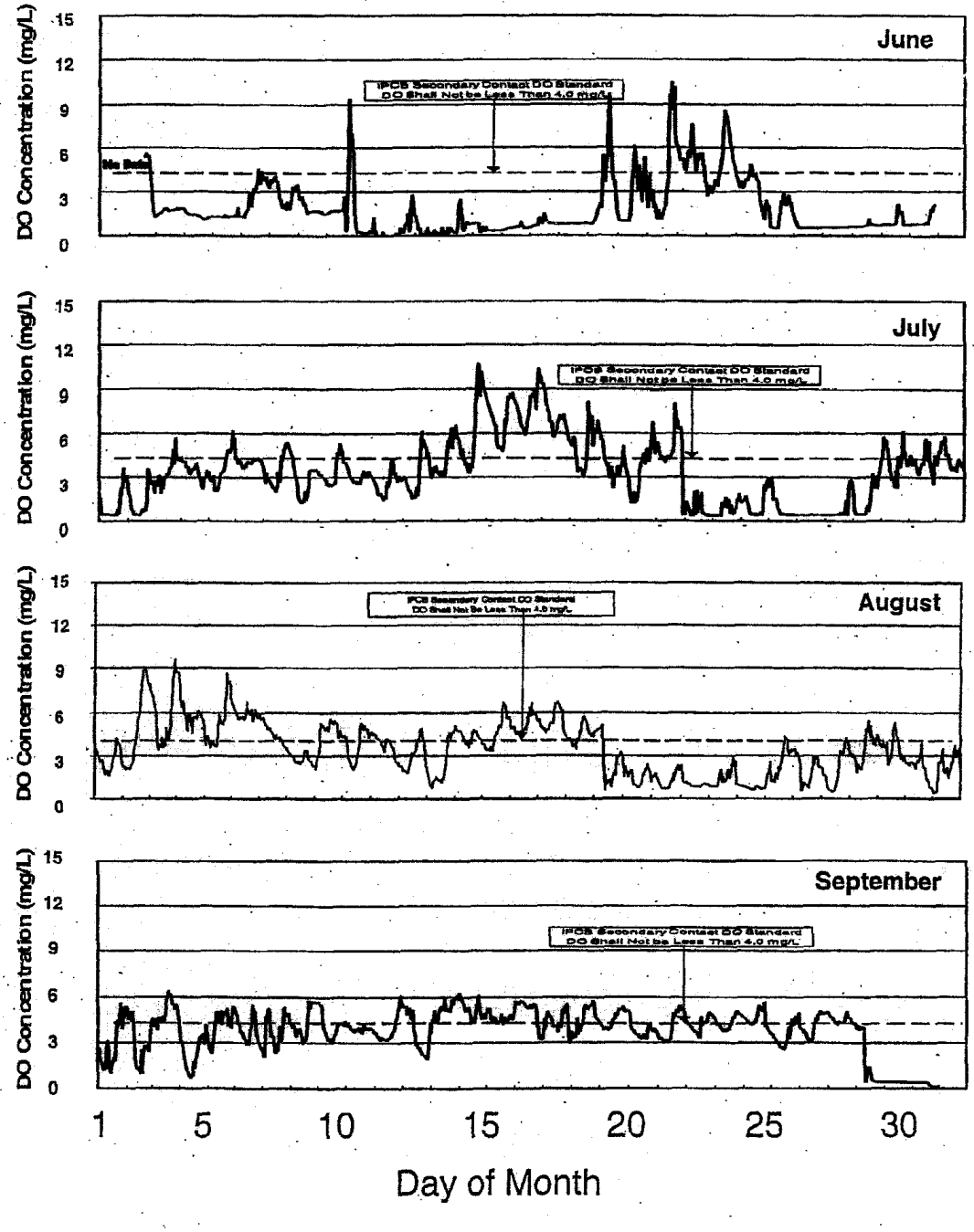
DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY
AT INTERSTATE HIGHWAY 55 IN BUBBLY CREEK
DURING 1998



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 3

DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY
AT INTERSTATE HIGHWAY 55 IN BUBBLY CREEK
DURING 1999



CSO event discharged 340 MG, or 4.5 times the volume of the creek. In August, a similar pattern of DO concentrations occurred. The CSO event on August 19 caused a reduction in DO concentration for 7 days. This event discharged 238 MG, or 3.2 times the volume of the creek. In September, the DO concentration remained near the standard until the end of the month when the CSO event of September 28 again caused a depression in the DO concentration.

June through September 2000. The data from the DO monitor at the I-55 Bridge was not available for most of June and the first half of July, as shown in Figure 4. The CSO event on June 13 and 14 discharged 476 MG or 6.3 times the volume of the creek. The June 24 event discharged 280 MG or 3.7 times the volume of the creek and the adverse impact of this event is shown in the partial data record. The CSO event of July 3 discharged 648 MG or 8.6 times the volume of the creek and the July 10 event discharged 354 MG or 4.7 times the volume of the creek. The DO concentration recovers slowly until July 26 when it is above the standard for most of the day and the diurnal variation in DO is as much as 9 mg/L. July 2000 ends with a drop in DO concentration, which is not the result of a CSO event.

The pattern of diurnal variations in DO concentrations in August 2000 is fairly consistent and does not appear to be severely affected by the CSO events on August 6 and 17. These events were comparatively small, discharging only 153 and 63 MG, respectively. The DO concentration is near the standard for the first part of September 2000. However, on August 12 the DO concentration drops to below 2 mg/L, an obvious result of the CSO event on the same day, which discharged 1,320 MG or 17.6 times the volume of the creek. The depressed DO concentrations last until August 27 (a period of 15 days) and the range of diurnal variation is reduced.

Hydraulic Conditions in June through September 2002

Flow in Bubbly Creek caused by the intake of water at RAPS from June 20 through October 2 and the two CSO events are shown in Table 4. CSO pumping to the creek and other rainfall events in the period June through September 2002 are shown in Table 5. From June 1 through 19, the only flow was caused by the two CSO events, which occurred prior to the start of the demonstration project. The event on June 4 discharged 62.3 MG, or 0.83 times the volume of the creek. The latter event on June 10 and 11 produced 308 MG, or slightly over 4 times the volume of the creek. By the end of June, the intake of creek water totaled 262.5 MG, less than the quantity of CSO discharged to the creek in early June. In the first 8 days of July, an additional 214.6 MG of creek water was taken in at RAPS.

Less than a month into the project, the CSO event on July 9 discharged 90.6 MG, or about 1.2 times the volume of the creek. In anticipation of this rainfall, the intake of creek water was curtailed, as shown in Table 3. There was an interval of 36 hours before the intake of creek water resumed. Intake continued through a period of lower than normal rainfall until late August, when another CSO event occurred. By this time, 678 MG of creek water had been taken in since the start of the project. The CSO event on August 22 and 23 discharged 1,390 MG, or approximately 18.5 times the volume of the creek. The intake of creek water was curtailed in anticipation of this rainfall. It was resumed after 4.3 days when capacity was available at the Stickney

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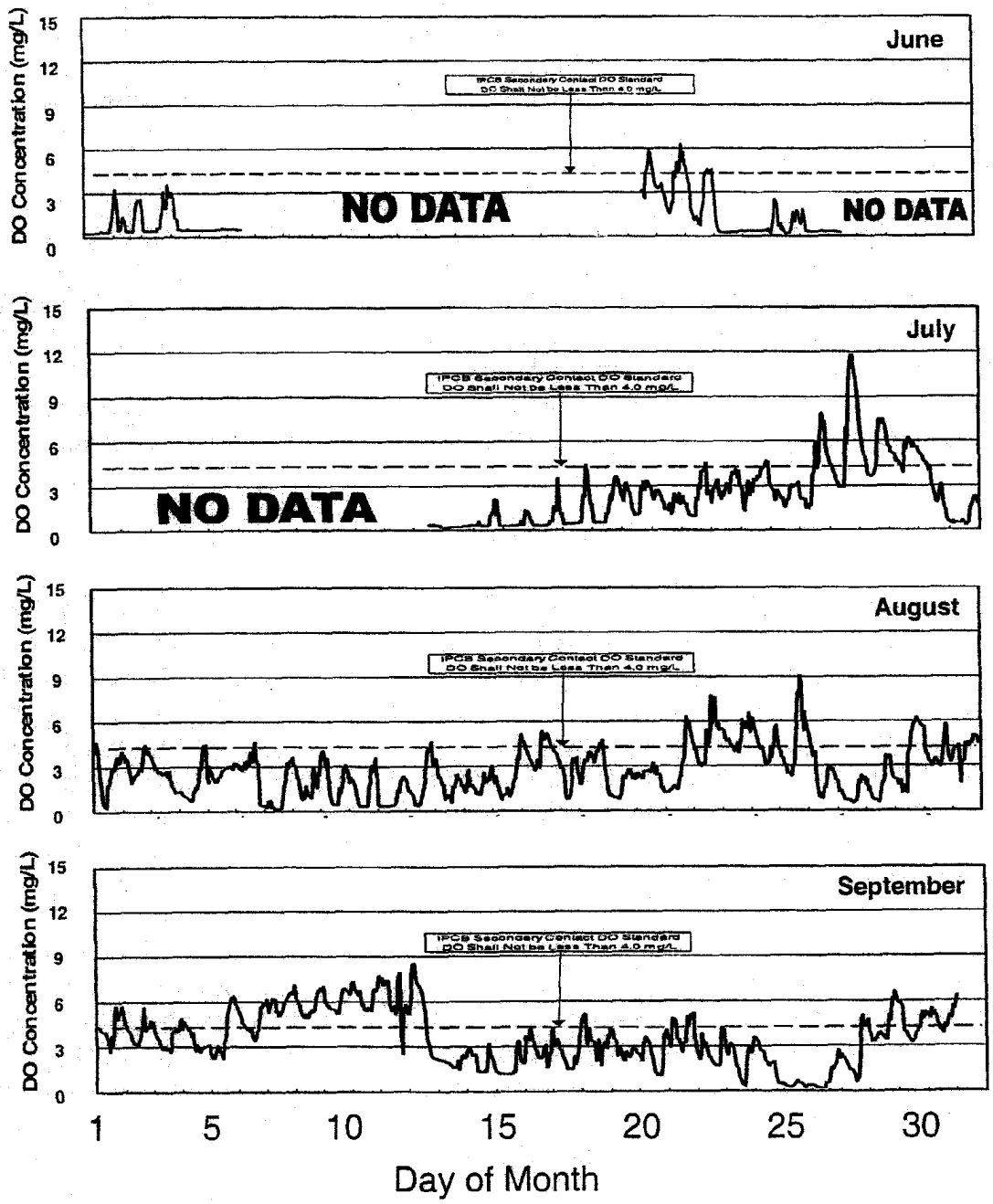
FIGURE 4

DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY
AT INTERSTATE HIGHWAY 55 IN BUBBLY CREEK
DURING 2000



Metropolitan Water Reclamation District of Greater Chicago

TABLE 5

Combined Sewer Overflow Pumped to Bubbly Creek from Racine Avenue Pumping Station June through September 2002

		Pumping Duration			
Date	Rainfall at Station (inches)	Start Time	End Time	Duration (hours)	Volume Pumped (million gallons)
6/04	0.33	3.50 p.m.	7:20 p.m.	3.5	62.3
6/10 6/11	1.60	7:30 p.m.	1:35 a.m.	6.1	308
7/09	0.94	3:20 a.m.	7:13 a.m.	3.9	90.6
8/22 8/23	3.34	4:35 a.m.	8:50 a.m.	28.3	1,390

Other Rainfall without Pumping to Bubbly Creek

6/14	0.18				
6/25	trace				
8/04	0.12				
8/13	0.21				
9/02	0.75				
9/18	0.19				
9/20	0.32				

WRP. No more CSO events occurred through the end of September 2002. By the end of the project on October 2, 2,490 MG of creek water had been discharged to the Stickney WRP at RAPS.

In addition to the above, the intake of flow was curtailed 4 times in anticipation of rainfall. During these times no CSO pumping occurred at RAPS. The dates and duration of the closures are: June 25 for 29 hours, August 13 for 23 hours, September 2 for 22 hours and September 23 for 5 days. Short-term closures also occurred for maintenance on June 24 for 2.5 hours, July 17 for 0.5 hours and July 24 for 4 hours.

DO Conditions in 2002

The low DO concentrations that appear at the I-55 Bridge, as shown in Figures 5 and 6 were caused by the CSO event of June 4. The larger CSO event of June 10 and 11 extended the period of depressed DO concentrations, about 15 days, until June 20, when the demonstration project began as shown on Figure 7. The intake of creek water at RAPS began at 7:00 a.m. and shortly after noon there was a noticeable increase in the DO concentration. The DO concentration dropped again and then improved steadily until near the standard at the I-55 Bridge at the close of June, as shown in Figure 8. In early July it rose slightly above the standard, as shown in Figure 9. Meanwhile, during this period at 36th Street, the DO concentration was between 0 and 3 mg/L. Also during this period, the nearest upstream DO monitor on the South Branch at Jackson Boulevard was measuring DO concentrations between 3 and 8 mg/L and most of these measurements were above the standard.

As shown in Figure 10, the CSO event on July 9 had a pronounced effect on the DO concentration. However, the period of depressed DO concentration only lasted 3.5 days at 36th Street and 4 days at I-55 before recovery began. The curtailment of creek intake at RAPS lasted 36 hours or 1.5 days. The DO concentration in the South Branch showed a depression on July 9 and 10. These depressed DO concentrations in the South Branch may have delayed the recovery in Bubbly Creek if the depressed condition also occurred near the mouth of Bubbly Creek. The South Branch DO concentrations returned to the standard by July 11. However, the standard was not reached at I-55 until July 14 and at 36th Street until July 16, as shown in Figure 11.

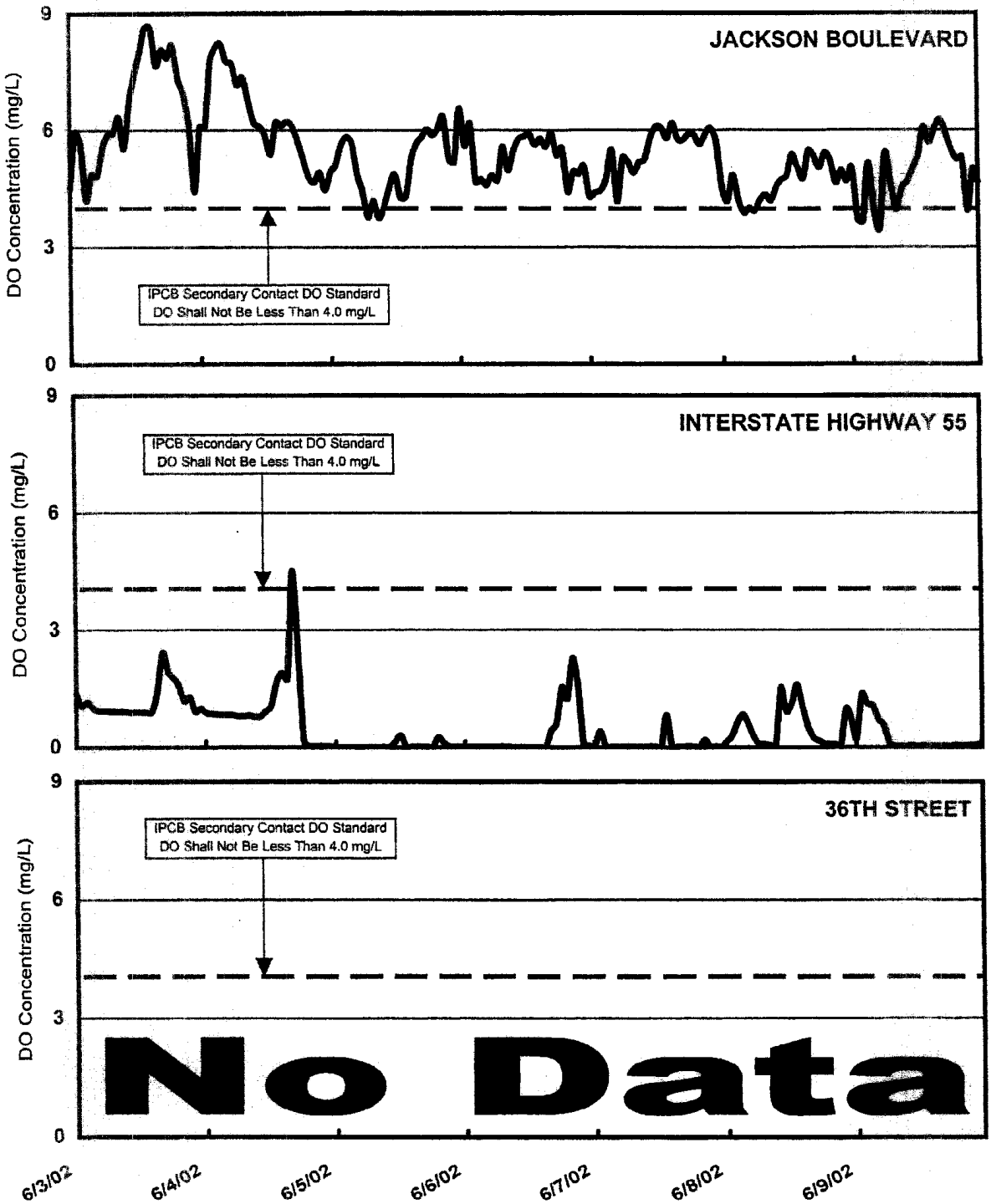
The week of July 15 through July 21 exhibited good DO conditions at all three locations. Remarkably, the DO concentrations were higher at 36th Street as result of the diurnal variation. There was a closure of the intake gate for 25 minutes on July 17 for maintenance, but such a short closure is not likely the cause of the drop in DO concentration for several hours at 36th Street on that day. The drop in DO concentration at 36th Street on July 21 cannot be related to a closure at RAPS or a CSO event.

Continued DO conditions at or above the standard are noted for the week of July 22 through July 28 in the South Branch, as shown in Figure 12. During this week, the DO concentrations at the I-55 Bridge were near, but not above the standard. Conditions at 36th Street were slightly less desirable; however, the diurnal variation did bring the DO concentrations above the standard for a part of 3 days and near to the standard on other days.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 5

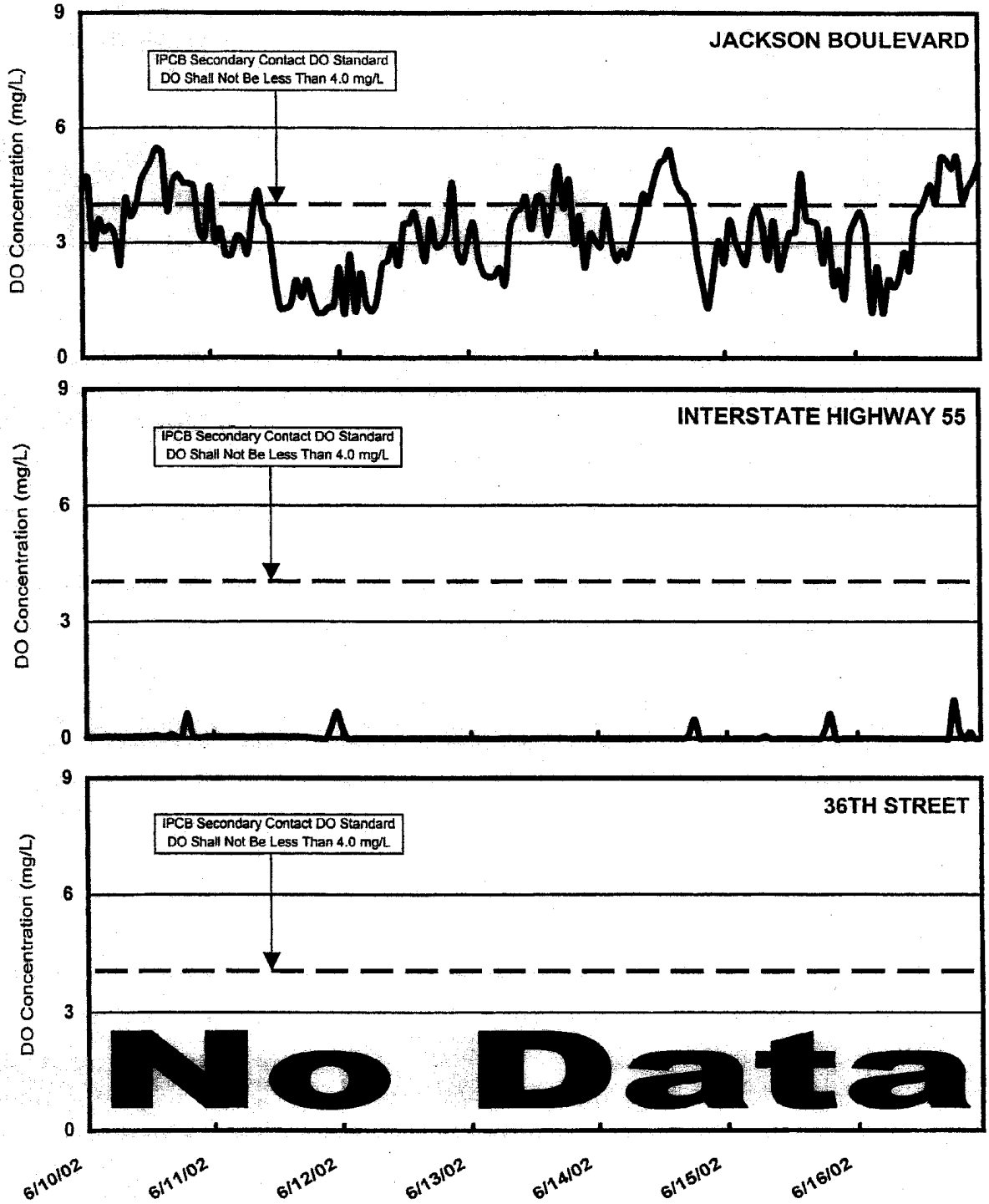
DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT
JACKSON BOULEVARD IN THE SOUTH BRANCH OF THE CHICAGO RIVER AND
INTERSTATE HIGHWAY 55 AND 36TH STREET IN BUBBLY CREEK
JUNE 3 THROUGH JUNE 9, 2002



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 6

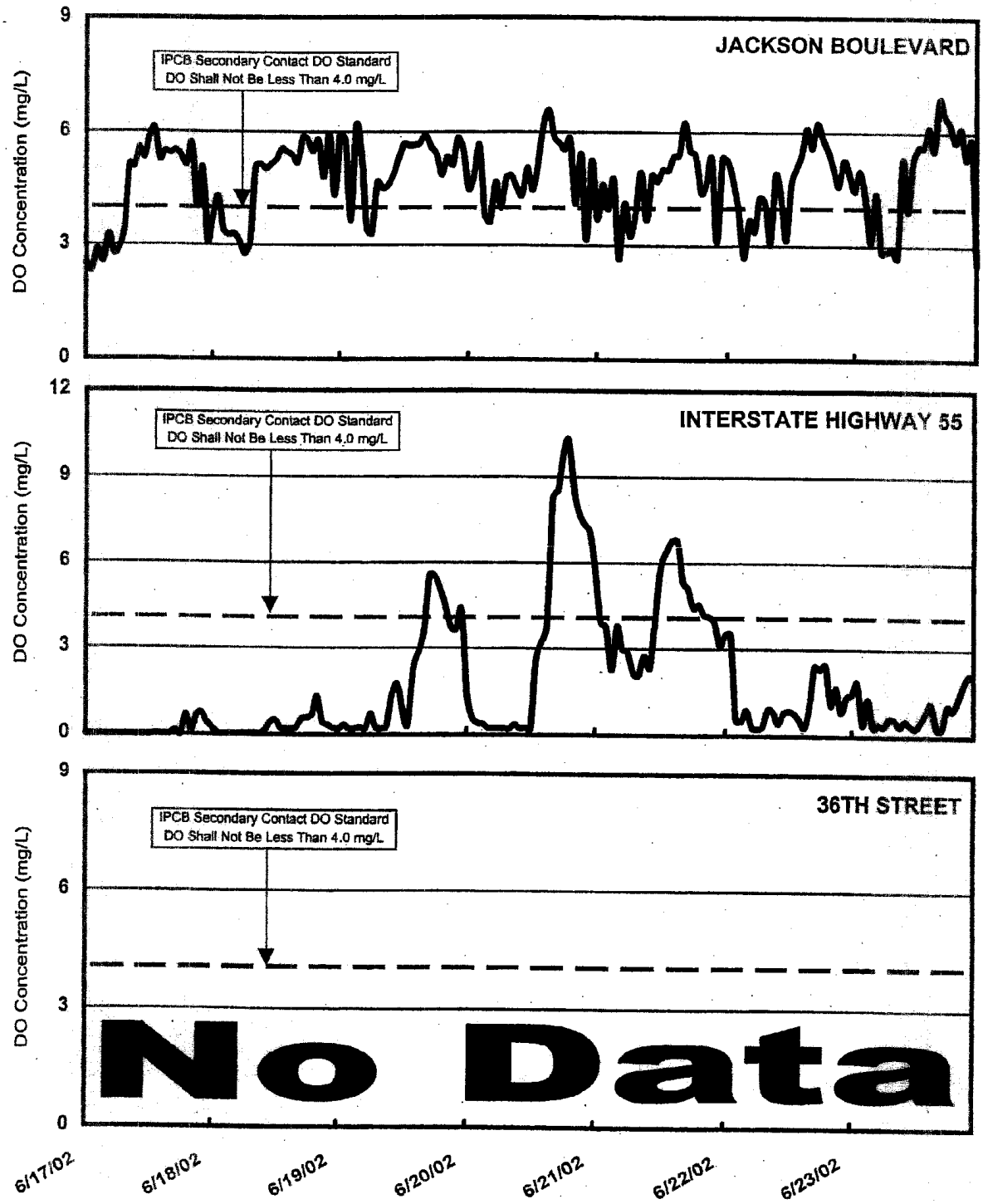
DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT
JACKSON BOULEVARD IN THE SOUTH BRANCH OF THE CHICAGO RIVER AND
INTERSTATE HIGHWAY 55 AND 36TH STREET IN BUBBLY CREEK
JUNE 10 THROUGH JUNE 16, 2002



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 7

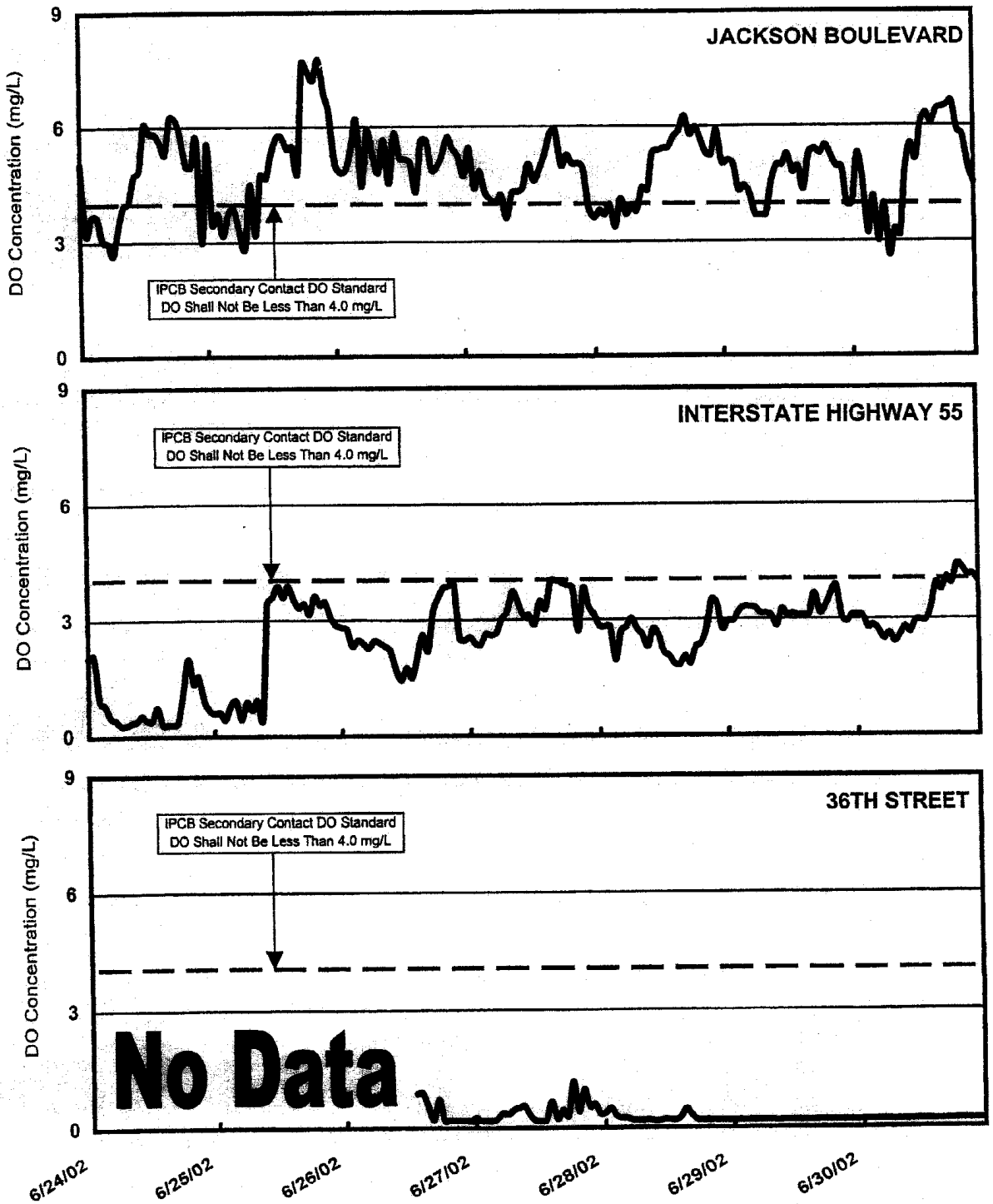
DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT
JACKSON BOULEVARD IN THE SOUTH BRANCH OF THE CHICAGO RIVER AND
INTERSTATE HIGHWAY 55 AND 36TH STREET IN BUBBLY CREEK
JUNE 17 THROUGH JUNE 23, 2002



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 8

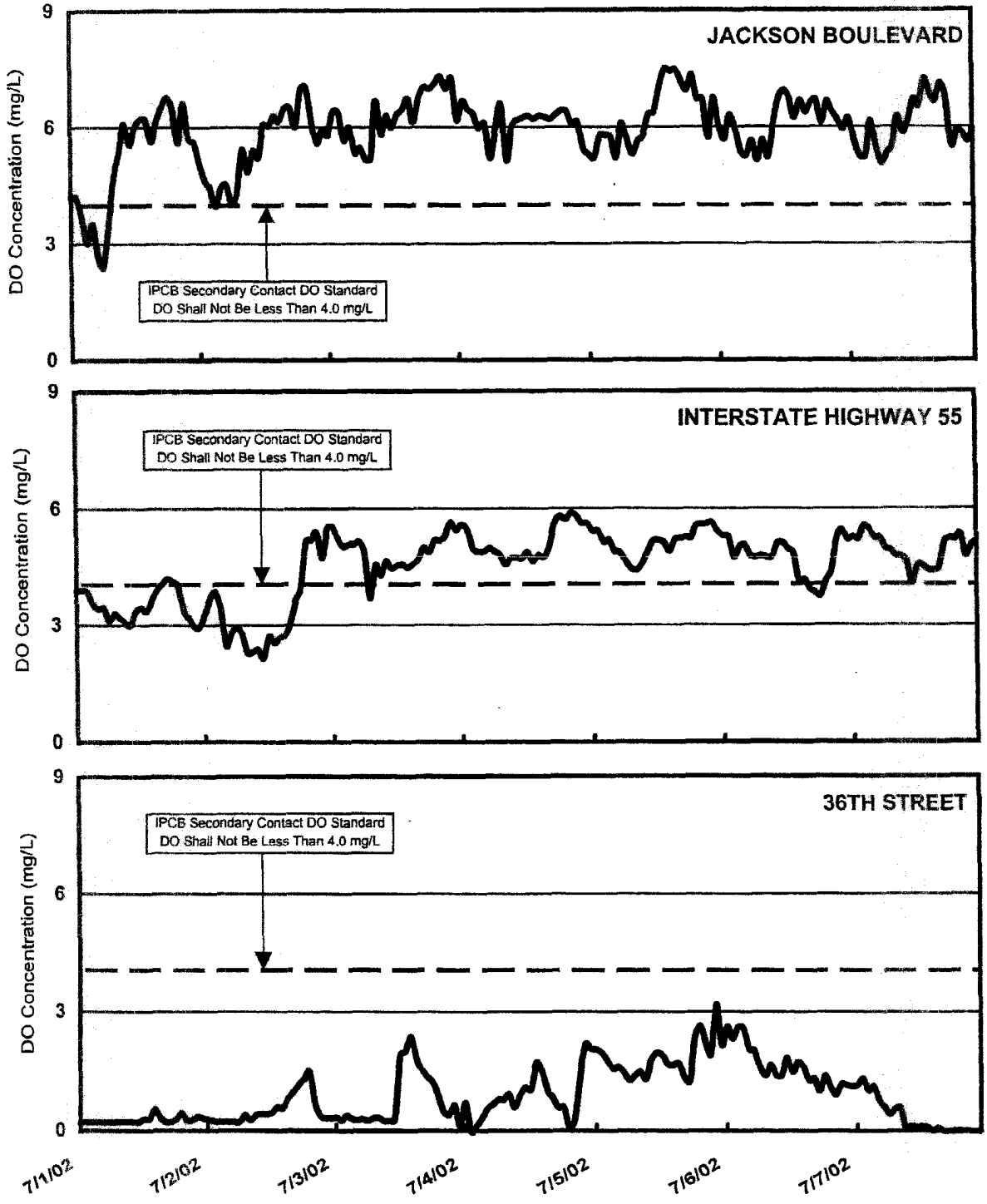
DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT
JACKSON BOULEVARD IN THE SOUTH BRANCH OF THE CHICAGO RIVER AND
INTERSTATE HIGHWAY 55 AND 36TH STREET IN BUBBLY CREEK
JUNE 24 THROUGH JUNE 30, 2002



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 9

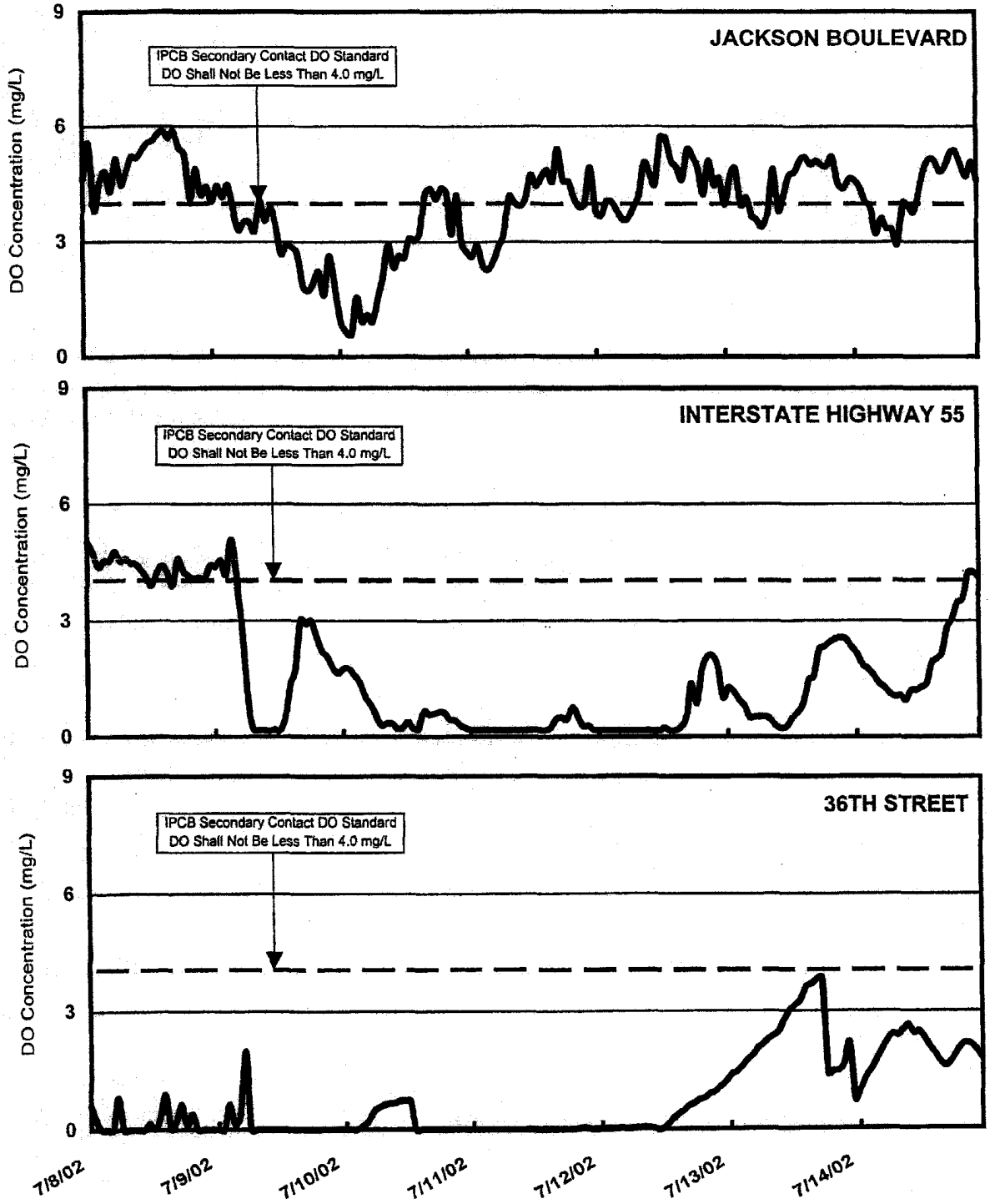
DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT
JACKSON BOULEVARD IN THE SOUTH BRANCH OF THE CHICAGO RIVER AND
INTERSTATE HIGHWAY 55 AND 36TH STREET IN BUBBLY CREEK
JULY 1 THROUGH JULY 7, 2002



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 10

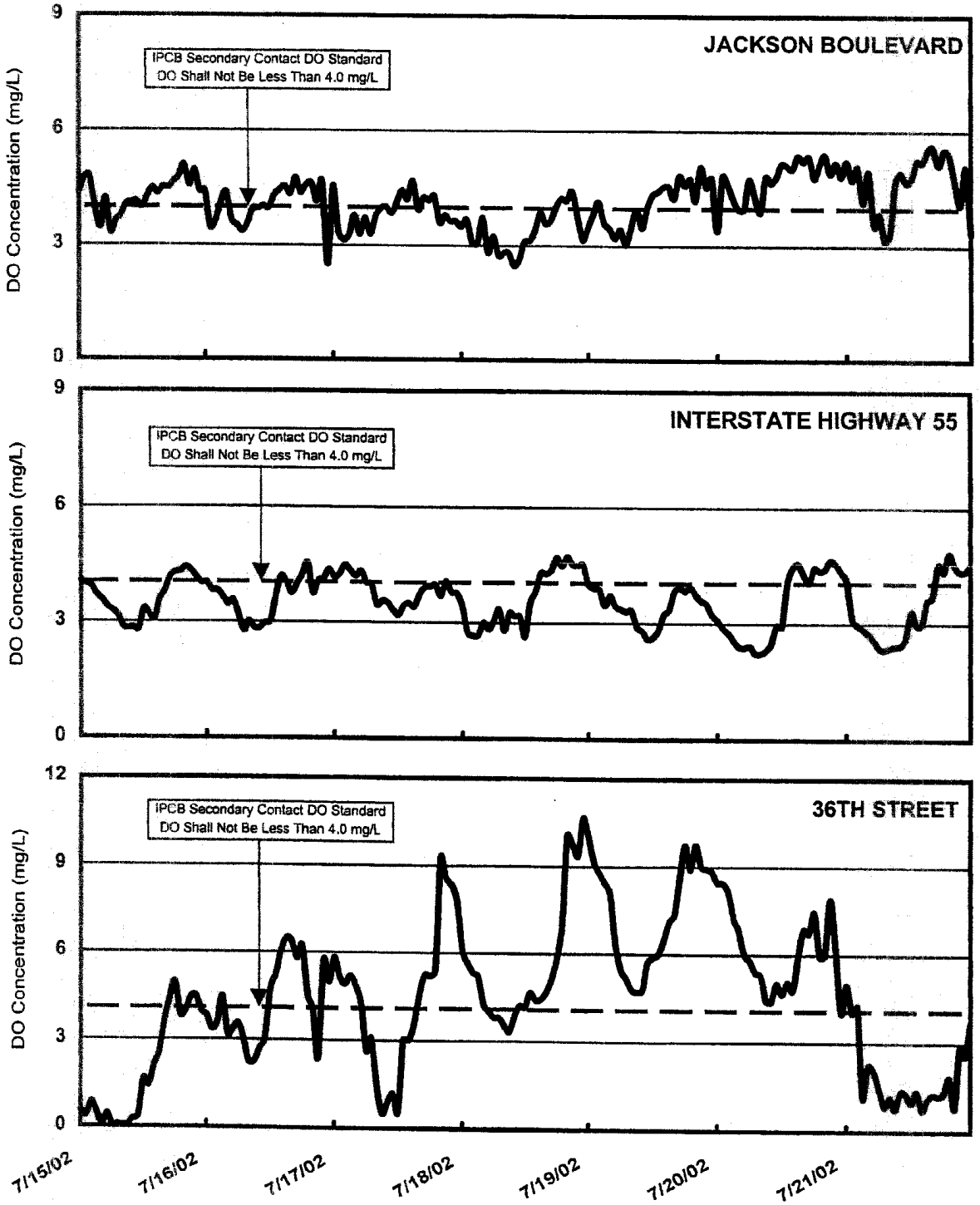
DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT
JACKSON BOULEVARD IN THE SOUTH BRANCH OF THE CHICAGO RIVER AND
INTERSTATE HIGHWAY 55 AND 36TH STREET IN BUBBLY CREEK
JULY 8 THROUGH JULY 14, 2002



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 11

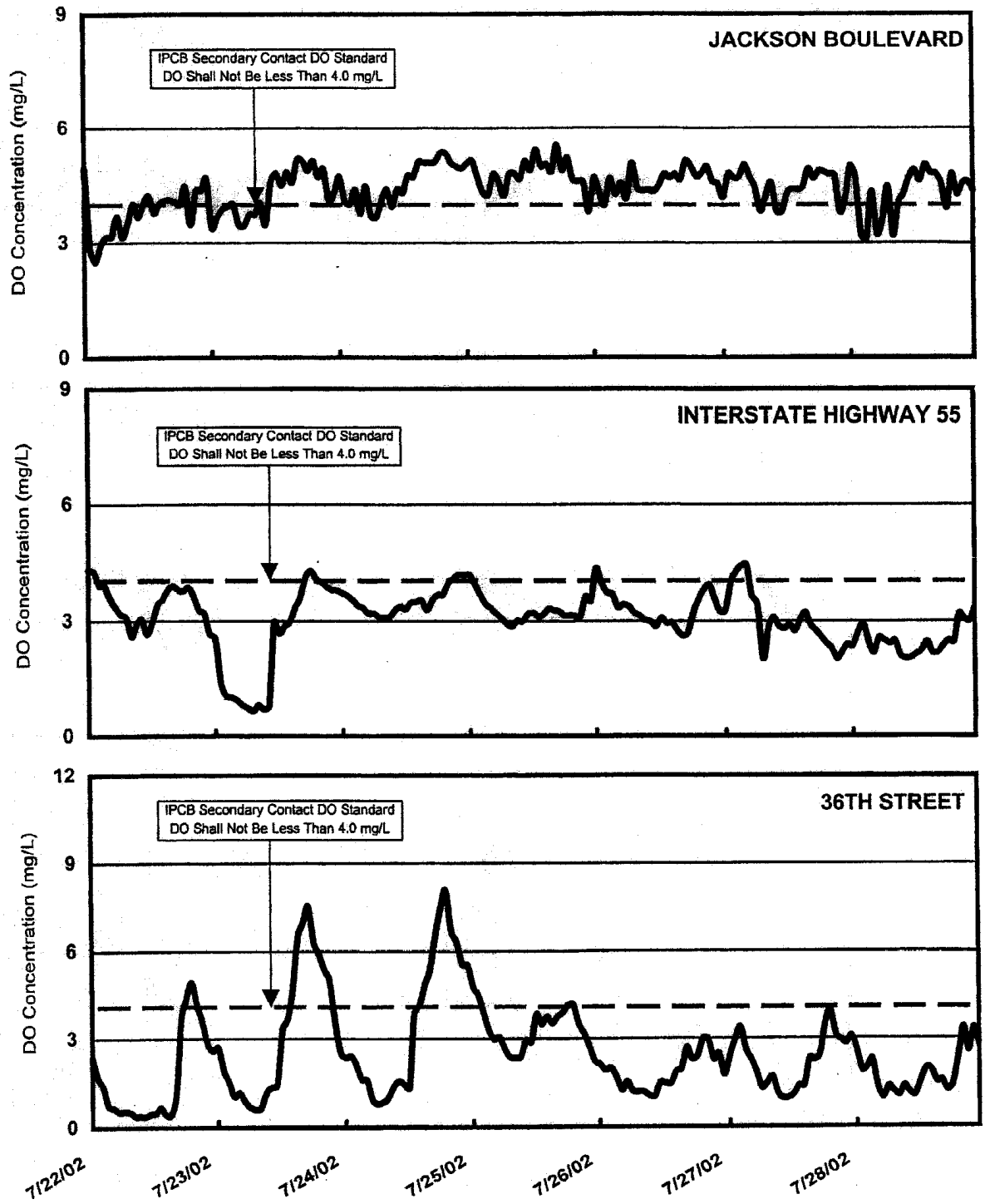
DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT
JACKSON BOULEVARD IN THE SOUTH BRANCH OF THE CHICAGO RIVER AND
INTERSTATE HIGHWAY 55 AND 36TH STREET IN BUBBLY CREEK
JULY 15 THROUGH JULY 21, 2002



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 12

DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT
JACKSON BOULEVARD IN THE SOUTH BRANCH OF THE CHICAGO RIVER AND
INTERSTATE HIGHWAY 55 AND 36TH STREET IN BUBBLY CREEK
JULY 22 THROUGH JULY 28, 2002



There was a closure of intake flow for 4 hours on July 24; however, this did not appear to effect the DO concentrations. The decrease in DO concentration at I-55 on July 23 is not related to an intake closure at or the discharge of CSO from RAPS.

For most of the week beginning July 29, DO conditions in the South Branch were at or above the standard as shown in Figure 13. For the first 3 and last 2 days at both I-55 and 36th Street, DO concentrations were less than the standard. This was not related to an intake closure at or CSO discharge from RAPS. Diurnal variations are mild in the South Branch, are more evident in Bubbly Creek at I-55 and are pronounced at 36th Street. The diurnal variations account for the low nighttime DO concentrations at I-55 and 36th Street.

Figure 14 shows good DO concentrations well above the standard in the South Branch for the entire week of August 5. Except for the first 2 days, the DO concentrations at I-55 are near the standard and above it about half the time. The same is true at 36th Street except for the first 3 days. The depressed DO concentrations at both locations are not related to a closure of intake flow or discharge of CSO at RAPS.

Good water quality conditions were experienced during the week of August 12, as shown on Figure 15. The DO concentrations were at or above the standard for most of the period at all locations and dropped below 3 mg/L only briefly at I-55 and 36th Street. The brief depression in DO concentrations in the South Branch was due to rainfall in other parts of the watershed. The rain warning on August 13 caused the closure of creek intake at RAPS from the afternoon of August 13 to the afternoon of the following day. This may have had a slight impact on the DO concentrations in Bubbly Creek as noted in the DO concentration decrease in the afternoon of August 13 at I-55.

The major storm on August 22 and 23 dominated water quality conditions during the latter part of the week of August 19, as shown in Figure 16. Prior to the storm, water quality was well above the standard in the South Branch, but less than the standard for half the time at I-55 and for most of the time at 36th Street. The effect of the storm in the South Branch was a depression below the standard twice, but the DO concentration did not go below 3 mg/L. The effect on Bubbly Creek was more pronounced, causing the DO concentration to drop to 0 mg/L for over 2 days. The DO data at 36th Street was not available. The DO concentrations at I-55 began to recover as the weekly period closed.

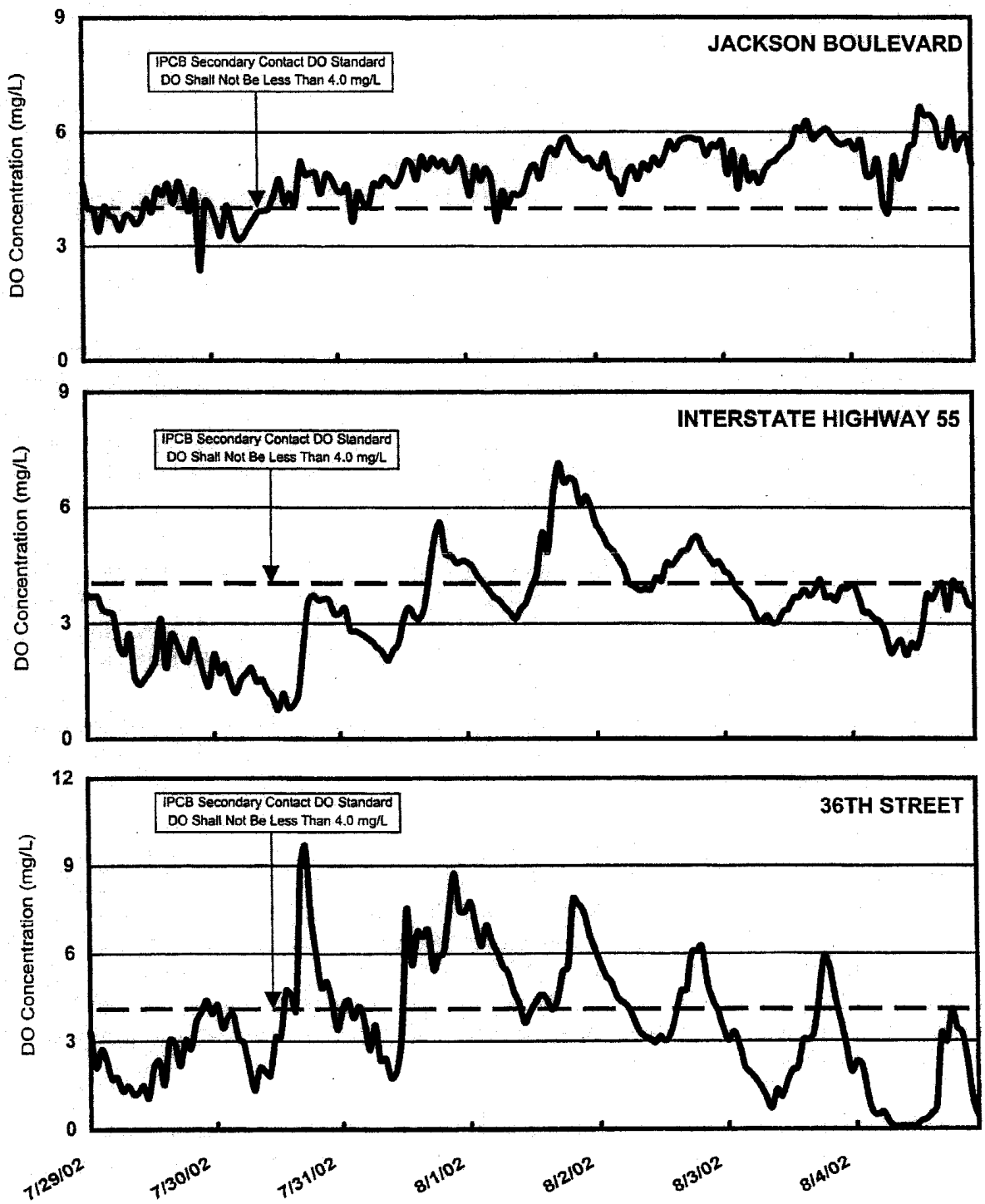
During the following week, the DO concentration was well above the standard in the South Branch. At I-55, the DO recovered to the standard by August 28, as shown in Figure 17. The closure of the intake gate at RAPS lasted until mid-morning on August 26 and later that day, the DO concentration at I-55 showed significant recovery to 2.0 mg/L. This was less than 4 days since the pumping of CSO ceased and less than 1 day since the intake was reopened at RAPS. Full recovery of DO concentrations to the standard at I-55 occurred in 5 days after the cessation of CSO pumping and 2 days after the intake gate was reopened. No data was available to measure the DO recovery at 36th Street.

Another storm on September 3 caused a brief depression of DO concentrations in the South Branch as shown in Figure 18. This storm did not cause CSO pumping at RAPS, but the rain

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 13

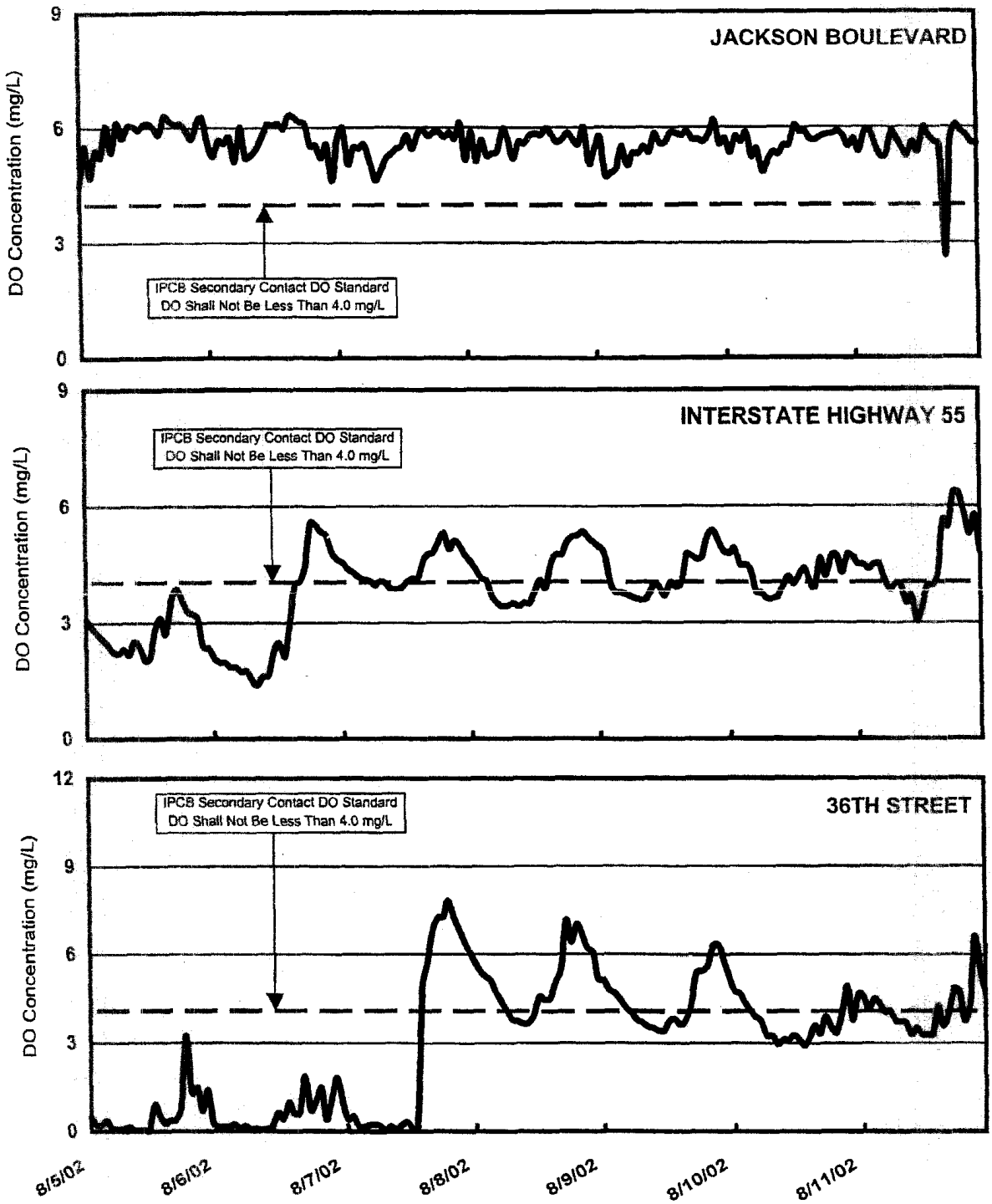
DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT
JACKSON BOULEVARD IN THE SOUTH BRANCH OF THE CHICAGO RIVER AND
INTERSTATE HIGHWAY 55 AND 36TH STREET IN BUBBLY CREEK
JULY 29 THROUGH AUGUST 4, 2002



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 14

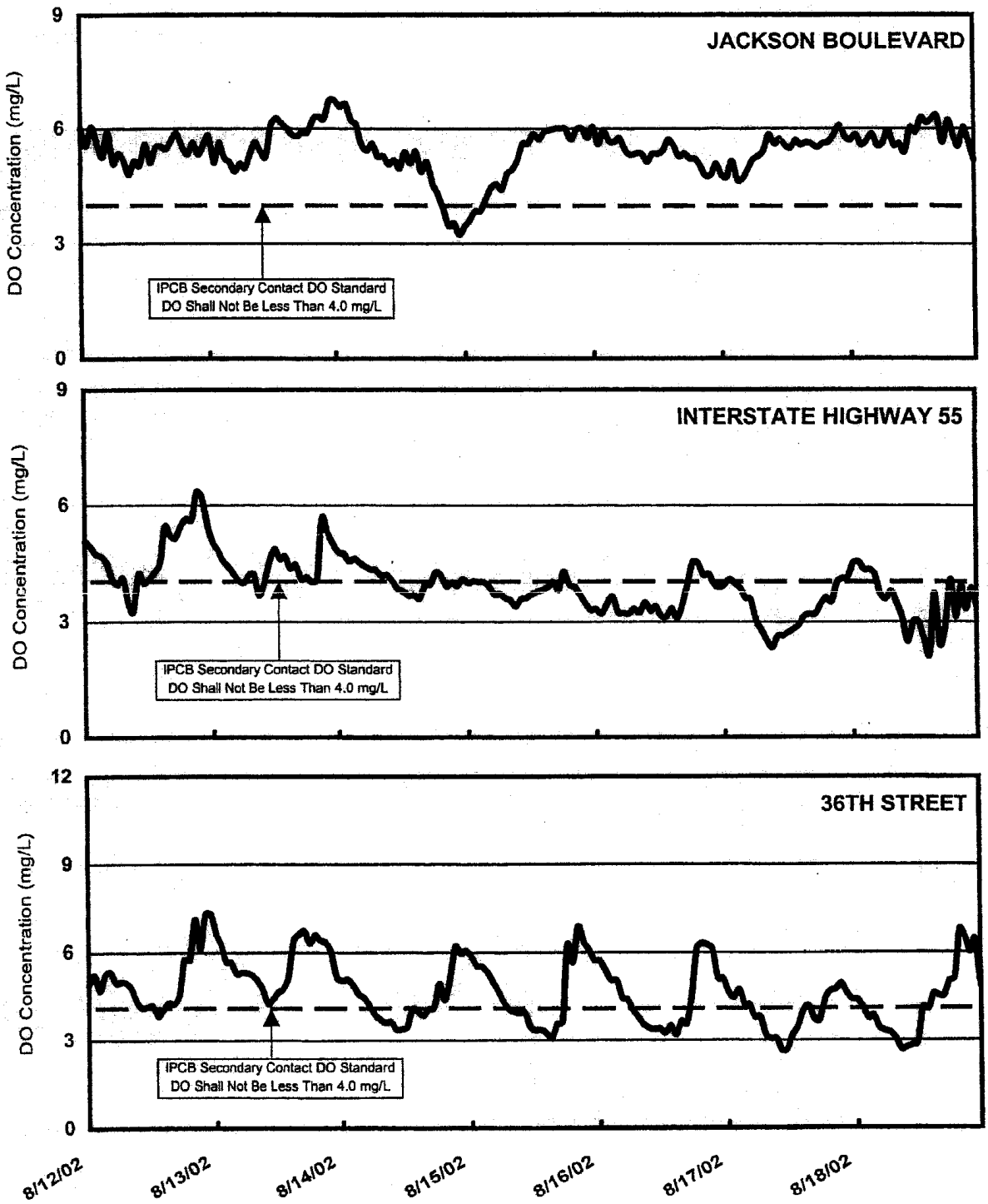
DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT
JACKSON BOULEVARD IN THE SOUTH BRANCH OF THE CHICAGO RIVER AND
INTERSTATE HIGHWAY 55 AND 36TH STREET IN BUBBLY CREEK
AUGUST 5 THROUGH AUGUST 11, 2002



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 15

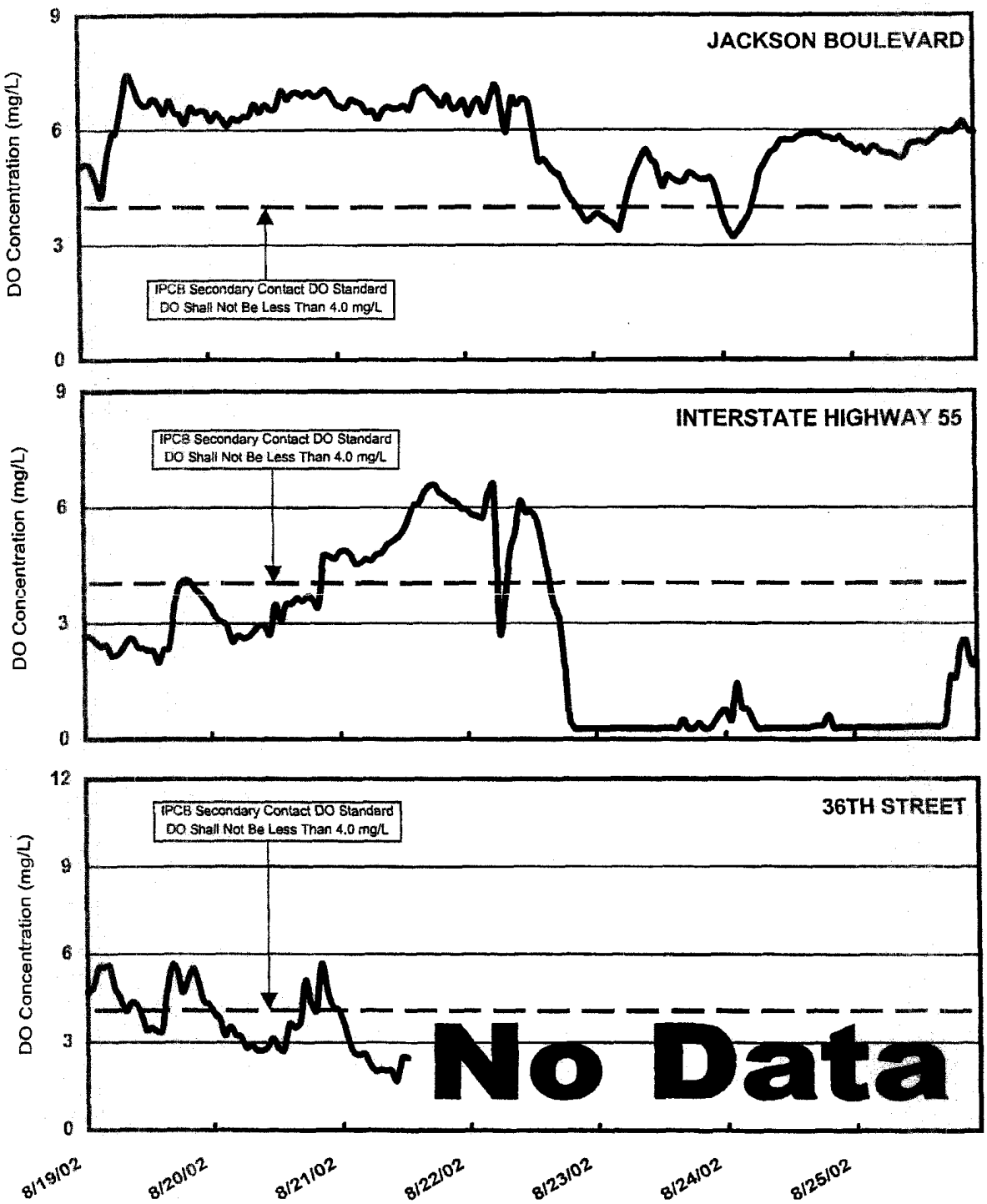
DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT
JACKSON BOULEVARD IN THE SOUTH BRANCH OF THE CHICAGO RIVER AND
INTERSTATE HIGHWAY 55 AND 36TH STREET IN BUBBLY CREEK
AUGUST 12 THROUGH AUGUST 18, 2002



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 16

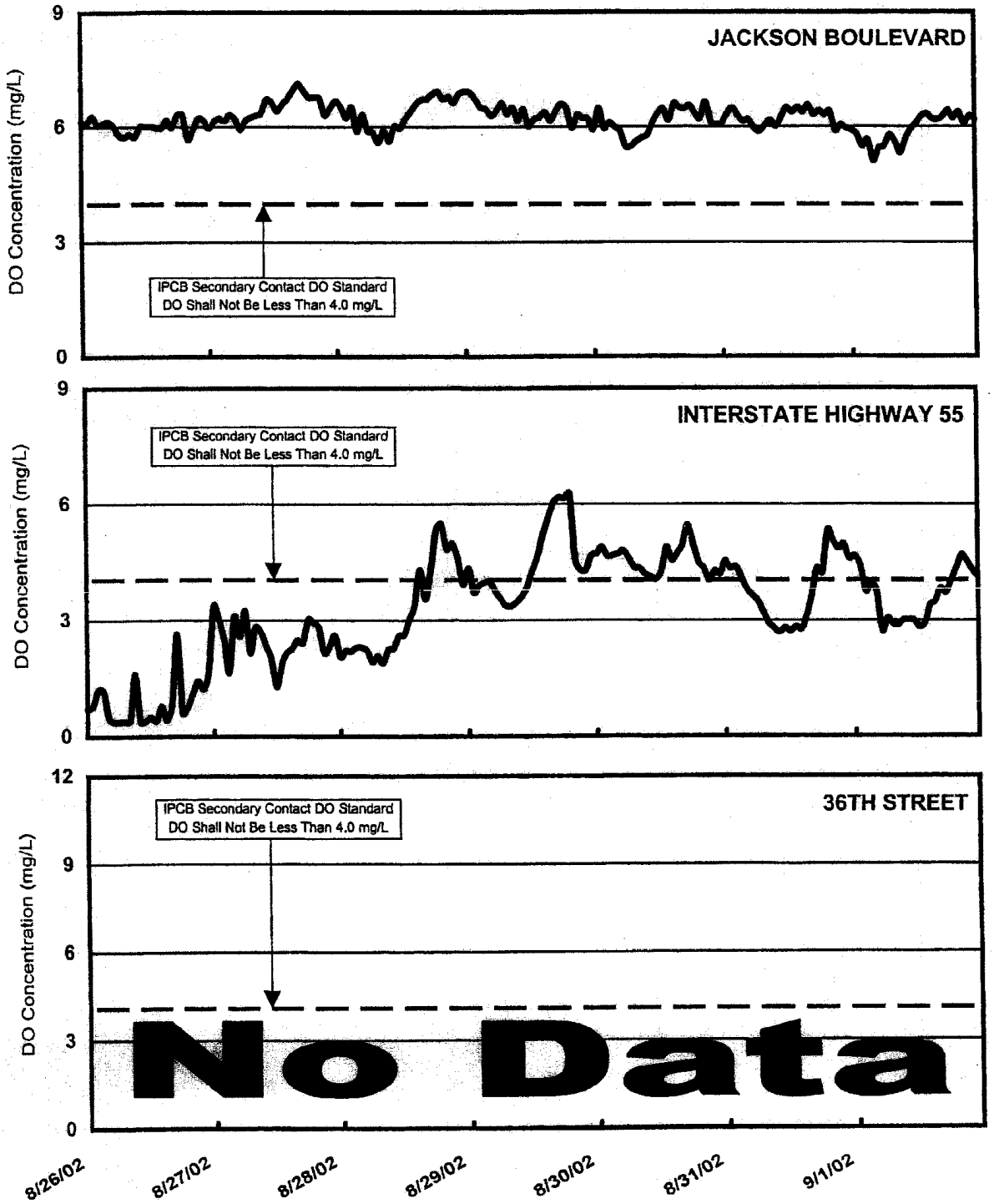
DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT
JACKSON BOULEVARD IN THE SOUTH BRANCH OF THE CHICAGO RIVER AND
INTERSTATE HIGHWAY 55 AND 36TH STREET IN BUBBLY CREEK
AUGUST 19 THROUGH AUGUST 25, 2002



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 17

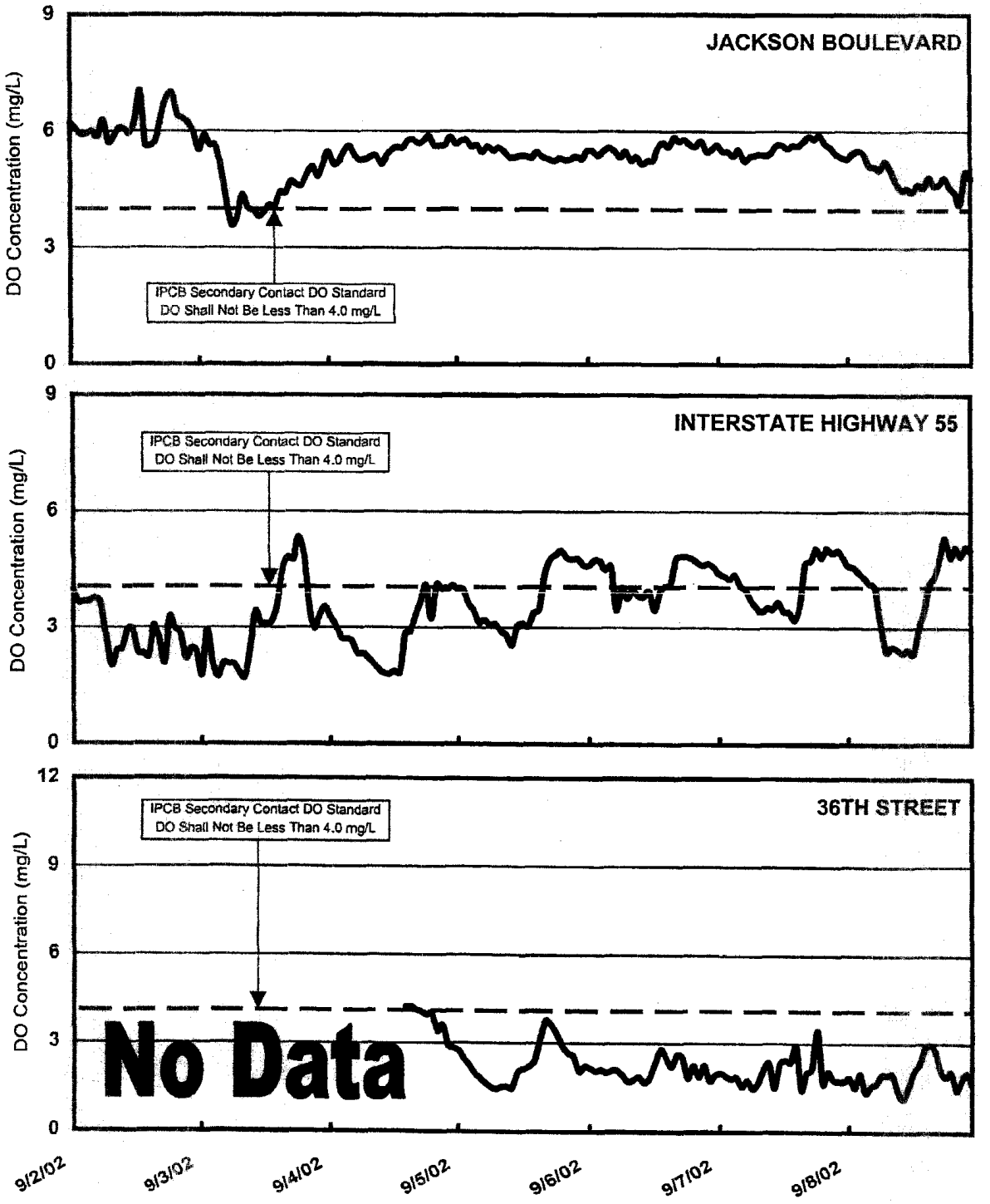
DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT
JACKSON BOULEVARD IN THE SOUTH BRANCH OF THE CHICAGO RIVER AND
INTERSTATE HIGHWAY 55 AND 36TH STREET IN BUBBLY CREEK
AUGUST 26 THROUGH SEPTEMBER 1, 2002



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 18

DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT
JACKSON BOULEVARD IN THE SOUTH BRANCH OF THE CHICAGO RIVER AND
INTERSTATE HIGHWAY 55 AND 36TH STREET IN BUBBLY CREEK
SEPTEMBER 2 THROUGH SEPTEMBER 8, 2002



warning resulted in closure of the intake gate for 22 hours on September 2 and 3. The closure coincided with a depression of DO concentrations at I-55; however, the DO remained above 2 mg/L for most of the period of closure. For the remainder of the week, DO concentrations at I-55 varied above and below the standard with the variations being caused by photosynthesis. These variations were not as pronounced at 36th Street during the latter part of the week and the DO concentration remained below 3 mg/L.

The DO concentration remained above the standard in the South Branch for the week of September 9, as shown in Figure 19. Except for a significant depression on September 9 and 10 and a minor depression on September 15, the DO concentration remained near the standard in Bubbly Creek at the I-55 Bridge. Data was available at 36th Street for only the first 2.5 days of the week and this showed variations between 1 and 3 mg/L. The diurnal variation was pronounced on September 10 and 11.

Although no significant rainfall activity eventually occurred, the intake gate at RAPS was closed early on September 18 due to a rain warning and it remained closed for 5 days. Although the closure may have caused DO concentrations below the standard in Bubbly Creek at the I-55 Bridge, as shown in Figure 20, it did not appear to adversely affect the DO at 36th Street. The DO concentrations at 36th Street were near the standard during the middle of the week and rose well above the standard on the last two days. The diurnal variation was obvious, but the magnitude of the variations was only on the order of 2 to 3 mg/L.

Water quality conditions remained stable the following week as shown in Figure 21. The DO in the South Branch remained well above the standard, while it was near the standard in Bubbly Creek. The DO concentration at I-55 was below the standard for the first day of the week, but then rose to above the standard. This may have been related to the reopening of the intake gate early in the morning on September 23. In the same interval, the DO concentration at 36th Street, which began the week well above the standard, decreased to near the standard for the balance of the week. The diurnal variation was 2 mg/L or less.

The last week of the demonstration project began with good water quality. The end of the demonstration project was marked by the closure of the intake gate in the afternoon of October 2 due to a rain warning. As shown in Figure 22, the DO concentration remained well above the standard in the South Branch, at the standard in Bubbly Creek at the I-55 Bridge and slightly below the standard at 36th Street. A significant storm on October 4 caused CSO pumping to the creek at RAPS and a subsequent decrease in DO concentrations.

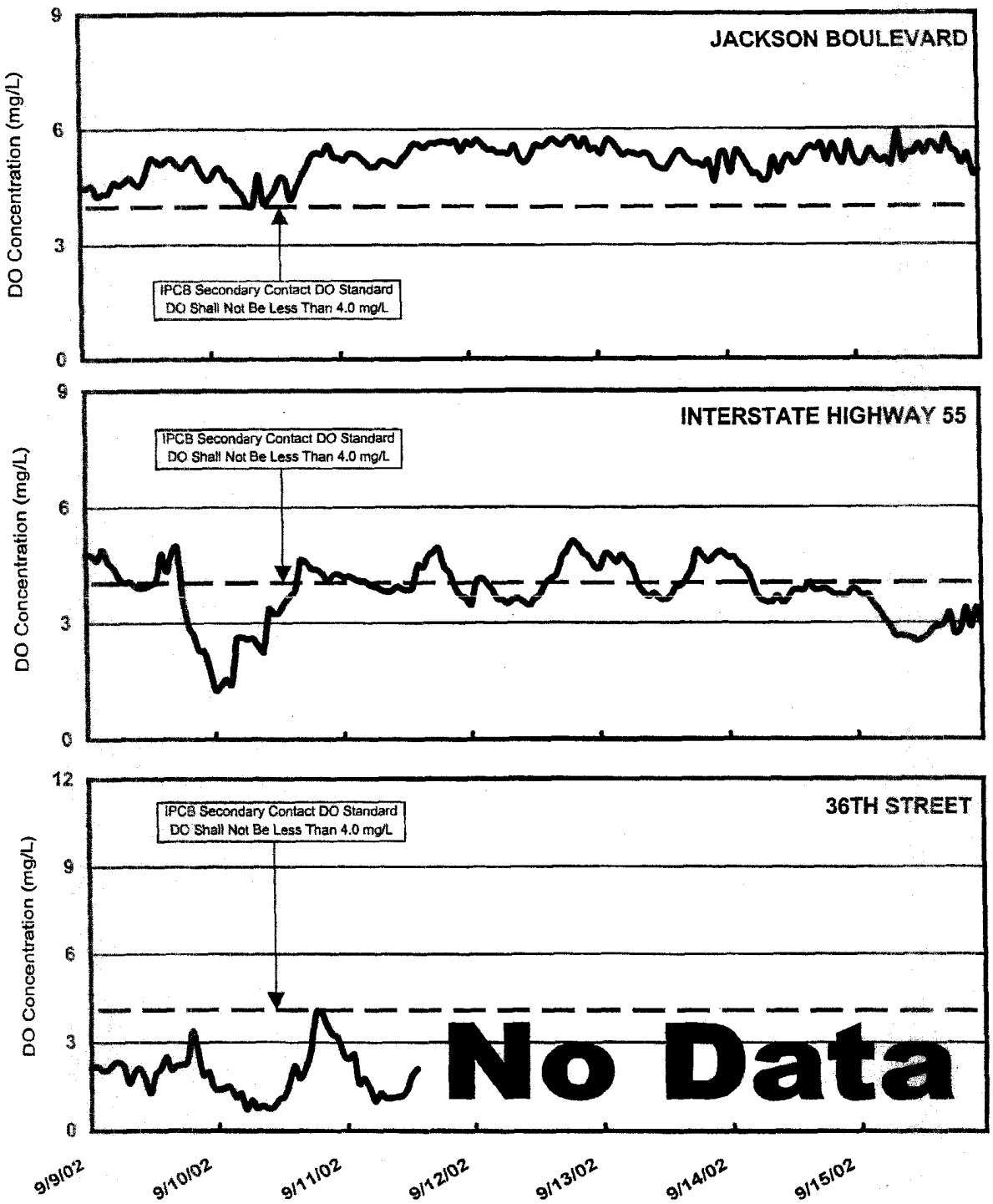
Recovery of DO Following a CSO Event

Although only two CSO events occurred during the demonstration project period, these events are compared to similar events in earlier years. However, only the DO monitor at the I-55 Bridge can be used for comparison. This will show if the occurrence of flow in Bubbly Creek subsequent to a CSO event has a beneficial effect on DO conditions.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 19

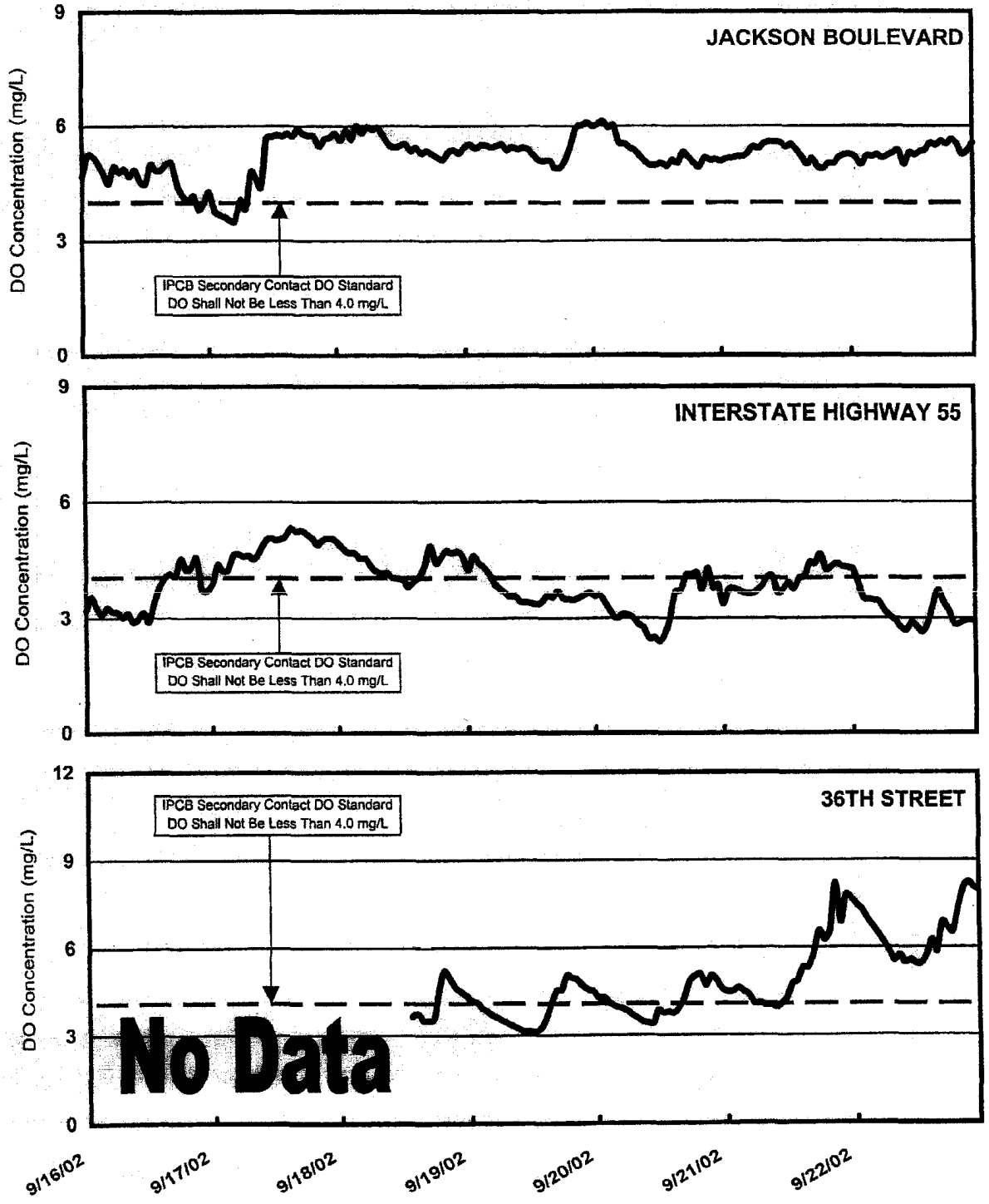
DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT
JACKSON BOULEVARD IN THE SOUTH BRANCH OF THE CHICAGO RIVER AND
INTERSTATE HIGHWAY 55 AND 36TH STREET IN BUBBLY CREEK
SEPTEMBER 9 THROUGH SEPTEMBER 15, 2002



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 20

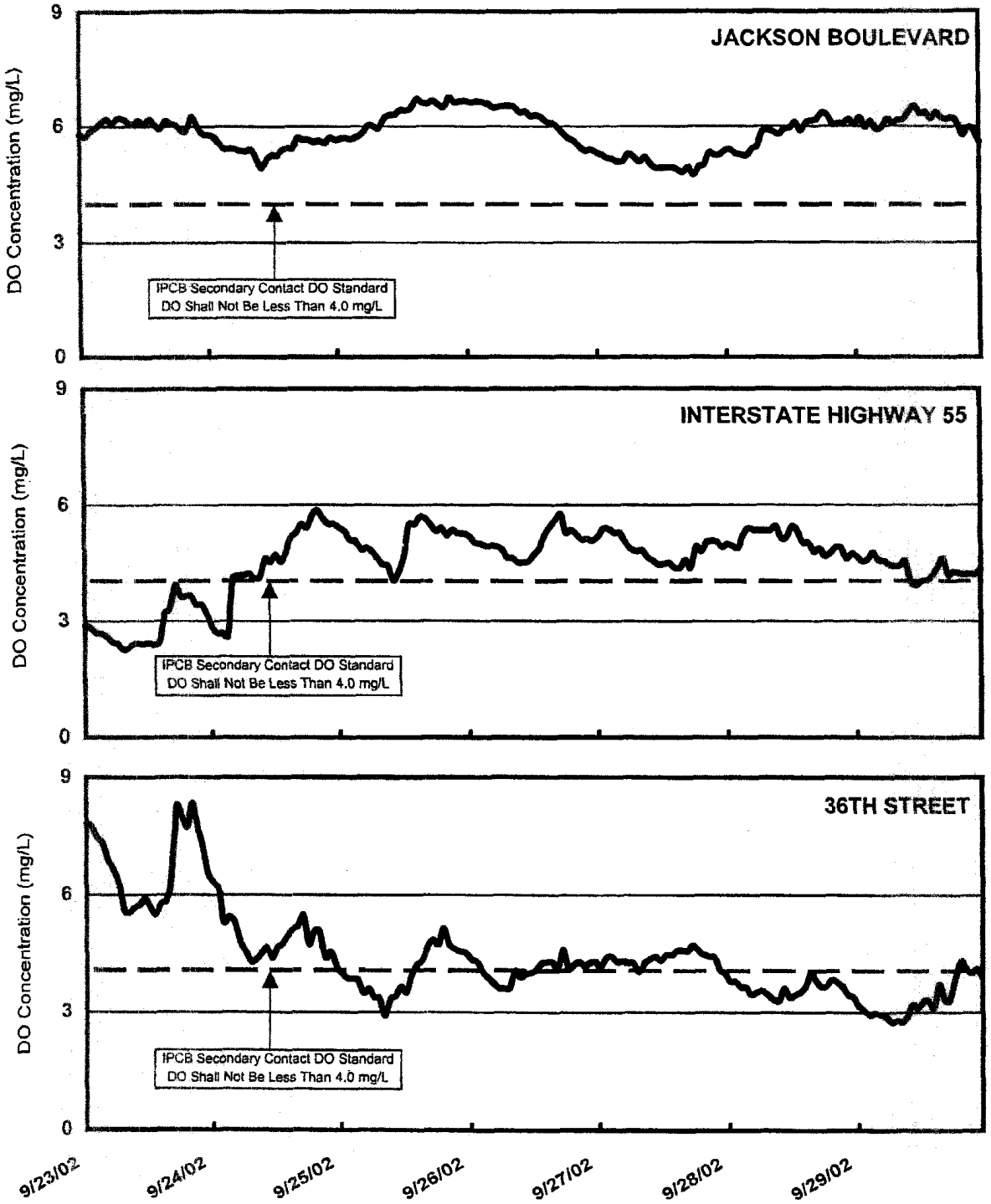
DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT
JACKSON BOULEVARD IN THE SOUTH BRANCH OF THE CHICAGO RIVER AND
INTERSTATE HIGHWAY 55 AND 36TH STREET IN BUBBLY CREEK
SEPTEMBER 16 THROUGH SEPTEMBER 22, 2002



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 21

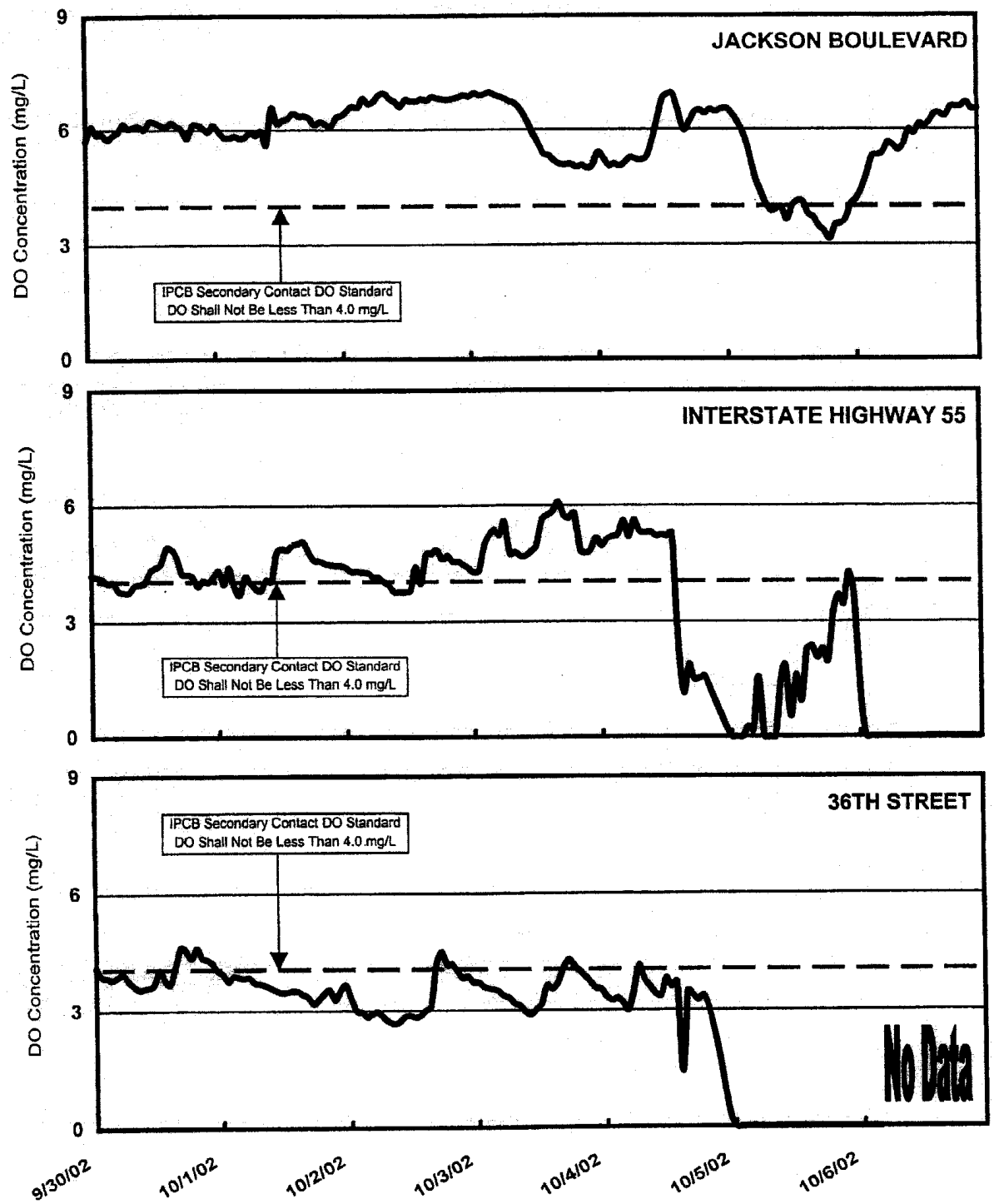
DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT
JACKSON BOULEVARD IN THE SOUTH BRANCH OF THE CHICAGO RIVER AND
INTERSTATE HIGHWAY 55 AND 36TH STREET IN BUBBLY CREEK
SEPTEMBER 23 THROUGH SEPTEMBER 29, 2002



METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

FIGURE 22

DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT
JACKSON BOULEVARD IN THE SOUTH BRANCH OF THE CHICAGO RIVER AND
INTERSTATE HIGHWAY 55 AND 36TH STREET IN BUBBLY CREEK
SEPTEMBER 30 THROUGH OCTOBER 6, 2002



CSO Event of August 22 and 23, 2002. This event resulted in the discharge of 1,390 MG of CSO over a 28.3-hour period. The creek intake gate was closed for 4.3 days. The closure of the intake gate at RAPS lasted until mid-morning on August 26 and later that day, the DO concentration at I-55 showed significant recovery to 2 mg/L. This interval was less than 4 days since the pumping of CSO ceased and less than 1 day since the intake gate was reopened at RAPS. At the intake flow rate of 20 mgd, it would take approximately 1 day for South Branch water to reach the I-55 Bridge. Full recovery of DO concentrations to the standard at I-55 occurred in 5 days after the cessation of CSO pumping and 2 days after the intake gate was reopened. See Figures 16 and 17. By comparison, the CSO event of September 11 and 12, 2000 resulted in the discharge of 1,320 MG of CSO. The depressed DO concentrations lasted until September 27, a period of 15 days until the DO returned to the standard, as shown in Figure 4. It should be noted that the DO concentration did not remain at zero for this extended period, but varied between 1 and 4 mg/L.

Each of these CSO events discharged a far greater quantity than the volume of the creek, 17.6 and 18.5 times for 2000 and 2002, respectively. The ambient water was totally removed and replaced with CSO, which for such a volume could be relatively dilute near the end of the pumping episode. For CSO events of this magnitude, inducing a flow in Bubbly Creek following the cessation of pumping appears to considerably reduce the length of the period of depressed DO concentrations.

CSO Event of July 9, 2002. This event resulted in the discharge of 90.6 MG over a 3.9-hour period. The creek intake gate was closed for 36 hours. The DO concentration at both I-55 and 36th Street dropped to 0.0 mg/L as shown in Figure 10. Recovery of DO at both locations began the afternoon of July 12, less than 4 days after the cessation of pumping and 2 days following the reopening of the intake gate at RAPS. The volume of CSO was 1.2 times the creek volume, completely replacing the ambient water in the creek. Assuming plug flow in the creek, the remaining CSO volume in the creek of 75 MG would have been totally pulled back to RAPS in 2.8 days at the intake rate of 27 mgd. This calculated time is longer than the actual time that occurred for the recovery of DO concentrations at 36th Street. Prior to the event, the DO at I-55 was at or above the standard for several days. At 36th Street, the DO was at 0 mg/L prior to the event.

By comparison, the CSO events of August 6 and 17, 2000 discharged 153 and 61 MG, respectively. These events were 2.0 and 0.8 times the volume of the creek, respectively. These were isolated events, not preceded or followed by other CSO events. Prior to each event, the DO in the creek was approximately 3 mg/L and the DO returned to this level after the event. For the former event, the DO recovery was in approximately 24 hours and in the latter event, the recovery was within 6 hours. Based on this comparison, it cannot be said that the introduction of flow in Bubbly Creek soon after the event improved the recovery of DO concentrations. However, it is noted that the DO concentrations were higher both before and after the event in July 2002 than they were for the events in August 2000.

Comparisons with other smaller CSO events reveal a different effect than the comparison with the August 2000 CSO events. The August 19, 1999 CSO event discharged 238 MG or 3.2 times the volume of the creek and the June 24, 2000 CSO event discharged 280 MG or 3.7 times the

volume of the creek. Following both events, DO concentrations at I-55 were depressed and did not return to the standard for extended periods, 7 and 8 days, respectively.

The foregoing comparisons demonstrate that inducing a flow in Bubbly Creek shortly after a CSO pumping event significantly decreases the length of the period of depressed DO concentrations from as long as 1 or 2 weeks to as short as 2 days.

DO Concentrations During Dry Weather Periods

There were several extended dry weather periods for which comparisons of DO concentrations are made at I-55 to determine if there is a benefit from the introduction of flow in Bubbly Creek. In 2002, these periods are early July, early August and late September. These periods are compared to periods in September 1998; early July, early August and early September 1999; late July and late August 2000.

July 3 through 8, 2002. This 6-day period exhibited DO concentrations ranging from 4 to 6 mg/L at I-55, except for 2 very brief intervals on the 3 and 6. Diurnal variations of 2 mg/L were typical. DO concentrations at 36th Street varied from 0 to 3 mg/L. The intake flow averaged 27 mgd giving a flow through time in Bubbly Creek of 2.8 days.

August 7 through 13, 2002. This 7-day period exhibited DO concentrations at I-55 ranging from 3 to 6 mg/L with most diurnal variation in the 2 mg/L range. The diurnal variation at 36th Street was larger, varying from 3 to 8 mg/L. The intake flow averaged 27 mgd.

September 24 through October 1, 2002. This 8-day period exhibited DO concentrations at I-55 between 4 and 6 mg/L. Again, the diurnal variation was up to 2 mg/L. The DO at 36th Street varied between 3 and 5 mg/L with similar diurnal variations. The intake flow averaged 22 mgd, giving a flow through time in the creek of 3.4 days.

September 10 through 23, 1998. No CSO events occurred in September 1998 and this 14-day period was remarkable for its consistency, as shown on Figure 2. DO concentrations at I-55 varied from 2 to 6 mg/L, with the diurnal variation of 2 to 3 mg/L on most days.

July 3 through 20, 1999. The prior CSO event occurred 3 weeks before this period. The period was marked by strong diurnal variations of up to 8 mg/L, as shown on Figure 3. The DO concentration at I-55 varied from 2 to 10 mg/L. On July 15, 16 and 17, the DO concentration did not drop below the standard. However, on most of the other days in the period, the nighttime DO was below 3 mg/L.

August 3 through 20, 1999. This period was remarkably similar to the prior period. The CSO event previous to this period occurred 2 weeks earlier.

September 5 through 27, 1999. Over 2 weeks passed since a CSO event prior to the start of this period. The DO concentrations in the period varied from 2 to 6 mg/L with the diurnal variation up to 3 mg/L.

July 22 through 28, 2000. Almost 2 weeks passed since the previous CSO event prior to the start of this period. The DO concentrations at I-55 varied from 1 to 12 mg/L in the period, as shown in Figure 4. The diurnal variation was up to 9 mg/L. The nighttime DO was below the standard on all days in the period.

September 1 through 10, 2000. The previous CSO event occurred 2 weeks prior to the start of this period. DO concentrations in the period at I-55 ranged from 3 to 8 mg/L and diurnal variations were 2 mg/L on most days, but up to 3 mg/L on 1 day. On 4 days, the DO did not drop below the standard.

The foregoing examples of dry weather events show that on some days, the diurnal variation in DO concentration can benefit Bubbly Creek by keeping the DO concentration above the standard. However, the conditions that cause high daytime DO concentrations with nighttime lows above the standard are not known. Frequently, the nighttime low falls below the standard. Introduction of flow in the creek during dry weather appears to provide a slightly higher and more stable level of DO concentrations in the range of 3 to 6 mg/L. It also dampens the diurnal variation, which tends to keep the low nighttime DO concentrations closer to the standard.

REFERENCES

1. Hill, Libby (2000) "The Chicago River: A Natural and Unnatural History," First Edition, Lake Claremont Press, Chicago, IL

2. Polls, Irwin (2002) "Continuous Dissolved Oxygen Monitoring from Wilmette to Lockport in the Chicago Waterway System During August 1998 through July 2000," Metropolitan Water Reclamation District of Greater Chicago, Research and Development Department, Report No. 02-11.

3. Polls, Irwin (2001) interoffice Memorandum dated November 2, 2001.

ACKNOWLEDGEMENTS

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Maintenance and Operations Department's (M&O's) General Division Waterways Control Section for rainfall and storm data.

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M&O's Stickney WRP Treatment Operations Unit for plant operations information.

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R&D's Analytical Laboratory Division for sample analysis.

R&D's Aquatic Ecology and Water Quality Section for laboratory servicing of the CDOMs, summary data, line drawings and water quality information.

R&D's Experimental Design and Statistical Evaluation Section for ambient water quality monitoring data.

R&D's Field Services Section Marine Unit for creek depth soundings, field servicing of the DO monitors and collection of ambient water quality samples.

R&D's Field Services Section South Central Unit for daily temperature and water quality observations.

Special thanks to Ms. Jacqueline Smith for preparing tables and final report copy.

APPENDIX AI

LETTER TO THE ILLINOIS ENVIRONMENTAL PROTECTION AGENCY DATED JUNE 14, 2002 SUBJECT: SOUTH FORK OF THE SOUTH BRANCH OF THE CHICAGO RIVER (BUBBLY CREEK)

Protecting Our Water Environment

Metropolitan Water Reclamation District of Greater Chicago

100 EAST ERIE STREET CHICAGO, ILLINOIS 60611-3154 312-751-5600

BOARD OF COMMISSIONERS
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John C. Farnan, P.E.
General Superintendent

312-751-7900 FAX 312-751-5681

June 14, 2002

Mr. Toby Frevert
Illinois Environmental Protection Agency
1021 North Grand Avenue, East
Springfield, IL 62794-9276

Dear Toby:

Subject: South Fork of the South Branch of the Chicago River (Bubbly Creek)

For several years, concern has been expressed regarding the condition and water quality of Bubbly Creek. Recently, proposals for improvement have been discussed between representatives of the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) and the City of Chicago. In addition, residential development along the creek has made the need for improvement more pressing.

Some of the proposals suggest the creation of wetlands within the present creek banks and the reduction of hydraulic conveyance capacity. As you know, Bubbly Creek receives the discharge of combined sewer overflow (CSO) from the Racine Avenue Pumping Station (RAPS), hence, maintaining the hydraulic capacity of the creek is of paramount concern. Restriction of the capacity would increase the risk of flooding and basement backup in a large area of the south side of the city.

The discharge of CSOs from RAPS is infrequent, occurring on average only 17 times per year. During other times of the year the creek is stagnant and during warm dry weather periods, the creek becomes a nuisance with poor water quality and odors. Believing that the lack of flow during these periods contributes to these conditions, the MWRDGC proposes to cause flow to occur by opening a gate at RAPS and allowing a modest flow from the creek to be pumped to the Stickney Water Reclamation Plant (WRP). This would be performed only on a demonstration basis and only when the nuisance conditions occur or are likely to occur.

Subject: South Fork of the South Branch of the Chicago River (Bubbly Creek)

The MWRDGC monitors water quality at the downstream end of the creek. At the I-55 Bridge, we have installed a continuous dissolved oxygen monitor (CDOM), and we collect monthly grab samples from the Archer Avenue Bridge. We are preparing to install a CDOM near the upstream end of the creek near 36th Street. In this way, we will be able to monitor conditions of the creek and demonstrate the degree of improvement in causing flow during these dry weather conditions.

By causing this flow, water would be drawn from the South Branch through Bubbly Creek to RAPS. Since water quality in the South Branch is good, it should have a beneficial effect on Bubbly Creek. We anticipate taking in approximately 100 cubic feet per second at RAPS. This would cause negligible velocities, but provide for a one-day travel time through the 1.25-mile length of the creek. With negligible velocities, we do not expect that sediments would be resuspended and taken into RAPS. The water quality in Bubbly Creek is not expected to have any adverse impact on the treatment process or final effluent quality at the Stickney WRP.

At the end of the year, we will make an assessment of this operation to determine if it has the beneficial effect we anticipate. We will report the results of our findings to you.

If you have any questions, please contact this office.

Very truly yours,

Signature on file

John C. Farnan
General Superintendent

RL:js
cc: Commissioner Jimenez, Chicago Department of Environment
Mr. Lanyon
Mr. O'Connor
Mr. Zurad

APPENDIX AII
HISTORICAL INFRASTRUCTURE

The South Fork originally drained the area now occupied by the south central area of the City of Chicago. In the late 1800s, slaughterhouses and meat processing plants were relocated to the area south of 39th Street and west of Halted Street. This industrial activity had an adverse impact on the South Fork. Various means of flushing were attempted to abate nuisance conditions. The reversal of flow in the South Branch caused by the opening of the Chicago Sanitary and Ship Canal in 1900 by the Sanitary District of Chicago (SDC) did not relieve nuisance conditions in the South Fork. However, a plan was in the works to provide flushing of the South Fork.

39TH Street Sewage Pumping Station

This station is no longer in service, but it was located at 39th Street and Lake Michigan. Parts of the original structure remain visible in 2002, as it is now a Chicago Park District maintenance facility. The City of Chicago (City) built the station in 1905 to handle the sewage and drainage of the south side area between 39th Street and 87th Street. The City also built the 16-foot lakefront intercepting sewer, which received sewage from sewers draining to the lake. Discharge from the station was originally conveyed to the East Arm of the South Fork at Halsted Street in the 20-foot conduit under 39th Street, also built by the City. The station was also capable of pumping lake water for dilution of the sewage and flushing of the East Arm and South Fork. This was necessary because drainage and sewage from the Union Stock Yards also entered the East Arm and the South Fork.

The SDC paid the City for the portion of the station used for pumping and flushing water. On April 30, 1910, the station and 20-foot conduit in 39th Street were turned over to the SDC for operation and maintenance. The area drained was 22 square miles and the pumping rate varied from 100 to 1,500 cubic feet per second. The original pumps were steam-driven screw-type for lake water and centrifugal-type for sewage. In 1916, a steam-driven electric generator was installed for peaking capacity in conjunction with the Lockport Powerhouse. In 1925, two electrically-driven pumps were added for adequate capacity to keep up with increased development in the service area. The SDC cost for the station was $1,339,300 and the City cost was $430,700. Operations at the 39th Street Pumping Station were discontinued on December 9, 1939, and on May 3, 1940, the 39th Street Pumping Station was removed from service.

39th Street Conduit Extension

This 2,700 foot-long extension was constructed by the SDC from 1923 to 1926 at a cost of $2,814,900. It was the outlet for southeast side neighborhoods and part of the Union Stock Yards, varying in size from 22 by 23-feet to 24 by 27-feet, semi-elliptical section. It extended from the end of the City's 39th Street Conduit at Halsted Street, along 39th Street to a new outlet west of Racine Avenue, discharging to the South Fork. The conduit was built in the bed of the East Arm (Stockyards Slip). The construction made possible the filling-in of the Stockyards Slip and the paving of 39th Street. To maintain the outlet for the 39th Street Conduit and the 39th Street Pumping Station at the lakefront during construction, a temporary diversion channel was provided to the south of the slip. Construction difficulties slowed the progress of the work.

Racine Avenue Pumping Station

In the late 1930s, the SDC began the construction of the Racine Avenue Pumping Station (RAPS) located west of Racine Avenue on the north side of 39th Street. The station was placed in service on December 8, 1939, discharging to the South Fork and a day later, operation of the 39th Street Pumping Station was discontinued. Later, on March 22, 1940, RAPS discharge was diverted to the Southwest Side Number 4 Intercepting Sewer, 16.1 by 17.9 feet, and the West-Southwest Sewage Treatment Works, now the Stickney Water Reclamation Plant (WRP). Dry weather sewage was no longer discharged to the South Fork.

The RAPS provides for the drainage of sewage and storm water from a 30-square-mile area of the central and south side of the City of Chicago. The area served is roughly bounded by Western Avenue on the west, 87th Street on the south, Lake Michigan on the east and the Chicago River and South Branch on the north. All sewage and storm water from within this area is collected by local sewers and conveyed through four large intercepting sewers, which converge at the station. Southwest Side Intercepting Sewer Number 5, coming from the northeast is 9 by 11.3 feet in size and drains much of the central business district and lakefront of downtown Chicago. Another is the 39th Street Conduit coming from the east, draining areas along the lakefront from Roosevelt Road to 79th Street. The South Side Intercepting Sewer Number 1, twin sewers each 18 by 20 feet in size, come from the south and drain a vast area of the south side, north of 87th Street.

Originally, the station had six pumps capable of discharging to either the interceptor running west along 39th Street or the South Fork. The station was expanded in 1954 and currently contains 14 electrically driven pumps. Normally, one of the pumps is sufficient to pump sewage to the Stickney WRP, located six miles west at Austin Boulevard and 39th Street. During and following storm activity, the combination of sewage and storm water that cannot be treated at the Stickney WRP is first diverted to the Tunnel and Reservoir Plan (TARP) tunnels through three drop shafts located adjacent to RAPS. As the TARP tunnels fill, the excess flow must be relieved by pumping to the South Fork, or Bubbly Creek as it is commonly known. The creek is adjacent to RAPS and runs north, flowing into the South Branch near 2700 south Ashland Avenue.

During intense storms with excessive rainfall amounts, it is likely that all 14 pumps at RAPS will be operated and discharge to the creek to prevent local flooding and basement backup. RAPS can serve as a relief for the Stickney WRP by pulling back from the interceptor running west in 39th Street. The maximum capacity of these pumps is 6,000 cubic feet per second. At this rate of discharge, Bubbly Creek will rise approximately three feet adjacent to RAPS in order to develop the gradient needed to move the water through the creek to the South Branch. The velocity of water in Bubbly Creek under this condition will be from three to five feet per second.

References:

- Lanyon, Richard, personal knowledge.
- MWRDGC, Maintenance and Operations Department Annual Report, List of Important Dates.
- SDC, *Engineering Works,* August 1928, pp. 37 and 49.

APPENDIX AIII

MAINTENANCE AND OPERATIONS DEPARTMENT
BUBBLY CREEK DEMONSTRATION PROJECT GUIDELINES

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

MAINTENANCE AND OPERATIONS DEPARTMENT

BUBBLY CREEK DEMONSTRATION PROJECT GUIDELINES

Protocol to Start/Stop Drawback

Purpose: These guidelines have been developed for a demonstration project to determine if a constant flow of water through Bubbly Creek when nuisance conditions are likely to occur will improve water quality conditions and what flow rate is needed to result in these improved conditions. The protocol is subject to change as the demonstration project moves forward and experience is gained drawing back from Bubbly Creek.

Conditions For Drawback

WHEN TO DRAWBACK

Drawback of flow from Bubbly Creek should be done only when nuisance conditions occur or are likely to occur.

1. Using the plant's operating condition as the controlling criteria following a period of RAPS discharge to Bubbly Creek (capacity available, plant conditions permit) drawback will commence and continue until plant conditions dictate otherwise as noted below.

2. M&O and R&D department heads, in consultation with the General Superintendent, will establish the drawback flow rate from time to time. This will be communicated to the SW AETPO I and used until changed by the Chief of M&O.

WHEN NOT TO DRAWBACK

1. Bubbly Creek drawback shall never start or continue when there is a rain warning or rain is falling.

2. Bubbly Creek drawback is not to occur when:

   - Stickney's flow is at plant capacity.
   - DO concentration in pass 3/4 of the aeration batteries is at or below 1 ppm.

WHEN TO TERMINATE AN ON-GOING DRAWBACK

Bubbly Creek drawback will be terminated when:

1. The DO in pass 3/4 of the aeration batteries receiving the drawback begins dropping rapidly (1.0 ppm or more within a half-hour period) or declines steadily to less than 1 ppm.

2. The NH_3 in pass 3/4 of the aeration batteries receiving the drawback begins rapidly (0.5 ppm or more within a half-hour period) or steadily to 2 ppm.

3. When conditions demand, i.e. dewatering of TARP, Rider 32 pumping restrictions, maintenance requiring a low sewer, etc., drawback will be terminated.

Drawback Quantity

The Bubbly creek drawback flow rate shall be attempted at several flow rates between 0 and 100 MGD (155 cfs). Initially, flows will be limited to 42 cfs (27 MGD, a 4" opening). Based on experience at that flow rate, rates will be increased incrementally up to 100 MGD or the maximum flow SWRP treatment can tolerate, whichever occurs first. The following pumping priorities may reduce drawback flow rates.

PUMPING PRIORITIES

1. TARP

Maintaining TARP availability is to take priority over Bubbly Creek drawback. Therefore, TARP pumping shall continue to follow the previously established TARP pumping protocol. If needed, Bubbly Creek drawback is to be suspended or reduced during TARP pumping operations.

2. RAPS

RAPS dry weather pumping is to take priority over Bubbly Creek drawback. However, as necessary and practical, RAPS pumping may occur simultaneously with Bubbly Creek drawback through Gate #1. Simultaneous RAPS pumping and drawback must not cause a discharge of sewage into Bubbly Creek.

3. Special Conditions

The SW AETPO I shall determine any restriction of drawback flow, as may otherwise become necessary.