CONTINUOUS DISSOLVED OXYGEN MONITORING
QUALITY ASSURANCE PROJECT PLAN

Revision 2.0

Effective Date: April 1, 2011

Organization: Metropolitan Water Reclamation District
of Greater Chicago
Department of Monitoring and Research

Address: 100 East Erie Street
Chicago, Illinois 60611-2803

Telephone: (312) 751-5190

GROUP A: PROJECT MANAGEMENT

A1: Approval Sheet:

_______________________________________ Date___________

Thomas Granato
Acting Director of Monitoring and Research

____________________________________ Date___________

Catherine O'Connor
Assistant Director of Monitoring and Research
Environmental Monitoring and Research Division

_______________________________________ Date___________

John McNamara
Quality Assurance Coordinator
Monitoring and Research

A2: TABLE OF CONTENTS

A3: Distribution List

A copy of this Quality Assurance Project Plan (QAPP) will be distributed to each person signing the approval sheet and each person involved with project tasking identified in Section A4. A copy of this QAPP shall be available on request to any person participating in the project from any of the personnel listed in Section A4. Persons not employed by the Metropolitan Water Reclamation District of Greater Chicago (District) may obtain a copy of this QAPP from the District website under the "M&R Data and Reports" section.

As this document will be updated annually, the reader is advised to check with the Project Manager for the latest revision if his copy is more than one-year old. Revision 2.0 has been prepared following the United States Environmental Protection Agency guidance document EPA QA/R-5 titled "EPA Requirements for Quality Assurance Project Plans," March 2001.

A4: Project/Task Organization

The responsible persons for project management are:

Project Director:
Thomas Granato
Acting Director of Monitoring and Research

Project Manager:
Catherine O'Connor
Assistant Director of Monitoring and Research
Environmental Monitoring and Research Division

Network Coordinator:
Jennifer Wasik
Supervising Aquatic Biologist

Field Operations Manager:
Sharon Sopcak-Phelan
Pollution Control Officer 3

Environmental Monitoring Manager,
Aquatic Ecology and Water Quality Section:
Thomas Minarik Jr.
Senior Aquatic Biologist

Quality Assurance Officer:
John McNamara
Quality Assurance Coordinator

Figure 1 is the organization chart for the project. Primary lines of communication are shown as dashed lines. However, within the District, communication between any of the project participants may occur and is in fact encouraged as questions or issues arise.

Overall, project planning, including the selection of monitoring locations, is performed jointly by the Project Director, the Project Manager, and the Network Coordinator. The Project Director and Project Manager are responsible for project staffing, funding, and the proper execution of the entire project. The Network Coordinator oversees the execution of routine project activities, resolves major deviations from procedures, assists in the final review of project reports, and prepares and updates the QAPP.

The Environmental Monitoring Manager coordinates day-to-day project activities, resolves minor deviations from procedures and ordinary quality control problems, supervises the data review, statistical analysis, management of the project database, and preparation of project reports.

The Field Operations Manager is responsible for the execution of field activities. A field team deploys the monitors, collects and preserves samples, makes field measurements, and transports the retrieved monitors and collected samples to the Aquatic Ecology and Water Quality Section. These activities are primarily done by boat, but certain monitoring stations require a land-based team. Two days each week are required to retrieve and deploy the monitors at all monitoring stations.

The Aquatic Ecology and Water Quality Section maintains and calibrates the water quality monitors, downloads collected data from the monitors, and assists in the cross-sectional dissolved oxygen (DO) profiling performed at each monitoring location each spring, summer and fall. The Environmental Monitoring Manager oversees the fabrication, installation, and maintenance of the protective housing needed for field deployment of the water quality monitors. An aquatic biologist (biologist) oversees field deployment and retrieval of the water quality monitors, reviews monitoring data for abnormalities, prepares time series plots of DO data, and directs the laboratory's quality control program.

The Quality Assurance (QA) Officer is responsible for oversight of quality control for the project and reviewing the QAPP.

A5: Problem Definition/Background

The Chicago Area Waterway System (CAWS) was designed to convey Chicago's sewage and stormwater away from Lake Michigan, Chicago's primary source of drinking water. This was accomplished by the construction of the Chicago Sanitary and Ship Canal (CSSC) and the reversal of the flow in the Chicago River and South Branch Chicago River. Instead of flowing into Lake Michigan, the Chicago River and South Branch Chicago River now flow into the CSSC. The CSSC collects the area's sewage effluents and stormwater runoff and carries it into the Des Plaines River at the canal juncture south of Lockport. Major waterways in the CAWS include the North Shore Channel, the Chicago River, the North and South Branches of the Chicago River, the CSSC, Little Calumet River, and the Calumet-Sag Channel. The CAWS is shown in Figure 2. The service area of the District is essentially all of Cook County.

The data from this project will also be used in conjunction with other District projects to determine overall water quality of the waterway system. These other projects include the Ambient Water Quality Monitoring project, which analyzes inorganic and organic parameters at 59 monitoring locations, and a biological survey project that assesses biological health by monitoring the diversity of biological species and their abundance at various locations in the waterway system.

A6: Project/Task Description

Currently, DO and water temperature are monitored at 18 locations in nine Chicago area waterways. The monitored waterways include the following rivers, man-made channels, and canals:

Chicago Waterway System
- North Shore Channel
- North Branch Chicago River
- South Branch Chicago River
- Bubbly Creek (South Fork South Branch Chicago River)
- Chicago Sanitary and Ship Canal

Calumet Waterway System
- Little Calumet River
- Calumet-Sag Channel

Des Plaines Waterway System
- Des Plaines River
- Salt Creek

The CDOM program was initiated at 20 locations during the summer of 1998. These monitoring locations were concentrated on the North Shore Channel, the North Branch Chicago River, the Chicago River, the South Branch Chicago River, Bubbly Creek, the CSSC, and the Calumet-Sag Channel. The monitoring location on the Des Plaines River at Jefferson Street, Joliet, and the location on the Chicago River at the Chicago River Lock and Michigan Avenue were added in 2000. An additional 11 monitoring locations were added in 2001. These included additional locations on the Calumet-Sag Channel and locations on the Grand Calumet River, the Little Calumet River, and the Calumet River. An additional Bubbly Creek monitoring location at 36th Street was added in 2002. During 2004 a monitoring location was added at Foster Avenue on the North Shore Channel. During 2005 an additional

11 monitoring locations were added. These locations monitor Salt Creek and additional reaches of the Des Plaines River, Grand Calumet River, Little Calumet River, and North Branch Chicago River. During 2011, the CDOM program was reassessed and reduced to a total of 18 stations, 13 in the deep draft and five in wadeable locations.

Descriptions of all monitoring locations, both active and inactive, are provided in Tables 1, 2, and 3. Table 1 lists all monitoring locations and usage history. Table 2 shows the latitude and longitude of each monitoring location. Table 3 gives the IPCB waterway classification and IPCB DO water quality standard at each monitoring location. Figure 2 is a map showing the CAWS and the active monitoring locations.

The locations of the monitoring stations are reviewed at least annually. More changes in monitoring locations are likely as additional data is analyzed and additional water quality improvements are implemented.

A7: Quality Objectives and Criteria for Measurement Data

Measurement data must be accurate enough to determine compliance with the applicable IPCB DO water quality standards. The DO standards are stated to tenths of a milligram per liter (mg/L). Therefore, measurements of DO should be accurate to ± 0.1 mg/L.

The IPCB water quality standards for temperature specify the maximum allowable water temperature and maximum allowable temperature rises resulting from, for example, the discharge of heated effluents. These standards are stated in degrees Fahrenheit (°F), or to tenths of degrees Celsius (°C) following conversion of the standard from degrees F to degrees C. While these standards are presently not a primary concern of this project, temperature measurements to ± 0.5°C or less are necessary to ensure the accuracy of the recorded DO measurements, as these measurements are affected by temperature.

A8: Special Training/Certification

The tasking of the project has been assigned to personnel with appropriate job classifications. Project personnel are trained on the job to perform their assigned technical activities. No additional special training or certifications are required for the project.

A9: Documents and Records

Project Data and Reports

The Network Coordinator maintains the following project records and reports:

1. Monitoring data are stored in a custom designed Oracle® database. The DO database is backed up weekly.

2. Field observations performed during monitor retrieval and deployment are stored electronically in an Excel® spreadsheet.

3. Laboratory calibration and maintenance records are stored electronically in an Excel® spreadsheet.

4. Seasonal cross-sectional DO surveys at each monitoring station are stored electronically in an Excel® spreadsheet.

5. Statistical summary tables and graphics depicting hourly data are prepared weekly with Excel® software.

Other Reports and Communications

1. The Project Manager and Network Coordinator shall retain copies of all correspondence related to the transmittal of project data to the IEPA. The Network Coordinator shall retain electronic copies of data transmitted to the IEPA.

2. The Project Manager and Network Coordinator shall retain copies of annual M&R reports pertaining to continuous DO monitoring.

3. The Project Manager and QA Officer shall retain copies of all annual updates and revisions of this QAPP.

4. The Network Coordinator shall retain copies of all sampling procedures and analytical procedures used for collection and analysis of project samples.

5. The Network Coordinator and Environmental Monitoring Manager shall retain copies of all laboratory analytical reports and correspondence with other laboratories.

6. The Project Manager and Network Coordinator shall retain copies of all management reports pertinent to continuous DO monitoring.

7. The Project Manager and Network Coordinator shall retain copies of all communications pertinent to continuous DO monitoring to and from outside agencies and other interested parties.

All of the records and reports listed above will be retained for a minimum of ten years at the Cecil Lue-Hing Research and Development Complex located at the Stickney WRP.

GROUP B: DATA GENERATION AND ACQUISITION

B1: Sampling Process Design (Experimental Design)

Selection of Monitoring Locations

Forty-eight locations have been selected for DO monitoring in the Chicago Waterway System (Table 1). Of these, 18 are currently actively monitored. The criteria used to select these locations were:

1. A history of low DO levels,

2. Above and below the confluence of major waterways,

3. Proximity to an artificial aeration station,

2. Above and below the major WRPs,

5. Below pumping stations, such as the North Branch and Racine Avenue, and below discretionary Lake Michigan diversion locations,

6. Proximity to ambient biological monitoring locations.

To ensure the suitability of a sampling location, cross-sectional DO profiles are made at each site to verify the uniformity of DO concentrations. Uniform cross-sectional DO at a monitoring location is necessary to ensure that representative DO measurements could be obtained from a single DO monitor. Cross-sectional DO profiles are routinely repeated three times each year (spring, summer, and fall) at each monitoring location to verify that cross-sectional uniformity of DO concentrations has been maintained.

Monitoring locations may be added or removed from the monitoring network based upon periodic assessments of monitoring needs and available resources. Table 1 shows the monitoring history of monitoring locations used for this project.

Measurement Frequency

The DO concentration at any point in a waterway is subject to many influences. Measurements taken at infrequent intervals, such as weekly or even daily, may be insufficient to adequately characterize fluctuations that may occur during wet weather events or diurnal fluctuations that may occur in wadeable waterways. Previous monitoring has shown that hourly measurements will record these changes and allow for a more comprehensive understanding of DO behavior in the CAWS. After CDOM has been conducted for a suitable amount of time at a given station, it may not be necessary to continue such intensive monitoring until conditions change in that waterway due to operational upgrades, completion of reservoirs, or changes in lake diversion amounts, for instance.

Parameters Measured and Information Monitored

When DO measurements are taken, it is important to record water temperature since the DO saturation concentration will increase as temperature decreases. Besides DO and temperature measurements, the project tracks, to the extent possible, lake water diversions, precipitation, and recorded CSOs into the waterways. Also available are the WRP effluent flows and associated analytical data. The monitored information will impact DO concentrations and, therefore, is necessary to interpret the collected DO data.

B2: Sampling Methods

The YSI water quality monitors used for this project are programmed to record DO and temperature measurements at hourly intervals. The alkaline batteries used by the monitors (AA or C cells) generally allow field deployment a period of at least two weeks. The monitors are always scheduled for a two-week deployment. The monitors are exchanged in prescheduled batches, on Tuesdays and Wednesdays. Rarely, usually because of inclement weather, monitors may be in the field for extended periods during which they will continue to collect measurement data until the batteries are exhausted. In one instance, monitors were found to be operational after having been under ice for two months.

The monitors are secured in eight-inch stainless steel pipes to protect them from marine vessels, debris, and vandalism. The monitors are typically deployed inside a 12- to 15-foot pipe vertically mounted on the side of a suitable bridge abutment, dolphin, or seawall. The monitors are generally positioned two to three feet below the water surface. These pipes have numerous two-inch openings in the pipe wall to allow water to flow freely through the housing and around the monitor, thereby ensuring accurate DO and temperature measurements.

B3: Sample Handling and Custody

The newly prepared and calibrated monitors are transported to the monitoring stations in coolers that contain enough tap water to saturate the air inside the cooler with humidity. The monitors that are retrieved from the waterway are placed in the same coolers for transport back to the laboratory. When the monitors arrive in the Aquatic Ecology and Water Quality Section Laboratory, they are suspended vertically in a water-filled tank referred to as the "receiving tank."

When a monitor is deployed at a sampling location, a water sample is collected for wet chemistry DO analysis at the laboratory. These water samples are preserved in the field in accordance with Standard Methods, Method 4500-O C.

The maximum holding time before analysis for DO samples permitted by Standard Methods and 40 CFR Part 136 is eight hours. However, because these samples and the monitors that are retrieved are not returned to the laboratory until late afternoon, the analysis of the samples is not performed until the following morning. This means that the actual holding times of these samples prior to analysis are usually 16 to 24 hours. While in excess of the maximum permitted holding time, this is not considered critical as these samples are used only to corroborate field measurements made by the monitors and are not reported as project data.

B4: Analytical Methods

Each DO monitor utilizes a DO probe, a conductivity probe, and a thermistor to measure water temperature. The DO probes are either the YSI rapid pulse type or the optical DO sensor type. The rapid pulse sensor measures the current at the electrode, which is linearly proportional to the partial pressure of DO at the surface of the membrane barrier. The optical DO sensor measures the lifetime of the luminescence, which is inversely proportional to the amount of oxygen present. The DO probe calibration is performed with a single point adjustment of the monitor readout in mg/L DO to the DO of a reference sample. The conductivity sensor measures the voltage drop between the electrodes and converts it to specific conductance. Temperature is measured with a thermistor that changes in proportion to resistance with temperature variation.

For this project, the water in the monitor storage tank is used as the reference sample for monitor calibration. The DO of the storage tank water is determined using the Winkler method as given in Standard Methods, Method 4500-O C, "Azide Modification" (Winkler). The monitors used for the project automatically compensate for temperature-induced changes. The use of monitors to obtain in situ DO measurements eliminates errors associated with sample handling and storage when samples are collected for wet chemistry DO analysis.

Water samples are taken biweekly at each monitoring location when freshly calibrated monitors are deployed for corroborating DO analysis in the laboratory. These field samples are also analyzed using the Winkler test. The samples are manually titrated with a digital burette. According to Standard Methods, the standard deviation of the Winkler test is approximately 0.06 mg/L.

B5: Quality Control

Daily calibration checks of the monitor DO membrane electrodes are made while the monitors are maintained in a ready state in the laboratory prior to field deployment.

Monitors are recalibrated whenever the monitor DO is not within ± 0.2 mg/L of the Winkler DO measurement of the storage tank water. A monitor will not be deployed if the DO check on the day scheduled for deployment is not within ± 0.2 mg/L of the Winkler test.

The automatic collection of DO and temperature data does not lend itself to the use of quality control measures that would normally be employed in the laboratory analysis of samples. Therefore, great care is exercised in the calibration of monitors and verification that each monitor has maintained its calibration after deployment.

To verify that data collected by each monitor is accurate, the following quality control measures are employed:

1. Verification of the accuracy of each monitor after retrieval against the Winkler DO measurement in the receiving tank.

2. Checking of the last DO measurement of the retrieved monitor with the first DO measurement of the newly deployed monitor.

3. Checking of the last field DO measurement made by each monitor against the DO of a grab water sample taken in the waterway next to the deployed monitor.

If acceptance criteria for these measurement verifications are not met, the data collected by that monitor may be rejected. Sections B10 and D1 detail these verification procedures.

B6: Instrument Testing, Inspection, and Maintenance

YSI monitors (models 6920 and 6600) are used for this project. In addition to the monitors that are at all times deployed at the active monitoring sites, an equal number of monitors are kept in controlled storage in the laboratory after being prepared for deployment the following week. Other monitors that are not deployed, or are not being prepared for deployment, are available to replace those monitors that require servicing that cannot be performed in the laboratory.

The monitors are maintained as required by the manufacturer's manuals and the laboratory SOPs. Inventoried parts and supplies include batteries, o-rings, DO membranes, wiper assemblies, calibration standards for the conductivity sensors, electrolyte for DO sensors, DO electrodes, and temperature/conductivity sensors.

When the monitors are returned to the laboratory, the field data is downloaded (see Section B10), and the monitors are cleaned of surface debris. The membranes and electrodes are inspected for damage with a 5-40 power microscope. Scratched or damaged membranes are replaced. The electrodes are cleaned with a fine grit sandpaper if corrosion is present or if the monitor cannot hold its calibration. The potassium chloride electrolyte is replaced if air bubbles are trapped under the membrane, whenever the electrodes are cleaned, and whenever the membrane is replaced.

The thermistor in each monitor is checked annually against a certified thermometer traceable to a National Institute of Standards and Technology (NIST) standard. When the error of the thermistor exceeds 0.5°C, the temperature/conductivity sensor is changed. If the temperature measurement is still beyond the acceptance range, the monitor is returned to the manufacturer for service.

B7: Instrument Calibration and Frequency

Monitors awaiting field deployment are stored in the Aquatic Ecology and Water Quality Section Laboratory in water-filled, stainless steel holding tanks. While suspended vertically in these tanks, each DO sensor is checked at least once daily, Monday through Friday, against the Winkler DO measurement of the water in the holding tank. A monitor is recalibrated whenever the sensor DO is more than ± 0.2 mg/L from the Winkler DO.

Monitors that are scheduled for deployment are checked twice on the day before deployment and once in the morning of deployment. If on the day of scheduled deployment the DO concentration recorded by a DO sensor is found to be outside of the acceptance range of ± 0.2 mg/L, the monitor is not deployed in the field.

B8: Inspection/Acceptance of Supplies and Consumables

Supplies and consumables shall be inspected by a technician in the Aquatic Ecology and Water Quality Section and accepted only if they satisfy all specifications for the intended use.

B9: Non-direct Measurements

Non-direct measurements are not required for this project.

B10: Data Management

Every other week the 18 deployed water quality monitors are exchanged with cleaned and newly calibrated monitors. The retrieved monitors are brought back to the Aquatic Ecology and Water Quality Laboratory and placed in the receiving tank. The following morning each monitor is checked for accuracy against a Winkler DO measurement of the receiving tank water. While still in the receiving tank, the DO, temperature, and conductivity data collected during the previous week are downloaded from each monitor data logger into the project Oracle® database by a laboratory technician. The DO measurements are corrected for initial error and instrument drift using the observed errors from the Winkler measurements found for the holding tank DO measurement taken on the morning of deployment and the receiving tank DO taken the morning after retrieval. Sensor drift is assumed to be linear over time and the DO correction is calculated for each hourly measurement.

A biologist prepares a hard copy of the hourly DO data recorded at each monitoring station in service during the past two weeks. The biologist reviews the hourly DO data and summarized temperature and specific conductivity data for inconsistent measurements and highlights them for later review by a second biologist.

A biologist then transfers the hourly DO values for all monitoring stations from the Oracle® database into an Excel® application using Access®. A statistical summary table of the week's data is then prepared for the monitoring stations in each river system. The summary table prepared for a monitoring station lists the number of DO measurements, the mean, the minimum recorded DO, the maximum recorded DO, and the percent of DO measurements above the applicable DO water quality standard (Appendix I). The biologist also prepares a graph of the hourly DO measurements for each monitoring station (Appendix II).

Following each storm event, the Maintenance and Operations Department (M&O) prepares a storm report that details the rainfall amount, pumping station overflows, and back flows to Lake Michigan. The storm report is available to laboratory staff via Microsoft Outlook®.

M&O personnel also compile the daily flow information for Lake Michigan discretionary diversion. The discretionary diversion data is transmitted to the Aquatic Ecology and Water Quality Section on a monthly basis.

A biologist assesses the total rainfall recorded at rain gauges throughout the District's service area in order to determine whether a storm event occurred in a specific geographic area during the monitoring period. Overflows at the North Branch, Racine Avenue, and 125th Street Pumping Stations are evaluated by a biologist to verify the impact at monitoring stations on the North Branch of the Chicago River, CSSC (above the Stickney WRP outfall), and the Little Calumet River, respectively. A biologist reviews the daily discretionary diversion flows at the Wilmette Pumping Station, Chicago River Controlling Works, and O'Brien Lock to determine the effects at monitoring stations on the North Shore Channel (above the North Side WRP outfall), South Branch Chicago River, and the Little Calumet River, respectively.

Then a biologist reviews and verifies the field DO data. The criteria used to review and validate the DO data are stated in Section D1. Following the data review process, the biologist revises the weekly DO summary tables and DO hourly plots as necessary. The DO summary tables and DO plots are included in a weekly project report that also describes events, such as discretionary diversions, precipitation, and CSOs.

GROUP C: ASSESSMENT AND OVERSIGHT

C1: Assessment and Response Actions

Routine assessments are not used in this project.

C2: Reports to Management

The Project Manager and all those on the approval list will receive from the Network Coordinator all investigation and corrective action reports concerning quality control problems and other non-conformance issues from field personnel and participating laboratories.

Project related systems audits or special data quality assessments are not undertaken.

GROUP D: DATA VALIDATION AND USABILITY

D1: Data Review, Verification, and Validation

A biologist reviews and verifies the field DO data. The field data from any water quality monitor may be rejected following review of these quality control checks:

1. Comparison of Monitor DO Measurement with Winkler DO

   A grab DO sample is taken in close proximity to the protective enclosure during the biweekly exchange of monitors. The Winkler DO from the grab sample is compared with the last DO measurement of the retrieved monitor and the first DO measurement of the newly deployed monitor. A difference of 2.0 mg/L or more between the grab Winkler DO and the closest corresponding DO recorded by either monitor at the site will alert the biologist of a possible problem and may result in the rejection of the field data.

2. Precision of Measurements Between Exchanged Monitors

   The last hourly DO value measured by a retrieved monitor is compared with the first hourly DO value recorded by the newly deployed monitor at each location. A difference of 2.0 mg/L or more alerts the biologist that accuracy of the data from either the retrieved monitor or the newly deployed monitor may be suspect. Further evaluation of the data and the results of the check of retrieved monitor accuracy will provide the biologist with information to determine if the data from either monitor may be inaccurate and should be rejected.

3. Accuracy of Retrieved Monitors

   The DO in the laboratory receiving holding tank is measured by the Winkler method and compared with the DO value recorded at the same time by the retrieved monitors in the holding tank. A difference of 1.0 mg/L or more is used as a rejection criterion for the biweekly batch of field collected data.

D2: Verification and Validation Methods

The Project Manager and the QA Officer shall be informed of all situations where data integrity has been found compromised by errors, including storage of incorrect data or the corruption of stored data. All responsible persons identified in Section A4, and all known data users shall be informed of data problems when they are discovered and the corrective action taken. The QA Officer shall prepare the disclosure report for distribution.

D3: Reconciliation with User Requirements

The QAPP shall govern the operation of the project at all times. Each responsible person listed in Section A4 shall adhere to the procedural requirements of the QAPP and ensure that subordinate personnel do likewise.

This QAPP shall be reviewed annually to ensure that the project will achieve all intended purposes. All the responsible persons listed in Section A4 shall participate in the review of the QAPP. The annual review shall address every aspect of the program including:

1. The accuracy of the information contained in the QAPP and incorporation of changes made since its completion.
2. The adequacy and location of monitoring stations.
3. The adequacy of measurement frequency at each location.
4. Sampling procedures.
5. Analytical procedures.
6. The appropriateness of parameters monitored.
7. Changes in data quality objectives and minimum measurement criteria.
8. Whether the data obtained met minimum measurement criteria.
9. Corrective actions taken during the previous year for field and laboratory operations.
10. The adequacy of quality control procedures.
11. All interim reports and annual project report.
12. Review of other user requirements and recommendations.

The project will be modified as directed by the Project Director. The Project Manager shall be responsible for the implementation of changes to the project and shall document the effective date of all changes made.

It is expected that, from time to time, ongoing and perhaps unexpected changes will need to be made to the project. Significant changes or deviations in the operation of the project shall not be made without authorization by the Project Director. The need for a change in project operation should be conveyed to the Network Coordinator. Data users and other interested persons may also suggest changes to the project to the Network Coordinator.

The Network Coordinator shall evaluate the need for the change, consult with the Project Manager and others as appropriate, and make a recommendation to the Project Director for approval. The Network Coordinator shall, in a timely manner, inform the appropriate project personnel of approved changes in project operation.

Following approval, a memorandum documenting each authorized change shall be prepared by the Network Coordinator and distributed to all the responsible persons listed in Section A4. Approved changes shall be considered an amendment to the QAPP and shall be incorporated into the QAPP when it is updated annually.

Following the annual QAPP review, the Network Coordinator will prepare an updated version of the QAPP with the assistance of the QA Officer.

References

Hill, Libby, The Chicago River, A Natural and Unnatural History, Lake Claremont Press, 2000.

Lanyon, Richard, "Chicago River Reversal Solves Public Health Crisis," Wetland Matters, Vol. 5, No. 2, September 2000.

Lanyon, Richard, Seminar presented at the Stickney WRP, March 30, 2001.

Standard Methods for the Examination of Water and Wastewater, Prepared and published jointly by the American Public Health Association, the American Water Works Association and the Water Environment Federation, Washington, D.C., 20th edition, 1998.

State of Illinois Rules and Regulations, Title 35: Environmental Protection, Subtitle C: Water Pollution, Chapter I: Pollution Control Board, January 14, 1999.

FIGURE 1: CONTINUOUS DISSOLVED OXYGEN MONITORING PROJECT ORGANIZATION CHART

```
|---Project Director
|       (Planning, decision making, and
|         ultimate execution of project)
|
O----Project Manager
|    |   (Project planning, staffing, execution
|    |     and reporting)
|    |
O----O---QA Officer
|    |   |   (Project QA/QC, review of QAPP)
|    |   |
O----O---O-  Network Coordinator
     |   |  |   (Coordination of project activities, review
     |   |  |     of M&R reports, review of monitoring data,
     |   |  |     preparation of QAPP, provide data to IEPA)
     |   |  |
     |   O--O--  Field Operations Manager
     |   |  |         (Execution of field activities by field team)
     |   |  |                       |
     |   |  |               Field Team
     |   |  |                 |  (Monitor deployment, water sample collection
     |   |  |                 |    and preservation, field measurements, and
     |   |  |                 |    transport of monitors and samples)
     |   |  |                 |
     |   O--O--  Environmental Monitoring Manager
     |      |       Aquatic Ecology and Water Quality Section (AEWQ)
     |      |          (Troubleshoot database issues, prepare M&R annual reports,
     |      |            and supervise data review)
     |      |                        |
     O------O--  AEWQ Laboratory Technicians and Biologists
                    (Analysis of DO water samples, calibrate DO
                    sensors, clean and maintain water quality
                    monitors, download data from monitors,
                    conduct cross-sectional DO surveys, review of monitoring
                    data, preparation of statistical summaries and DO graphs,
                    and collection of auxiliary information.)
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FIGURE 2: CURRENTLY ACTIVE CONTINUOUS DISSOLVED OXYGEN MONITORING STATIONS

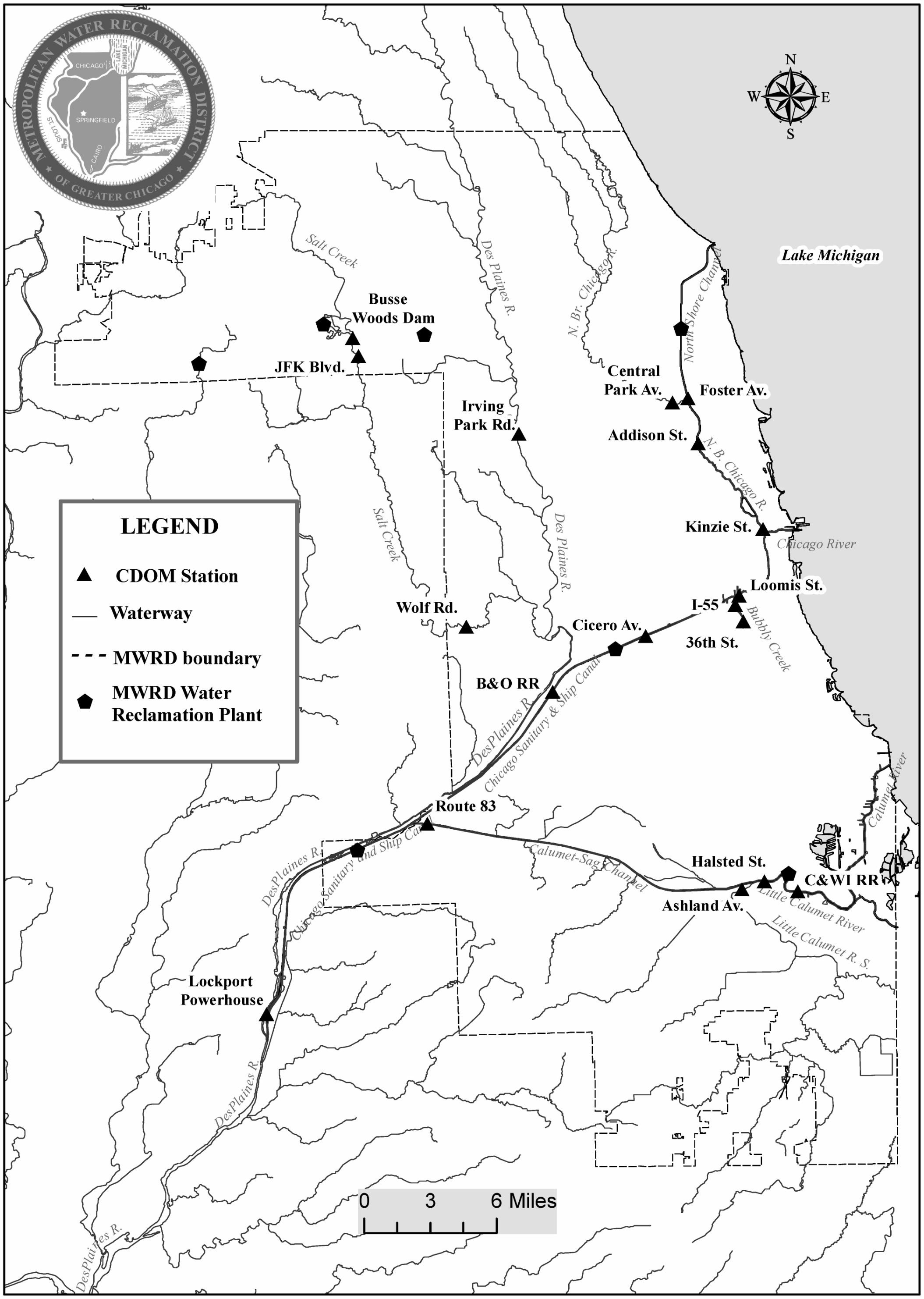

TABLE 1: SAMPLING HISTORY AT EACH MONITORING LOCATION

Loc. ID	Continuous DO Monitoring Location	Time Period DO Measured Hourly at Location	Status
1	Linden St., North Shore Channel	August 1998 - March 2004	Inactive
2	Simpson St., North Shore Channel	August 1998 - March 2004	Inactive
3	Main St., North Shore Channel	August 1998 - Dec. 2010	Inactive
4	Devon Ave., North Shore Channel	August 1998 - January 2001	Inactive
57	Foster Ave., North Shore Channel	August 2004 - Present	Active
66	Central Park Ave., North Branch Chicago River	July 2005 - Present	Active
5	Lawrence Ave., North Branch Chicago River	August 1998 - January 2001	Inactive
6	Addison St., North Branch Chicago River	August 1998 - Present	Active
7	Fullerton Ave., North Branch Chicago River	August 1998 - Dec. 2010	Inactive
8	Division St., North Branch Chicago River	August 1998 - March 2004	Inactive
9	Kinzie St., North Branch Chicago River	August 1998 - Present	Active
21	Chicago River Controlling Works, Chicago River	March 2000 - March 2004	Inactive
22	Michigan Ave., Chicago River	March 2000 - March 2004	Inactive
10	Clark St., Chicago River	August 1998 - Dec. 2010	Inactive
11	Jackson Blvd., South Branch Chicago River	August 1998 - March 2004	Inactive
12	Loomis St., South Branch Chicago River	August 1998 - January 2001, April 2003 - Present	Active
49	36th St., Bubbly Creek	June 2002 - Present	Active
13	I-55, Bubbly Creek	August 1998 - January 2001, April 2002 - Present	Active
14	Cicero Ave., Chicago Sanitary & Ship Canal	August 1998 - Present	Active
15	B&O Central RR, Chicago Sanitary & Ship Canal	August 1998 - Present	Active
16	Route 83, Chicago Sanitary & Ship Canal	August 1998 - Dec. 2010	Inactive
17	River Mile 302.6, Chicago Sanitary & Ship Canal	August 1998 - March 2004	Inactive
18	Romeoville Rd., Chicago Sanitary & Ship Canal	August 1998 - March 2004	Inactive
19	Lockport Powerhouse, Chgo. Sanitary & Ship Canal	August 1998 - Present	Active
58	Devon Ave., Des Plaines River	October 2005 - Dec. 2010	Inactive
62	Irving Park Rd., Des Plaines River	July 2005 - Present	Active
63	Ogden Ave., Des Plaines River	July 2005 - Dec. 2010	Inactive
64	Material Service Rd., Des Plaines River	October 2005 - Dec. 2010	Inactive

TABLE 1 (Continued): SAMPLING HISTORY AT EACH MONITORING LOCATION

Loc. ID	Continuous DO Monitoring Location	Time Period DO Measured Hourly at Location	Status
23	Jefferson St., Des Plaines River	March 2000 - Dec. 2010	Inactive
31	130th St., Calumet River	July 2001 - March 2004	Inactive
67	Hohman Ave., Grand Calumet River	July 2005 - April 2008	Inactive
32	Torrence Ave., Grand Calumet River	July 2001 - Dec. 2010t	Inactive
33	Conrail RR, Little Calumet River	July 2001 - March 2004	Inactive
34	C&W Indiana RR, Little Calumet River	July 2001 - Present	Active
35	Halsted St., Little Calumet River	July 2001 - Present	Active
65	Wentworth Ave., Little Calumet River	July 2005 - Dec. 2010	Inactive
36	Ashland Ave., Little Calumet River	July 2001 - Present	Active
37	Division St., Calumet-Sag Channel	July 2001 - March 2004	Inactive
38	Kedzie Ave., Calumet-Sag Channel	July 2001 - March 2004	Inactive
39	Cicero Ave., Calumet-Sag Channel	July 2001 - Dec. 2010	Inactive
40	River Mile 311.7, Calumet-Sag Channel	July 2001 - November 2004	Inactive
41	Southwest Hwy., Calumet-Sag Channel	July 2001 - March 2004	Inactive
42	104th Ave., Calumet-Sag Channel	July 2001 - October 2010	Inactive
20	Route 83, Calumet-Sag Channel	August 1998 - Present	Active
68	Busse Woods Main Dam, Salt Creek	October 2005 - Present	Active
59	J. F. Kennedy Blvd., Salt Creek	July 2005 - Present	Active
60	Thorndale Ave., Salt Creek	July 2005 - March 2009	Inactive
61	Wolf Rd., Salt Creek	July 2005 - Present	Active

TABLE 2: LATITUDE AND LONGITUDE OF MONITORING LOCATIONS

Loc. ID	Continuous DO Monitoring Location	Latitude	Longitude
1	Linden St., North Shore Channel	42° 04.390'	87° 41.140'
2	Simpson St., North Shore Channel	42° 03.350'	87° 42.400'
3	Main St., North Shore Channel	42° 02.010'	87° 42.570'
4	Devon Ave., North Shore Channel	41° 59.820'	87° 42.610'
57	Foster Ave., North Shore Channel	41° 58.5660'	87° 42.2860'
66	Central Park Ave., North Branch Chicago River	41° 58.3790'	87° 42.0882'
5	Lawrence Ave., North Branch Chicago River	41° 58.100'	87° 42.020'
6	Addison St., North Branch Chicago River	41° 56.790'	87° 41.720'
7	Fullerton Ave., North Branch Chicago River	41° 55.520'	87° 40.450'
8	Division St., North Branch Chicago River	41° 54.210'	87° 39.430'
9	Kinzie St., North Branch Chicago River	41° 53.440'	87° 38.330'
21	Chicago River Lock, Chicago River	41° 53.280'	87° 36.580'
22	Michigan Ave., Chicago River	41° 53.340'	87° 37.370'
10	Clark St., Chicago River	41° 53.241'	87° 37.893'
11	Jackson Blvd., South Branch Chicago River	41° 53.911'	87° 38.135'
12	Loomis St., South Branch Chicago River	41° 50.747'	87° 39.662'
49	36th St., South Fork South Branch Chicago River	41° 49.071'	87° 39.437'
13	I-55, South Fork South Branch Chicago River	41° 50.648'	87° 39.878'
14	Cicero Ave., Chicago Sanitary & Ship Canal	41° 49.169'	87° 44.616'
15	B&O RR Bridge, Chicago Sanitary & Ship Canal	41° 46.990'	87° 49.540'
16	Route 83, Chicago Sanitary & Ship Canal	41° 42.420'	87° 55.750'
17	River Mile 302.6, Chicago Sanitary & Ship Canal	41° 41.240'	87° 58.470'
18	Romeoville Rd., Chicago Sanitary & Ship Canal	41° 38.450'	88° 03.549'
19	Lockport Powerhouse, Chicago Sanitary & Ship Canal	41° 34.277'	88° 04.711'
58	Devon Ave., Des Plaines River	41° 59.7633'	87° 51.5629'
62	Irving Park Rd., Des Plaines River	41° 57.1905'	87° 51.2461'
63	Ogden Ave., Des Plaines River	41° 49.2501'	87° 48.6311'
64	Material Service Rd., Des Plaines River	41° 35.7913'	88° 04.1275'
23	Jefferson St., Des Plaines River	41° 31.489'	88° 05.155'
31	130th St., Calumet River	41° 39.619'	87° 34.195'
67	Hohman Ave., Grand Calumet River	41° 37.4546'	87° 31.0777'

TABLE 2 (Continued): LATITUDE AND LONGITUDE OF MONITORING LOCATIONS

Loc. ID	Continuous DO Monitoring Location	Latitude	Longitude
32	Torrence Ave., Grand Calumet River	41° 38.652'	87° 33.542'
33	Conrail RR, Little Calumet River	41° 38.345'	87° 33.955'
34	C&W Indiana Harbor Belt RR, Little Calumet River	41° 39.026'	87° 36.695'
35	Halsted St., Little Calumet River	41° 39.431'	87° 38.450'
65	Wentworth Ave., Little Calumet River	41° 35.1058'	87° 31.7625'
36	Ashland Ave., Little Calumet River	41° 39.110'	87° 39.625'
37	Division St., Calumet-Sag Channel	41° 39.160'	87° 40.250'
38	Kedzie Ave., Calumet-Sag Channel	41° 39.120'	87° 41.920'
39	Cicero Ave., Calumet-Sag Channel	41° 39.345'	87° 44.313'
40	River Mile 311.7, Calumet-Sag Channel	41° 40.626'	87° 47.532'
41	Southwest Hwy., Calumet-Sag Channel	41° 40.812'	87° 48.642'
42	104th Ave., Calumet-Sag Channel	41° 41.352'	87° 53.052'
20	Route 83, Calumet-Sag Channel	41° 41.810'	87° 56.480'
68	Busse Woods Main Dam, Salt Creek	42° 01.0089'	88° 00.0289'
59	J. F. Kennedy Blvd., Salt Creek	42° 00.3152'	87° 59.7498'
60	Thorndale Ave., Salt Creek	41° 59.0307'	87° 59.4212'
61	Wolf Rd., Salt Creek	41° 49.5759'	87° 54.0781'

TABLE 3: ILLINOIS POLLUTION CONTROL BOARD USE CLASSIFICATION AND DISSOLVED OXYGEN STANDARD AT EACH MONITORING LOCATION

Loc. ID	Continuous DO Monitoring Location	IPCB Classification	DO Standard mg/L
1	Linden St., North Shore Channel	General use	3.5-6.0[1]
2	Simpson St., North Shore Channel	General use	3.5-6.0[1]
3	Main St., North Shore Channel	General use	3.5-6.0[1]
4	Devon Ave., North Shore Channel	Secondary contact	4.0
57	Foster Ave., North Shore Channel	Secondary contact	4.0
66	Central Park Ave., North Branch Chicago River	General use	3.5-6.0[1]
5	Lawrence Ave., North Branch Chicago River	Secondary contact	4.0
6	Addison St., North Branch Chicago River	Secondary contact	4.0
7	Fullerton Ave., North Branch Chicago River	Secondary contact	4.0
8	Division St., North Branch Chicago River	Secondary contact	4.0
9	Kinzie St., North Branch Chicago River	Secondary contact	4.0
21	Chicago River Lock, Chicago River	General use	3.5-6.0[1]
22	Michigan Ave., Chicago River	General use	3.5-6.0[1]
10	Clark St., Chicago River	General use	3.5-6.0[1]
11	Jackson Blvd., South Branch Chicago River	Secondary contact	4.0
12	Loomis St., South Branch Chicago River	Secondary contact	4.0
49	36th St., South Fork South Branch Chicago River	Secondary contact	4.0
13	I-55, South Fork South Branch Chicago River	Secondary contact	4.0
14	Cicero Ave., Chicago Sanitary & Ship Canal	Secondary contact	4.0
15	B&O RR, Chicago Sanitary & Ship Canal	Secondary contact	4.0
16	Route 83, Chicago Sanitary & Ship Canal	Secondary contact	4.0
17	River Mile 302.6, Chicago Sanitary & Ship Canal	Secondary contact	4.0
18	Romeoville Rd., Chicago Sanitary & Ship Canal	Secondary contact	4.0
19	Lockport Powerhouse, Chicago Sanitary & Ship Canal	Secondary contact	4.0
58	Devon Ave., Des Plaines River	General use	3.5-6.0[1]
62	Irving Park Rd., Des Plaines River	General use	3.5-6.0[1]
63	Ogden Ave., Des Plaines River	General use	3.5-6.0[1]
64	Material Service Rd., Des Plaines River	General use	3.5-6.0[1]
23	Jefferson St., Des Plaines River	Secondary contact	4.0
31	130th St., Calumet River	General use	3.5-6.0[1]
67	Hohman Ave., Grand Calumet River	Secondary contact	4.0
32	Torrence Ave., Grand Calumet River	Secondary contact	4.0
33	Conrail RR, Little Calumet River	Secondary contact	4.0
34	C&W Indiana Harbor Belt RR, Little Calumet River	Secondary contact	4.0

TABLE 3 (Continued): ILLINOIS POLLUTION CONTROL BOARD USE CLASSIFICATION AND DISSOLVED OXYGEN STANDARD AT EACH MONITORING LOCATION

Loc. ID	Continuous DO Monitoring Location	IPCB Classification	DO Standard mg/L
35	Halsted St., Little Calumet River	Secondary contact	4.0
65	Wentworth Ave., Little Calumet River	General use	3.5-6.0[1]
36	Ashland Ave., Little Calumet River	General use	3.5-6.0[1]
37	Division St., Calumet-Sag Channel	Secondary contact	3.0
38	Kedzie Ave., Calumet-Sag Channel	Secondary contact	3.0
39	Cicero Ave., Calumet-Sag Channel	Secondary contact	3.0
40	River Mile 311.7, Calumet-Sag Channel	Secondary contact	3.0
41	Southwest Hwy., Calumet-Sag Channel	Secondary contact	3.0
42	104th Ave., Calumet-Sag Channel	Secondary contact	3.0
20	Route 83, Calumet-Sag Channel	Secondary contact	3.0
68	Busse Woods Main Dam, Salt Creek	General use	3.5-6.0[1]
59	J. F. Kennedy Blvd., Salt Creek	General use	3.5-6.0[1]
60	Thorndale Ave., Salt Creek	General use	3.5-6.0[1]
61	Wolf Rd., Salt Creek	General use	3.5-6.0[1]

[1]The General Use Standard requires that during the period March through July, DO shall not be less than 5.0 mg/L at any time or less than 6.0 mg/L as a daily mean averaged over seven days, and that during the period August through February, DO shall not be less than 3.5 mg/L at any time, or less than 4.0 mg/L as a daily minimum averaged over seven days, or less than 5.5 mg/l as a daily mean averaged over 30 days.

CONTINUOUS DISSOLVED OXYGEN MONITORING
QUALITY ASSURANCE PROJECT PLAN

APPENDIX I

EXAMPLE OF A WEEKLY DISSOLVED OXYGEN SUMMARY TABLE

TABLE AI-1: DISSOLVED OXYGEN VALUES IN THE NORTH SHORE CHANNEL, NORTH BRANCH CHICAGO RIVER, SOUTH BRANCH CHICAGO RIVER, BUBBLY CREEK, AND CHICAGO SANITARY AND SHIP CANAL DURING THE PERIOD JANUARY 5, 2010, THROUGH JANUARY 14, 2010[1]

Monitor Location	Waterway	IPCB Standard	Number of DO Values	DO Concentration (mg/L) Min	Max	Mean	Percent of DO Values Above Standard
Foster Avenue	North Shore Channel	4.0	166	8.1	9.2	8.6	100.0
Central Park Avenue	North Branch Chicago River	3.5/5.0	168	12.8	13.8	13.3	100.0
Addison Street	North Branch Chicago River	4.0	167	8.2	9.3	8.8	100.0
Kinzie Street	North Branch Chicago River	4.0	167	7.9	13.1	9.5	100.0
Loomis Street	South Branch Chicago River	4.0	167	9.9	11.7	10.7	100.0
Interstate Highway 55	Bubbly Creek	4.0	168	7.8	10.4	9.3	100.0
Cicero Avenue	Chicago Sanitary and Ship	4.0	167	8.8	11.3	10.1	100.0
B&O Central Railroad	Chicago Sanitary and Ship	4.0	168	8.2	9.7	9.2	100.0
Lockport Powerhouse	Chicago Sanitary and Ship	4.0	168	7.5	8.7	8.2	100.0

[1]Parameter was measured hourly using a YSI Model 6920 or Model 6600 continuous water quality monitor.

CONTINUOUS DISSOLVED OXYGEN MONITORING
QUALITY ASSURANCE PROJECT PLAN

APPENDIX II

EXAMPLE OF AN HOURLY DISSOLVED OXYGEN PLOT

FIGURE AII-1: DISSOLVED OXYGEN CONCENTRATION MEASURED HOURLY AT ADDISON STREET IN NORTH BRANCH CHICAGO RIVER JANUARY 5, 2010, THROUGH JANUARY 12, 2010