Metropolitan Water Reclamation District of Greater Chicago
(District)

MAINTENANCE AND OPERATIONS DEPARTMENT

COLLECTION SYSTEM
OPERATION AND MAINTENANCE MANUAL
(Combined Sewer Overflow and Capacity Management Operations and Maintenance Plan)
DRAFT

NPDES No. IL0028088 – O'Brien (North Side) WRP
NPDES No. IL0028053 – Stickney WRP
NPDES No. IL0028061 – Calumet WRP
NPDES No. IL0028070 – Lemont WRP
NPDES No. IL0047741 – Kirie WRP
NPDES No. IL0036137 – Hanover Park WRP
NPDES No. IL0036340 – Egan WRP

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For public review and comment

Prepared by
Technical Services Unit

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INTRODUCTION

The mission of the District is to protect the health and safety of the public in its service area, protect the quality of the water supply source (Lake Michigan), improve the quality of water in watercourses in its service area, protect businesses and homes from flood damages, and manage water as a vital resource for its service area. The District's service area is 883.5 square miles of Cook County, Illinois. The District is committed to achieving the highest standards of excellence in fulfilling its mission.

Flow within the Chicago Area Waterways System (CAWS) as well as flow between CAWS and Lake Michigan are controlled by five structures: Wilmette Pump Station, Chicago River Controlling Works and Lock, O'Brien Controlling Works and Lock, Lockport Lock and Dam, and Lockport Controlling Works.

While exercising no direct control over the wastewater collection and transmission systems maintained by cities, towns, and villages in Cook County, the District does control municipal sewer construction by permits in suburban Cook County. It also provides, operates and maintains the main trunk lines (interceptors) for the collection of wastewater and treatment thereof as well as facilities to store, treat, and release combined sewage and stormwater runoff within its jurisdiction.

The District is located primarily within the boundaries of Cook County, Illinois. The District serves an area of 883.6 square miles, which includes the City of Chicago and 128 suburban communities. The District serves an equivalent population of 10.35 million people; 5.25 million real people, a commercial and industrial equivalent of 4.5 million people, and a combined sewer overflow equivalent of 0.6 million people. The District's 554 miles of intercepting sewers and force mains range in size from 12 inches to 27 feet in diameter, and are fed by approximately 10,000 local sewer system connections.

The District's Tunnel and Reservoir Project (TARP) is one of the country's largest public works projects for pollution and flood control. One hundred and nine miles (109.4) of tunnels, 8 to 33 feet in diameter and 150 to 300 feet underground, have already been constructed and are in operation.

The District owns and operates one of the world's largest water reclamation plants, in addition to six other plants and 22 pumping stations. The District treats an average of 1.4 billion gallons of wastewater each day. The District's total wastewater treatment capacity is over 2.0 billion gallons per day.

The District controls approximately 76 miles of navigable waterways, which are part of a national system connecting the Atlantic Ocean and the Great Lakes with the Gulf of Mexico. In conjunction with its biosolids recycle and land reclamation program, the District owns over 13,500 acres of land in Fulton County, Illinois.

Beginning in 2005, the District was assigned responsibility for stormwater management for all of Cook County, including areas outside of the District's corporate boundaries. Activities have focused on organization and ordinance development, development of watershed plans and projects as well as implementation of a small stream maintenance program.

1.0 MANAGEMENT

1.1 PURPOSE

The purpose of this manual is to describe the means by which the District accomplishes two of its primary objectives: to avoid contamination of the Chicago Area Waterways (CAWS) and to protect the health and safety of the public in its service area. The District serves an area of 883.6 square miles which includes the City of Chicago and 128 suburban communities. Of the total service area, approximately 375 square miles have combined sewers and 508.6 square miles have separate sewers. Managing combined sewer overflows (CSOs) within the combined areas and separate sewer overflows (SSOs) within the separate areas are key to the District accomplishing its above primary objectives. To this end, this manual describes the Infrastructure Management, End of Pipe Management, Public Outreach and Education, Technology Testing, and associated Standard Operating Practices necessary to achieve our stated objectives.

1.2 ORGANIZATION

The District is governed by a nine-member Board of Commissioners. Commissioners are elected at large and serve on a salaried part-time basis. Three commissioners are elected every two years for six-year terms.

The Executive Director, who reports directly to the Board of Commissioners, manages the District's day-to-day operations. Eight appointed department heads report to the Executive Director.

Under the direction of the Executive Director, three departments undertake the primary responsibility for carrying out the objectives stated above: Maintenance and Operations, Engineering, and Monitoring and Research.

- Maintenance and Operations has four divisions: General, North Area, Stickney Area and Calumet Area
- Engineering has three divisions: Infrastructure Management, Process Facilities Design, and Construction
- Monitoring and Research has three divisions: Environmental Monitoring and Research, Analytical Laboratories, and Industrial Waste

1.2.1 Maintenance and Operations (Relevant Division)

The General Division has three relevant sections:

- Waterways Control Section
    1. Administrative Unit
    2. Channels Operations Unit
    3. Channel Control Unit
    4. Lockport Powerhouse Unit
- Collection Systems Section
    1. Collection System Administration Unit

2. North Service Area Unit
3. Central Service Area Unit
4. South Service Area Unit

- Technical Administration Section
    1. Technical Administration Unit
    2. Technical Services Unit
    3. Contract Preparation Unit

1.2.2 Engineering (Relevant Division)

The Infrastructure Management Division consists of four relevant sections:
- Administrative Section
- Collection Facilities/TARP Section
- Local Sewer Systems Section
- Stormwater Management Section

1.2.3 Monitoring and Research (Relevant Divisions)

The Environmental Monitoring and Research Division consist of two relevant sections:
- Analytical Microbiology and Biomonitoring Section
- Aquatic Ecology and Water Quality Section

The Analytical Laboratories Division consists of two relevant sections:
- Stickney Analytical Laboratory
- Industrial Waste Analytical Laboratory

The Industrial Waste Division consists of seven relevant sections:
- Industrial Waste Administrative
- Enforcement
- User Charge and Technical Services
- Field Services Central Area
- Field Services South Area
- Field Services North Area
- Field Services Northwest Area

The responsibilities of each division are described in further detail in subsequent sections of this manual.

See the District's current Budget Book on the District's website for an organizational chart and additional information on the Relevant District Departments, Divisions, Sections and Units:

http://pepportal.mwrd.local:50100/irj/portal/anonymous?NavigationTarget=navurl://45687c4bebc14a072052f943c334a50b

2.0 INFRASTRUCTURE MANAGEMENT

2.1 POLLUTION PREVENTION CONTROL

2.1.1 Local Sewers Section

The Local Sewers Systems Section administers the Watershed Management Ordinance (WMO). Articles 7, 9, and 10 of the WMO regulate the design, construction, operation, and maintenance of public and private sewer connections for residential, commercial, institutional, governmental and industrial developments, public sewerage systems, and treatment facilities, which discharge directly or indirectly into District facilities or waters within the District's jurisdiction through the review and issuance of permits. The WMO also requires stormwater management facilities for developments to ensure that the runoff from new developments and redevelopments do not exacerbate existing runoff and flooding conditions.

The WMO's Technical Guidance Manual (TGM) provides minimum engineering standards for the design, construction, operation, and maintenance of the above-referenced facilities. Proposed sewer construction plans/applications must demonstrate compliance with relevant articles of the WMO before a sewer construction permit is issued.

The WMO, TGM, and other related documents can be found on the District's website at http://wmo.mwrd.org.

2.1.1.1 Inflow and Infiltration Control Program

The separate sanitary sewers within the District's service area are designed and intended to receive and convey only domestic and industrial wastewaters together with a limited amount of groundwater infiltration. Stormwater runoff and excessive groundwater infiltration, however, have in many cases been entering and overloading sanitary sewers through deficiencies in the sewer systems such as open pipe joints, cracked or broken pipes, leaking manholes, and illegal connections (i.e., direct or indirect stormwater/groundwater connections to separate sanitary sewers). Sewer overloading arising from such deficiencies may cause health hazards, financial losses, and inconvenience to area residents. These detrimental conditions occur as a consequence of water pollution from treatment plant bypasses and sewage overflows into streams, and also as a result of backups of sewage into buildings and onto streets and yards. Excessive extraneous clear water flows also result in additional sewage treatment costs to the public.

Since the enactment of the 1985 Sewer Summit Agreement (SSA), many communities have invested in rehabilitation efforts, yet the sewer systems still have excessive stormwater inflow and groundwater infiltration (I/I) requiring further reduction. Many communities still need to establish on-going maintenance programs and budgets that continually repair local systems.

The Illinois Environmental Protection Agency (IEPA) has imposed a special condition as part of the District's National Pollutant Discharge Elimination System (NPDES) Permits that requires the owners and/or operators of separate sanitary sewer systems that discharge directly and/or indirectly to the District's facilities (satellite entities) to implement measures in addition to those required under the SSA if excessive I/I causes or contributes to sanitary sewer overflows (SSOs) and/or basement backups (BBs). In order to address the requirements set forth in the NPDES Permits and other federal, state and local regulations, it is the intent of the District to set forth a regionally applied Infiltration/Inflow Control Program (Program) for the rehabilitation and correction of sanitary sewer system deficiencies, and for the continuation of adequate long-term sanitary sewer management and maintenance programs by the satellite entities that are tributary to the District's facilities.

As a result of the above, the District created an Advisory Technical Panel (ATP) consisting of representatives of the tributary agencies, consultants, a sewer contractor and representatives from the District. Representatives from the USEPA and IEPA participated in the ATP discussions. The purpose of the ATP was to seek input and suggestions for the creation of a new I/I Control Program. The first meeting of the ATP was held on November 18, 2011 and continues to meet quarterly. The new I/I Control Program was adopted by the Board of Commissioners on July 10, 2014, and development of the Technical Guidance Manual is ongoing. The new Infiltration/Inflow Control Program, is incorporated into Article 8 of the WMO which can be found on the District's website at http://wmo.mwrd.org.

2.1.2 Industrial Waste/Enforcement Programs

The Industrial Waste Division (IWD) of the Monitoring and Research Department consists of four sections: Administrative, User Charge and Technical Services, Field Services, and Enforcement. The primary responsibility of IWD is the enforcement of the District's Sewage and Waste Control Ordinance (SWCO) and the User Charge Ordinance (UCO) which can be found on the District's website at

http://pepportal.mwrd.local:50100/irj/portal/anonymous?NavigationTarget=navurl://77736bc1946759617132ba3e6459cb26

IWD is also responsible for the collection, compilation and presentation of data pertaining to industrial user discharges to the District's sewerage system. IWD also carries out the District's responsibility as a primary response agency for hazardous materials emergencies in Cook County.

2.1.2.1 Administrative Section

The Administration Section is responsible for the general administration of IWD and for coordination and direction of the work of the User Charge and Technical Services, Field Services, and Enforcement Sections.

2.1.2.2 User Charge and Technical Services Section

The User Charge and Technical Services Section administers the District's federally-approved User Charge system as authorized under the UCO. The Section receives and reviews reports from approximately 3,500 users annually containing calculations of their respective User Charge liabilities under the UCO and documentation corroborating their data. The costs for the administration of the SWCO and the UCO are recovered from industrial users through Minimum Pretreatment Requirements charges, Noncompliance Enforcement charges and User Charge Verification charges.

2.1.2.3 Field Services Section

The Field Services Section (FSS) of IWD conducts inspections and sampling of wastewater discharges at various industrial and commercial facilities within the District's jurisdiction to determine compliance with the SWCO and for verification of user-provided data as required by the UCO. On average, approximately 2,500 locations are sampled and 3,000 locations inspected each year. Corrective compliance action is taken against facilities that are found in violation of the SWCO.

The FSS is on call 24 hours per day, 365 days per year, to respond to emergency situations or complaints. These calls originate from local municipalities, Police and Fire Departments, the EPA, the Coast Guard, private citizens, or as industrial self-reported incidents involving the discharge or potential discharge of harmful wastes into the sanitary sewers or the waterways of Cook County. The FSS responds to approximately 350 such calls each year.

Additionally, the FSS is responsible for the following activities:

- Monitors the quality of Lake Michigan and the Chicago Area Waterway System in order to detect and reduce the incidence of pollution and to protect the area's source of drinking water.
- Collects samples from groundwater monitoring wells installed in the vicinity of the District's Tunnel and Reservoir Plan (TARP) and at certain District facilities to detect the presence of contaminants from District operations.
- Monitors the wastes brought by chemical toilet service companies for discharge at the Stickney WRP.
- Investigates willful and/or accidental spills and discharges of pollutants and hazardous, toxic, or volatile materials into the sewer systems and waterways, and oversees containment and cleanup activities pertaining to such events.

2.1.2.4 Enforcement Section

The Enforcement Section is responsible for the routine administration and enforcement of the SWCO, which incorporates the federal categorical and non-categorical pretreatment regulations and specifies limits for contaminants and other wastes discharged into the sewer systems and waterways within the District's boundaries.

2.1.2.5 Sewage and Waste Control Ordinance

The SWCO was first adopted in 1969 and has been comprehensively amended to include technically-based local discharge limits and the District's USEPA-approved Pretreatment Program. Its purpose is the protection of the public health and safety by abating and preventing pollution. Through the administration of the SWCO and the Pretreatment Program, the District can control the quantity and quality of sewage, industrial wastes and other wastes discharged to the sewer system, WRPs and waterways. The result is the protection of the treatment processes at the District's Water Reclamation Plants (WRP), the water quality of the receiving waterbody, and the quality of the biosolids generated at the District, while providing for worker safety. This also allows the District to achieve compliance with its National Pollutant Discharge Elimination System permits, in addition to producing exceptional good quality biosolids for final utilization.

2.1.2.6 Pretreatment Program

In 1985, the USEPA granted its approval of the District's Pretreatment Program. Pursuant to the General Pretreatment Regulations that contain the requirements for an approved pretreatment program, the District must require compliance by industrial users with the applicable USEPA categorical pretreatment standards as well as the local limits. Under the provisions of Appendix D to the SWCO, the Enforcement Section issues individual control mechanisms (Discharge Authorizations) to all Significant Industrial Users (SIUs) in order to establish conditions for their discharge of pollutants into the District's sewer system. SIUs are typically those that are: a) subject to categorical pretreatment standards; or b) discharges greater than 25,000 gallons per day of process wastewater. The Discharge Authorizations (DAs) establish pollutant-specific effluent limitations applicable to the specific industry. DA Forms can be found on the District's website at

http://pepportal.mwrd.local:50100/irj/portal/anonymous?NavigationTarget=navurl://640af2860c5dc5cf31d3591dc62503dc

The DAs also establish self-monitoring, sampling, reporting, notification and record-keeping requirements including identification of the pollutants to be monitored, sampling points, and sampling frequency. SIUs are required to submit Continued Compliance Reports twice per year. Continued Compliance Report Forms can be found on the District's website at

http://pepportal.mwrd.local:50100/irj/portal/anonymous?NavigationTarget=navurl://640af2860c5dc5cf31d3591dc62503dc

Under its Pretreatment Program, the District, at a minimum, must inspect and sample all industrial users subject to categorical pretreatment standards and other significant industrial users at least annually to verify compliance with the applicable standards. During the inspections, Environmental Specialists (ESs) from the FSS routinely make observations of discharge points, process areas, pretreatment systems, generation of sludge and other process residues, maintenance of records, and any other items required by the SWCO. Information is collected pertaining to chemical storage facilities, hazardous waste generation, spill control plans, industrial user self-monitoring techniques (when observed), and industrial user production rates. Professional staff of the IWD have attended and completed a training program in the performance of pretreatment facility inspections. Knowledge gained has been incorporated into the development of the Inspection Check List now being used by the District. Wastewater samples are obtained from industrial users' discharge points and analyzed for compliance with pollutant concentration limits.

The Enforcement Response Procedure (ERP) is detailed in Appendix F to the SWCO. The ERP has been developed to include a range of enforcement responses available to the District to effectively enforce the terms and conditions of the SWCO. The ERP establishes a framework, the Response Option Matrix, in which the District will assess the degree of noncompliance by an industrial user and may consider both mitigating and aggravating circumstances in determining the appropriate enforcement response. The ERP also establishes minimum response levels for incidents of noncompliance that are deemed critical in nature, including interference with and pass-through of the treatment processes. The following types of enforcement are available to the District in response to incidents of noncompliance:

- Notice of Noncompliance
- Cease and Desist Order
- Show Cause Proceedings
- Court Proceedings
- Civil or Criminal Referrals

When the District determines that an industrial user is in violation of the SWCO, an Order is issued against the non-complying industrial user. Industrial users found in noncompliance are required to submit a written compliance schedule containing specific measures that will be taken to attain compliance along with specific milestone dates for taking these actions. In each case, on-site inspection and sampling is performed by the District to verify an industrial user's claim of compliance. If the inspection and/or sampling confirms noncompliance, the District may determine that Show Cause action is warranted. Show Cause proceedings involve hearings conducted by a Hearing Officer appointed by the Board of Commissioners. At the conclusion of the hearings, the Hearing Officer makes a finding of fact and a recommendation to the Board for action regarding the non-complying industrial user. The recommendation, upon adoption, becomes an Order of the Board (Board Order). An industrial user in significant noncompliance with a Board Order may be recommended for legal action in the Circuit Court of Cook County, to halt the condition of noncompliance either by mandamus or by injunction. Pursuant to Chapter 70, Section 2605/7bb of the Illinois Compiled Statutes, the District may seek a penalty of not less than $1,000.00 nor more than $10,000.00 per day for each day the industrial user remains in noncompliance with a Board Order. The District may also seek to recover reasonable attorney's fees, court costs and other expenses of litigation, and costs for inspection, sampling, analysis and administration relating to the enforcement action, beginning with the issuance of the initial Order. The SWCO also includes the following enforcement mechanisms, designed to elicit more decisive industrial user action in response to noncompliance issues:

- Administrative civil penalty authority, ranging from $100 to $2,000 per day of violation
- Late filing fees for required reports, ranging from $100 to $1,000 per day
- Authority to impose liens on a user's property for nonpayment of penalties

2.1.3 Detection and Elimination of Illegal Connections

During routine inspections performed on District-owned interceptors by the Sewer Maintenance Unit, illegal connections are sometimes observed visually or through televised inspections. In the event an illegal connection is suspected, the information is forwarded to the Local Sewers Section, described in 2.1.1, for further investigation and corrective action.

2.1.4 Detection and Elimination of Dry Weather Overflows

Dry weather overflows are detected through routine interceptor sewer and control structure inspections, activation of tide gate alarms, and from observations from other agencies and private citizens. The Sewer Maintenance Unit makes regular visits to the structures where dry weather overflows potentially could occur. The purpose of the frequent inspections is to be able to detect situations and problems before they cause overflows during dry weather. Sewer Maintenance Unit personnel are available 24 hours per day, 7 days per week to investigate reports of problems. As a result of an inspection, recommendations are made to implement corrective action and eliminate dry weather overflows as soon as possible. Upon verification, all such dry weather bypasses are reported immediately to the IEPA.

In situations where the problem is due to excessive flow from local lines, rather than to the malfunction of the connection to the interceptor or TARP, the owner of the local sewer system and the Engineering Department's Local Sewer Systems representative are notified.

2.2 INFRASTRUCTURE AND FACILITY MAINTENANCE

2.2.1 Overview

The District's interceptor system, extending 554 miles in length, serves an area of 883.6 square miles which includes the City of Chicago and 128 Suburban Communities. Although relatively durable, sewers will deteriorate over time and regular inspections and maintenance schedules are imperative for protecting critical infrastructure and imperative to protecting public health. The 554 miles of District interceptors are inspected, maintained and rehabilitated with joint efforts between the M&O and Engineering Departments. The District sewer systems are constructed using the following materials:

- Vitrified Clay Pipe for smaller pipes (12 to 18 inch)
- Cast in Place Concrete (pre 1950) of various sizes
- Pre-Cast Concrete of various sizes (after 1950)
- Ductile iron or High-Density Polyethylene (Force main)
- Various Liners (Rehabilitated Pipe)

In addition to the extensive network of sewers, the District also owns and maintains various pump and lift stations, reservoirs, outfall points and controlling structures within the Cook County boundaries. Maintenance and inspections of these structures are typically performed by the Sewer Maintenance Units while capital improvement or large rehabilitation projects are administered by the Engineering Department.

Tables 2.1 and 2.2 illustrate the age of the District's interceptor system and a list of physical assets by service basin.

Table 2-1 - Interceptor System Age

Installation Date	Percent of Total Interceptors
1900-1920	6.9
1921-1940	24.0
1941-1960	23.3
1961-1980	36.7
1981-Present	9.1

Table 2-2 – List of Physical Assets by Service Basin

	North	Central	South
Sewer Pipe 4" to 96"	178.5 miles	115.3 miles	167 miles
Sewer Pipe greater than 96"	15.9 miles	64.6 miles	27.9 miles
Local Sewer / Interceptor Connections	580+	900+	440+
Intercepting Structures	821	355	146
Tide Gates	111	273	81
Tarp Control Structures	60	143	99
TARP Shafts (1)	72	135	52
Pumping Stations	7	6	9
Reservoirs	22	4	9

(1) Excludes access or construction shafts

2.2.2 STANDARD INSPECTIONS AND PROCEDURES

The Sewer Maintenance Unit within the M&O Department is responsible for routine inspections of the District's collection system assets and various facilities. Routine inspections of the District's structures are performed regularly to ensure the integrity of the infrastructure. The M&O Department performs inspections of the following structures and facilities:

- Pump and Lift Stations
- Reservoirs and Dam Structures
- TARP Control Structures
- Tide Gates
- Inverted Siphons
- Drop Manholes and Connecting Structures

Inspection methods and asset descriptions for the various structures examined by the Sewer Maintenance Unit are found in Section 7 of the Collection Asset Management Plan provided in Appendix 2A and described further in section 2.3 of this document.

The District utilizes a Maintenance Management System (MMS) for asset inventory, scheduling maintenance work performed by in-house staff and to track preventative maintenance schedules. Additionally, a GIS database is used as a geographical approach for identifying District assets and categorizing each asset in the District's service area. It is the intent of the District to transfer its maintenance management program to a GIS-enabled application to leverage the geographic tools with results from inspections and rehabilitation programs. This will allow field staff to enter notes, create work orders and document the condition assessment remotely while performing an inspection.

2.2.3 INTERCEPTOR CLEANING

Sewer cleaning is the most routine maintenance performed on the District's interceptor system. Debris obstructions or blockages are revealed either through visual manhole inspections or through closed-circuit televising inspections (CCTV). Visual evidence will typically show whether the problem is localized or systematic while CCTV inspection can provide for a better overall condition assessment of the sewer. Typical cleaning methods for sewers include:

- Thorough cleaning by jetting or vacuuming
- Root removal and chemical treatment for prevention of root intrusion
- Repair or replacement of a section of sewer pipe

Sewer cleaning contracts are administered by the Sewer Maintenance Unit through multi-year agreements with a service contractor. If debris build-up, root intrusion or blockages are observed during routine inspections, the condition of the sewer is thoroughly evaluated and cleaning may be necessary as a corrective action. More frequent sewer cleaning and maintenance of problematic areas and emergencies are made on an as-needed basis.

2.3 CAPITAL ASSET MANAGEMENT PLAN (CAMP)

2.3.1 Overview

In 2013, the District replaced the Interceptor Inspection and Rehabilitation Program (IIRP) with the Collection Asset Management Plan (CAMP) to better assess the District's aging sewer system and infrastructure. Under IIRP, the District rehabilitated 45 miles of intercepting sewer to date with another 30 miles worth of rehabilitation identified and either in the pre-construction or planning stages. However, the IIRP program was replaced to provide a broader management framework for prioritizing the rehabilitation of various District structures. Though the objectives remain largely unchanged from IIRP, the District's CAMP provides an updated framework using widely accepted NASSCO standards and other standardized inspection methods while utilizing a risk based approach for prioritizing and scheduling rehabilitation. Under the CAMP, the program assesses District structures such as intercepting sewers, TARP collection structures, sludge and centrate lines, tide gates and other various passive and active structures surrounding District infrastructure.

2.3.2 CAMP

The main objective of the CAMP program is to accurately identify infrastructure rehabilitation needs by performing condition assessments on various structures and accurately prioritize rehabilitation work. Once a condition assessment is made on a structure, the initial conditions are used as a baseline against other structures for prioritization and for future inspections. Therefore, the thoroughness and inspection techniques used for the condition assessments are imperative. The District utilizes the following inspection methods when assessing collection system assets and other various structures:

- CCTV
- Digital Scanning
- Laser Profiling
- Sonar
- Multi-Sensored Technologies
- Pigging
- Manned Entry and Visual Inspections

The District's Sewer Design Section administers multi-year sewer inspection contracts which employs a few of the technologies noted above to identify segments of interceptors that are in need of repair. The inspection results are inventoried to track of the sewer's physical condition, repairs, and changes over time.

While the means and methods of obtaining inspection data are important at gathering initial information about the condition of the system, the proper interpretation of the data is even more important so that the condition assessments are consistent and rehabilitation can be correctly prioritized. As such, the District utilizes many standardization inspection programs including the National Association of Sewer Service Companies' (NASSCO) Pipeline Assessment and Certification Program (PACP). The NAASCO PACP is a program which standardizes condition categorization, inspection forms, coding of observations and defects found in pipelines. Also, the Manhole Assessment and Certification Program (MACP), provides similar training for the inspection of manholes. Several District employees are trained in both the NAASCP and MACP programs.

Once a condition assessment is properly categorized for a collection system asset, the asset is placed in a risk matrix and evaluated against other structures. The Sewer Design staff prioritizes the assets and employs one of the various rehabilitation methods for corrective action:

- Point Repair
- Full Structural Replacement
- Cure-in-Place Pipe (CIPP)
- Sliplining
- Spray Applied Products
- Open Cut Removal and Replacement

CAMP also addresses inspections for active and passive structures within the District's collection system. As previously noted, inspections for these assets are typically performed by the Sewer Maintenance Unit within the M&O Department. These assets are examined more frequently than sewer segments due to their vulnerability and inexpensive inspection techniques. The inspection of such assets also require specialized training which many District staff members receive through a variety of sources including in-house training, seminars, conferences and webinars. Offering the appropriate training helps provide guidance for thorough, accurate and consistent visual inspections. Corrective and preventive maintenance schedules are recorded in the District's MMS and repairs are commonly performed by in-house trades. Items typically addressed as part the corrective and preventive maintenance include:

- Gate/Stem and Mechanical Lubrication
- Replacement and Repair of Hardware
- Testing and Resetting of Communication Alarms
- Cleaning of Screens and Removal of Blockages
- Interior and Exterior Facility Maintenance

3.0 END OF PIPE MANAGEMENT

3.1 WATER QUALITY MONITORING

3.1.1 Ambient Water Quality Monitoring - Quality Assurance Project Plan (AWQM-QAPP)

The goals and objectives of this plan are in part to:

- Monitor the waterways in the District service areas through the collection and analysis of water samples to determine water quality on an ongoing basis and establish a historical record.
- Provide data that will be usable by the IEPA for assessment of water quality.
- Provide data that will be usable to evaluate the impact of District operations and projects including:
  - Water Reclamation Plants (WRPs).
  - Pretreatment Program.
  - Flood and pollution control Tunnel and Reservoir Plan (TARP).
  - Sidestream Elevated Pool Aeration (SEPA) Stations.
- Provide a broad surveillance of significant discharges to the waterways.
- Evaluate the effects of intermittent stormwater releases.
- Evaluate pollutants released from bottom sediments in the waterways.
- Coordinate the waterway monitoring performed by the District with the waterway monitoring performed by the IEPA's Bureau of Water.

The monitoring program consists of 28 sites within 13 bodies of water that extend over 225 river miles. Routine monitoring occurs monthly on four separate weekly sampling events as follows:

- First Monday: Eleven sites in the Des Plaines watershed.
- Second Monday: Four sites on the North Branch and North Shore Channel.
- Third Monday: Six sites on the Chicago River, the South Branch, South Fork and the Chicago and Sanitary Ship Canal.
- Fourth week: Six sites in the Calumet Watershed.
- Weekly: the Lockport Powerhouse Station on the Sanitary and Ship Canal.

When a holiday falls on a Monday, sampling is performed on Tuesday.

See Appendix 3A for the AWQM-QAPP.

3.1.2 Dissolved Oxygen

To comply with requirements in its National Pollution Discharge Elimination System (NPDES) permits, the District continuously monitors the dissolved oxygen (DO) levels at 13 locations in the Chicago Area Waterway System (CAWS). The Continuous Dissolved Oxygen Monitoring (CDOM) Program also covers six locations in wadeable Chicago area waterways. The District's Environmental Monitoring and Research (EM&R) Division maintains DO monitoring equipment and provides staff for the biweekly retrieval of monitors. Monitors are retrieved by the District's

Pollution Control boats at eleven monitoring stations. Housings for waterway based meters are attached to bridge abutments and serviced from the bow of the boat. Monitors at eight land-based locations are retrieved by a team consisting of two Pollution Control Technicians (PCTs). Land based meter housings are usually attached to bridge abutments and serviced from the top of the bridge. See Appendix 3B for the CDOM QAPP.

Weekly grab waterway samples are also collected for Winkler method DO analysis at 16 locations in the CAWS, in accordance with NPDES permits for the O'Brien, Stickney, and Calumet WRPs. Sampling is performed at the designated locations by EM&R personnel. All samples are delivered to the Stickney Analytical Laboratory for analysis.

3.1.3 Water Quality Monitoring from Pump Stations and Backflow to Lake Michigan

As specified in the NPDES permit for the O'Brien, Stickney and Calumet Water Reclamation Plants, the District is required to sample all discharges from specified major pumping stations into local waterways. The District additionally samples backflows to Lake Michigan at the Chicago River Controlling Works (CRCW), the Wilmette Pump Station, and the 95th Street Pump Station. The pump stations and their respective receiving waterway are listed below:

- North Branch Pump Station, North Branch of the Chicago River
- Racine Avenue Pump Station, South Branch of the South Fork of the Chicago River
- 95th Street Pump Station, Calumet River

Automatic sampling equipment as well as grab samples are taken during discharges and sampled for general chemistry parameters. The sampling protocol for discharges at area pump stations is included in Appendix 3C. The sampling protocols for reversals to Lake Michigan are included in Appendix 3D.

3.2 COMBINED SEWER OVERFLOWS (CSOs)

3.2.1 Tunnel and Reservoir Plan (TARP)

There are currently 393 active CSOs owned by the City of Chicago (186), suburban municipalities (168), and the District (39) within the District's 375 square mile combined sewer service area. The District's approved long-term control plan to address CSOs within its combined sewer service area is known as the Tunnel and Reservoir Plan (TARP).

On January 6, 2014, the United States District Court for the Northern District of Illinois entered an Order approving a Consent Decree entered into between the District, the United States Environmental Protection Agency and the Illinois Environmental Protection Agency. The Consent Decree provides an enforceable schedule for implementing TARP, which will result in a significant decrease in the volume of water discharged to the waterways from CSOs in Cook County, along with dramatically reducing the potential for flooding. There is also a section of the Consent Decree designed to foster the use of green infrastructure controls. The District is committed to executing this work as quickly as possible.

A copy of the District's Consent Decree is available on the District's website at

http://pepportal.mwrd.local:50100/irj/portal/anonymous/Home

Additionally, the most recent TARP Status Report is included in Appendix 3E.

3.2.2 CSO Monitoring and Reporting

The NPDES permits for the Stickney, Calumet, O'Brien, Kirie, and Lemont WRPs require that the District monitor the duration and frequency of each discharge from select, representative CSOs authorized in the permits and all other CSOs connected to TARP, for which the District has the ability to monitor through telemetry. The District has the capability to monitor 220 CSOs (56 percent of all CSOs). Proximity switches on the monitored tide gates along with pump operation records are used verify CSO discharges. On average, there is one monitored outfall for every 1.8 square miles of the combined sewer service area and for every half mile of TARP tunnel length. The District's Representative Monitoring and Reporting plans are available on the District's website at

http://pepportal.mwrd.local:50100/irj/portal/anonymous/overview

Additionally, the list of the monitored and unmonitored CSOs is included in Appendix 3F.

Monitoring of CSOs can be done either locally or remotely. However, it is typically accomplished remotely using the Remote Terminal Unit (RTU) system that communicates, via radio or hard-wired telephone lines, to workstations at the Stickney, Calumet, and Kirie WRPs. When a CSO flow exits to the outfall, it pushes open a tide gate which triggers an alarm. The tide gate alarm signal is then transmitted to the workstation and recorded in the system with details such as location, open time, close time, and duration of alarm. Not every alarm is a confirmed CSO, however. Communication failure, sensor malfunction, obstruction, or power loss can cause a false tide gate alarm. The Treatment Plant Operator (TPO) typically notifies the Sewer Maintenance Unit to confirm any suspicious tide gate alarms unless maintenance personnel are known to be on-site testing communications, performing maintenance, or conducting repairs. Usually, these activities occur during dry weather. When a crew is on-site, the TPO is notified and records the date, time, and activity in a log book. False dry weather alarms would therefore be confirmed.

Precipitation is monitored by a number of rain gauges located throughout the District service area. Precipitation readings are transmitted via telephone lines to a workstation at the Waterway Control Center located in the Main Office Building on Erie Street in Chicago. Because the network of telemetered CSOs operated by the District is representative of the entire TARP watershed and because the District operates, maintains and monitors the telemetry, the IEPA has allowed the local municipalities, served by TARP, to use the District's monitoring and reporting data to fulfill the requirements of their respective NPDES permits.

CSO discharges and precipitation readings are initially reported a few days after their occurrence on the District's website. It may take up to two weeks verify and post final CSO discharge data.

Final reports indicating the frequency and duration of all telemetered CSOs, along with an estimate of storm duration, total rainfall, CSO discharge volume (gallons), BOD5 loading (pounds), and SS loading (pounds) are submitted to the IEPA on a quarterly basis. The District will continue to provide monitoring and reporting as specified in the NPDES permits.

When confirmed by the District, an email notification of the CSO discharge is sent to interested parties and directs them to pertinent web pages, including a map showing the segment of waterway impacted by the CSO. Please refer to Section 4.3 for additional details on this topic.

3.2.3 Watershed Monitoring for Compliance with Consent Decree

Pursuant to the Consent Decree, the District is responsible for submitting a post construction monitoring plan of the Calumet River Watershed basin for monitoring water quality once the Thornton Composite TARP reservoir is operational. A post construction monitoring plan is established to evaluate discharges from CSO outfalls in the Calumet TARP System. Such post construction monitoring plan shall include the following elements:

i. CSO Outfall monitoring location, frequency, duration and estimated volume;
ii. Identification of water quality standards parameters of concern;
iii. In stream water quality monitoring relating to applicable water quality standards;
iv. Determination of whether MWRD's CSOs are in compliance with the then-effective Calumet NPDES Permit, including applicable water quality standards incorporated therein; and
v. The minimum duration of such monitoring.

In preparation for the monitoring plan, the District has elected to perform pre monitoring of the Calumet Watershed Basin to represent baseline water quality conditions. Data from the existing Ambient Water Quality Monitoring (AWQM) and Continuous Dissolved Oxygen Monitoring (CDOM) programs will largely be sufficient for pre- and post-construction monitoring of the Thornton Composite Reservoir. The plan also proposes to include additional sample locations throughout the Calumet Watershed for comparing conditions during wet weather events. Pre-monitoring of Calumet Watershed Basin for wet weather events will include water quality sampling during five wet weather events per year. Storms that accumulate 0.5" or greater of precipitation in the south basin and trigger CSO events in the Calumet System will be examined. The goal is to capture rain events with and without CSOs so that water quality can be compared taking into account other wet weather sources of pollution.

A post construction monitoring plan will also be developed for the McCook Reservoir.

3.3 WATERWAY MAINTENANCE

3.3.1 Boat Operations and Floatable Debris Removal in Waterways

The Channel Maintenance Unit, under the direction of an Administrative Unit, is primarily responsible for navigable waterway debris removal operations. The Channel Maintenance Unit, on a year round basis, services 76 miles of navigable waterways that include:

- The Chicago downtown area: Chicago River (North and South Branches)
- North Shore Channel
- Chicago Ship and Sanitary Canal
- Cal-Sag Channel

The 76 miles of navigable waterways are maintained by one Channel Maintenance Unit from the Stickney WRP and consists of a Boat Pilot, a Crane Operator, and Maintenance Laborers.

Debris removal operations concentrate on areas of high visibility and where health and safety are a concern. The crews respond to service calls; provide assistance to other District facilities; participate in special events and projects in cooperation with the City of Chicago, Chicago Ward Offices and other municipalities. The average yearly quantity of debris removed from this operation is approximately 2,667 cubic yards.

Debris can enter the waterway from various sources:

- Wind transported litter
- Debris discarded by people
- Fly dumping
- Rain events which transport debris from watersheds

Of special concern in promoting debris accumulation are wind conditions and water currents, which can change the quantity and location of debris on an hourly basis. Debris may consist of paper cups, wrappings, tree branches, and wood logs.

During an average day, the Sewer Maintenance Unit receives notifications of stream blockages from area municipalities, public works departments, and residents. The Channel Maintenance Crew is dispatched to assess the extent of the blockage and determine the necessary resources for removing debris such as landscape materials, fallen trees, and a multitude of debris from local streams, channels and bridge culverts. Typically, area public works departments will partner with the Channel Maintenance Crew to remove the debris from the banks of the streams and channels. If the local municipality's public works department is unable to remove the debris, a debris truck will assist the Channel Maintenance Crew with the removal of debris. In a given week, the Channel Maintenance Crew, on average, spends approximately 150 hours removing five tons of material, and fifty hours of boat travel and equipment maintenance.

After a one-inch rainfall event, the Channel Maintenance Crew will conduct a reservoir run in which the crew visually inspects area reservoirs. A report pertaining to blockages, water levels, accumulated debris at the intake structures and in culverts, is prepared and reviewed by the Civil Engineer.

3.3.1.1 Floatables Collection for Compliance with Consent Decree

Pursuant to Appendix B of the District's Consent Decree, the District is required to perform special operations for removing CSO floatables succeeding a storm event. The District is required to deploy its debris and collection boats within 24 hours after the conclusion of a storm event that triggers a CSO to collect floatables and other debris. Depending on the location of the CSO, the Channel/Small Streams Maintenance personnel will dispatch its staff to the appropriate work zone for debris collection.

3.3.2 Channel Maintenance Vessels

The District owns and operates one 33-foot pusher boat (DB1), equipped with a 50-foot barge and crane. DB1 is operated by a crew of four workers (one pilot, one crane operator and two laborers). The boat operates year round and is used to remove large debris such as trees, logs, portions of seawalls, dock sections, and other large debris from the waterways. This vessel is not used for small-type debris cleanup, due to its lack of maneuverability. DB1 transverses the waterways from Wilmette (North Shore Channel) to the O'Brien Locks (Cal-Sag Channel). Traveling this distance can take approximately 12 hours. With 76 miles of waterway to service, the debris boat crew requires ample time to effectively respond to any change in assignment. The North Branch takes up the majority of time spent in debris removal. The Cal-Sag Channel is serviced on average once a year. In a given week the Debris Boat crew, on average, spends approximately 25 hours removing 25 tons of material, and 15 hours traveling and performing maintenance.

The District also owns and operates two pontoon boats (PB1 and PB2, 28-foot & 24-foot respectively) which are smaller vessels that enable District crews to remove various debris using nets attached to poles. Each pontoon boat is operated by a crew of three workers (one pilot and two laborers). These boats are placed in service seasonally, from mid-April to mid-October, to service the downtown area. Routine coverage includes the waterway from Goose Island (North Branch) to the Amtrak Bridge (South Branch) and the South Fork of the South Branch of the Chicago River. Pontoon boats are also dispatched to other areas for debris removal on an as-needed basis.

The debris typically removed during pontoon boat runs consists of smaller floatable debris including paper, plastic bottles, Styrofoam cups, dead fish, and numerous other small objects. If larger debris is encountered, it will be towed to a safe drop off point and the debris boat notified to pick up said debris as their schedule permits. In a given week each pontoon boat, on average, covers approximately nine miles of waterway removing 60 cubic feet of debris.

Daily logs are filled out by the pilots of each vessel. Additionally, a floatables log is generated on a daily basis containing the waterway serviced, type of debris collected, and photos. These daily reports are compiled monthly and used to compile a floatables summary report.

3.3.3 Fish Kill Procedure

Whenever a CSO occurs at one of the District's pumping stations, WRP operations personnel contact Channel Maintenance Unit personnel. Two days following a pumping event (or on the Monday following a weekend), the Channel Maintenance supervisor will direct the pontoon boats to initiate a fish kill reconnaissance. Inspections are conducted downstream of the pumping stations to determine if the CSO discharge has resulted in a fish kill. The results of the reconnaissance are reported to the Director of Maintenance & Operations. If a fish kill has been observed, the pontoon boat crews will perform a clean up after M&R has inspected the site and released it for clean-up (See Appendix G for M&R's Fish Kill Procedures). The fish kill is also reported orally to the IEPA as soon as possible, with a written follow-up report on the results of the District's subsequent investigation, within five days.

3.3.4 Sidestream Elevated Pool Aeration (SEPA) and Instream Aeration Stations

SEPA Stations are used to provide additional aeration to the District waterways. The SEPA station concept involves pumping a portion of water from a stream into an elevated pool. The water is then aerated by flowing over a series of cascades or waterfalls, returning to the stream. At five separate sidestream elevated pool aeration (SEPA) stations, water from the channel is lifted 12 to 15 feet and allowed to drop over a series of weirs to create a waterfall and add oxygen to the waterway.

Instream Aeration Stations are located at Devon Avenue and Webster Avenue to improve Dissolved Oxygen (DO) level in the North Shore Channel and the North Branch of the Chicago River, respectively. DO levels of the North Shore Channel used to control the Devon station are monitored at the O'Brien WRP by the DO probe installed at the North Branch Pumping Station. Similarly, DO levels of the North Branch of the Chicago River used to control the Webster station are monitored at the O'Brien WRP by the DO probe installed at the Ohio Street Bridgehouse over the Chicago River.

The maintenance of the stations is performed by the M&O Department. Inspections of the facilities are performed two to three times per week while the stations are in operation. Staff routinely inspects and monitors the lift pumps, DO probes, and checks for oil leaks and monitors the intake and exit screens for blockages. The stations are typically operated between April 1st and November 1st. During non-operations, the facilities are inspected once a week to ensure that the upkeep of the stations is satisfactory.

4.0 PUBLIC EDUCATION AND OUTREACH

4.1 COMBINED SEWER OVERFLOW (CSO) PUBLIC NOTIFICATION PLAN

The District has utilized various methods for educating the public about the occurrence and impacts of CSOs. Many of these were implemented in response to the requirement for a CSO Public Notification Plan as specified in the NPDES permits for the Stickney, Calumet, and O'Brien Water Reclamation Plants (WRPs).

It was important in developing the CSO Notification Plan to solicit input and feedback from the affected public. The District considered the affected public to be a variety of groups which included governmental organizations, civic groups, recreational groups and any public citizen with an interest in or responsibility for the condition of the Chicago Area Waterway System (CAWS). The District identified the following organizations to be among the affected public:

- USEPA
- IEPA
- The City of Chicago
- All municipalities located adjacent to the CAWS
- The Friends of the Chicago River
- NeighborSpace
- The Openlands Project
- The Sierra Club
- The Civic Federation
- The Prairie Rivers Network
- The Lake Michigan Federation (now the Alliance for the Great Lakes)
- Other environmentally based organizations

Other groups which were specifically identified include the recreational and commercial users of the CAWS such as canoe or kayak clubs, high school or collegiate rowing teams and owners of marinas. Interested parties of the Use Attainability Analysis that has been underway for the CAWS were also identified and included in the District's efforts to include the public in the development of the CSO Plan.

The identified affected public was invited to a public meeting held on January 20, 2004 where the District presented its CSO Public Notification Plan. The public was notified about this meeting via the District's webpage, through news media alerts to all local print and electronic media, and direct notification (email and mail) when possible. Comments and feedback were solicited at that time and were incorporated into the finalized CSO Notification Plan as appropriate. The CSO Notification Plan includes informing the public of CSO events via email notification, the webpage, posting signage at CSO locations, and informing the appropriate agencies when river reversal to Lake Michigan occurred. See the District's website at

http://pepportal.mwrd.local:50100/irj/portal/anonymous/overview

4.2 CSO EMAIL NOTIFICATION

The District has implemented an email notification system whereby anyone who wants can receive an email from the District of a CSO occurrence. An electronic "Address Book" has been developed which contains a list of email addresses of interested parties, i.e. previously identified stakeholders. Also, members of the public are able to sign up to receive e-mail notification of CSO discharges by accessing the District's website

http://pepportal.mwrd.local:50100/irj/portal/anonymous/overview

These parties will be sent an email alert in the event of a known CSO or diversion to Lake Michigan. The email directs the recipient to the pertinent web pages, including a map showing the segment of the waterway which has been impacted by the CSO discharge. The Address Book will be updated on an as-needed basis as other members of the affected public are identified.

4.3 SIGNAGE AT DISTRICT CSO LOCATIONS

The District has installed signage at CSO outfall locations owned by the District and in public areas adjacent to the river on District property. These signs are two-sided and weatherproof. There are two types of signs that have been installed. One type has been posted near all of the 39 District-owned CSO outfalls, which identifies the outfall by number and cautions the public that the outfall may discharge sewage contaminated rainwater. The other sign has been installed approximately every 660 feet (+/- 40') along the waterways. Installation locations also include streets which end at the waterways and obvious/easy access points such as bridge abutments and overpasses. These signs caution the public that the waterway is not suitable for activities such as wading, swimming, jet skiing, water skiing, tubing, or any activity which involves body contact with the water. A copy of these signs may be viewed on the District's website at

http://pepportal.mwrd.local:50100/irj/portal/anonymous/overview

Copies of the signs have been made available to the TARP municipalities, including the City of Chicago, for their use in producing their own signs as required.

4.4 NOTIFICATION OF POTABLE WATER SUPPLY AGENCIES

The District continues to notify suppliers of potable water of CSO occurrences that result in a reversal of the waterways into Lake Michigan at Wilmette Harbor, the Chicago River and Controlling Works, and the O'Brien Lock.

4.5 DIRECT MAILINGS

Upon acceptance of the CSO Public Notification Plan by the IEPA, the District informed various entities of this via a letter. The letter transmitted the approved CSO Notificaiton Plan to the TARP municipalities, District property lessees, and Water, Health and Public Safety Government Organizations. The letter also informed these entities of the availability of the District's webpage and the email notification process. It also encouraged the municipalities and government organizations to link to the District's website.

4.6 SANITARY SEWER OVERFLOW (SSOs)

Based on historical inspections/observations, the District is currently aware of one location within its collection system that has experienced SSOs (Village of Worth Manhole near the District's Palos Hills Pumping Station). District staff continuously monitors this location during wet weather, secures and cleans the area when SSOs occur, and notifies the IEPA and local municipalities (verbally and in writing) after the occurrence of a SSO event. The District believes that future SSO occurrences at this location will be eliminated after the completion of the TARP Composite Reservoir. If any other SSOs are observed within the District's collection system, they will be handled in a similar manner.

Additionally, see Section 2.1.1.1 for a description of the District's new Inflow and Infiltration Control Program. This new program should minimize the occurrence of SSOs and basement backups in the District's separate sewer service area.

4.7 TELEPHONE HOTLINE

The District has a telephone hotline number (1.800.332.DUMP) which the public can call when a CSO discharge during dry weather or any SSO is observed. District personnel are then able to investigate the CSO or SSO and determine and rectify the cause of the discharge. This hotline number is posted on the CSO signs that have been installed at the District's CSO outfall locations.

APPENDIX 2A

CAPITAL ASSET MANAGEMENT PLAN (CAMP)

1 Introduction

The Metropolitan Water Reclamation District of Greater Chicago (District) is located primarily within the boundaries of Cook County, Illinois. The District serves an area of 883.6 square miles, which includes the City of Chicago and 128 suburban communities. The District serves an equivalent population of 10.35 million people, a population of 5.25 million people, a commercial and industrial equivalent of 4.5 million people, and a combined sewer overflow equivalent of 0.6 million people. The District's 554 miles of intercepting sewers and force mains range in size from 8 inches to 27 feet in diameter, and are fed by approximately 10,000 local sewer system connections.

The District's first sewer system was built in 1906 and, since then, the District has expended billions of dollars on sewer construction. Although relatively durable, sewers will deteriorate over time and some of the District's sewers have been in service for more than a century. Failures of aging sewers have cost the District millions of dollars over the years as expensive emergency repairs are made to correct catastrophic failures. The District has gradually adopted a more economical preventive maintenance practice that seeks to rehabilitate aging sewers to prevent failures and simultaneously extend the expected service life of the sewer.

As the sewer systems continue to age, repair and rehabilitation costs will only increase. Since the District's collection system is composed of critical infrastructure crucial to protecting public health, it is imperative to continue on the path of preventive maintenance and avoid costly and potentially dangerous failures. Given that sewer systems are below grade structures, problems are not usually visible on the surface until it is much too late. In order to fully assess and rehabilitate the sewer system, a comprehensive inspection and rehabilitation program is required.

In 1991, the District adopted the Interceptor Inspection and Rehabilitation Program (IIRP) to address the inspection and rehabilitation needs of the aging infrastructure. The intent of this document is to provide an updated framework for a comprehensive inspection, condition assessment and rehabilitation plan for the collection system assets and various other structures discussed in this document. The document will also outline the general guidelines for selection of rehabilitation methods for intercepting sewers, TARP tunnels, TARP connecting sewers, sludge and centrate lines, sewer force mains, and various structures described below. For the purpose of this document, the terms sewers, sewer system, or collection facilities will be used to describe all of these assets.

2 Inventory of Assets

2.1 Background and Description of Assets

2.1.1 Interceptor Sewers

The District's intercepting sewer system consists of 554 miles of sewers ranging in size from 8 inches to 27 feet in diameter and originally constructed of various materials including, but not limited to, reinforced concrete, brick, and ductile iron pipe. Construction of the intercepting sewer system began in 1906 and continued throughout the following century. Approximately one third of these intercepting sewers have been in service for over 50 years. A complete list of the District's intercepting sewers can be found in Appendix A.

Over the past two decades, all of the District's intercepting sewers have been inspected under IIRP. These inspections have resulted in rehabilitation projects for numerous intercepting sewers and force mains. Under IIRP, approximately 45 miles of sewers have been rehabilitated to date with another 30 miles worth of rehabilitation identified and either in the pre-construction or planning stages.

2.1.2 TARP Tunnels

Phase I of the Tunnel and Reservoir Plan (TARP) included construction of 109 miles of concrete lined tunnel excavated in rock. Construction of the TARP tunnels began in the late 1970s and was completed in 2006. While it is not expected that there would be significant wear in the newer tunnels, the oldest of tunnels is approaching the age at which condition assessments are justified. Manned entry into the live tunnels has been very limited since TARP has gone online, and remote inspections have not been performed due to cost and degree of difficulty; however, the limited experiences suggest that the condition of the tunnel liners are relatively good. Nonetheless, it is recommended to take a proactive approach to stay ahead of the inevitable deterioration of the tunnel system and include the TARP tunnels in the asset management plan. A complete list of the District's TARP Tunnels can be found in Appendix B.

2.1.3 TARP Connecting Sewers

TARP connecting sewers are typically high level sewers that convey flow from TARP connecting structures or junction structures to the TARP drop shafts. These sewers are not part of the interceptor system but act as gravity sewers feeding the deep tunnel system. Previous inspection and rehabilitation plans have not included the TARP connecting sewers; however, as the early segments of TARP have now been in service in excess of thirty years, it is appropriate to begin including these sewers in the plan for inspection and preventive maintenance. Most of the TARP connecting sewers are short runs between the connecting structures and the drop shafts, but there are some sewers that are thousands of feet in length. Failures of these sewers could prevent an interceptor or outfall sewer from relieving to TARP, potentially causing flooding and combined sewer overflows. A complete list of the District's TARP connecting sewers can be found in Appendix C.

2.1.4 Sludge and Centrate Lines

Sludge and centrate lines are force mains that convey sludge or centrate byproducts from one of the District's water reclamation plants (WRP) to another District location. These lines are unique for two reasons: 1) they are pressurized force mains and so do not flow by gravity and 2) they convey higher strength waste with higher solids content compared to the sanitary and combined sewers. A complete list of the District's sludge and centrate lines can be found in Appendix D.

2.1.5 Sewer Force Mains

In addition to the aforementioned sludge and centrate lines, the District operates a number of sewer force mains that convey sanitary and combined sewage. While the District's network of force mains pales in comparison to the extensive network of gravity sewers, ensuring that the force mains are maintained in good condition is equally vital. A complete list of the District's sewer force mains can be found in Appendix E.

2.1.6 Various Structures

Various passive structures (manholes, drop structures, inverted siphons, etc.) and active control structures (contain gates, valves, pumps, etc.) are a part of the collection system. The inline, passive structures can be inspected concurrently with their associated sewer or tunnel and can be rehabilitated on an as needed basis or along with the associated sewer or tunnel, depending on the severity of the situation observed. Inspection procedures for tide gates structures, pump and lift stations and other structures that contain mechanical and electrical equipment are included in section 7 of the document. These structures require more specialized inspections and more frequent maintenance attention. As such, these assets are regularly inspected by the Maintenance & Operations Department (M&O).

2.2 Asset Management Tools

2.2.1 GIS Database

A systematic approach will be used to identify and categorize each asset in the District's collection system and establish an inventory. The District has recently developed a comprehensive GIS system to catalog and locate assets District wide, which can be used to cross-check the inventory. The TARP computer models developed by the University of Illinois can also be used to cross-check the inventory.

It is intended to eventually utilize the GIS system for execution of the asset management plan and to document and record results from the inspection and rehabilitation program. The risk based prioritization score assigned to each segment, discussed in Section 4, can be input in tabular form into GIS to allow for a graphical representation of the data. Such a graphical representation will assist in planning and timing of rehabilitation work and minimizing disruptions to residents by avoiding a concentrate in one area.

2.2.2 MMS Database

In 1996, installation of an M&O-wide computerized Maintenance Management System (MMS) was completed. Use of MMS has enabled the District's M&O Department to increase the focus on preventive maintenance, improve inventory control and availability, more effectively utilize trades personnel, capture direct job/project costs, and overall, automate and improve the efficiency of the maintenance program for District assets.

Currently, all of the District's collection system assets are catalogued and identified in the District's MMS system which is administered by M&O. The database is used to identify previously repaired segments of sewers as well as repair prone sewer segments. This historical data can aid in the categorization and prioritization of the rehabilitation work.

Utilizing MMS, identification of maintenance issues and proper processing of work requests is done in a timely and efficient manner. Maintenance personnel, who have established rounds and are constantly working with the collection system, generate work requests on a regular basis. Work Requests are reviewed by M&O personnel and converted to work orders. Planners review and plan the work orders, which are then scheduled. The work flow process facilitates task allocation and helps in work prioritization.

Preventative maintenance (PM) programs have been developed with significant input from inspectors, trades, and engineers. The PM's generally include cleaning, adjustments, replacements of wear items, and inspections. The comprehensive database is useful for tracking asset repair history and monitoring labor and material cost associated with each work order. Records of maintenance expenditures and frequency of repairs is used for prioritizing replacement and rehabilitation. Additionally, asset details such as specifications, drawings and O&M manuals items are documented in the software to facilitate parts replacement and expedite maintenance repairs.

3 Condition Assessment Program

3.1 Goals

The goal of the condition assessment program is to provide an accurate evaluation of the current condition of the District's collection facilities in order to adequately prioritize rehabilitation and repair work, while minimizing costs and service disruptions resulting from failures. Such failures are costly and disruptive and can also pose a real risk to public safety through exposure to sewage and the development of sink holes. Eliminating sudden and catastrophic failures through an effective asset management plan while also extending the service life of existing sewers is an economical way to protect the public interest and preserve the District's assets.

3.2 Inspections

3.2.1 Frequency of Inspection

In order to fully assess the condition of the sewer system, and to accurately prioritize rehabilitation work, it is necessary that a complete evaluation be done on the entire system. The initial evaluation will set the baseline conditions of the system, to be used in the initial condition assessment and for comparison with subsequent inspections.

Previous efforts have called for an aggressive initial inspection schedule but neglected the value of the existing information compiled from previous inspections. The District's sewers have proven to be relatively resilient with most defects deteriorating slowly. To the extent possible, recent video inspection data can be used for completing the new evaluation methods and classifications; thereby reducing the cost and effort of the initial evaluation. Since there is existing data documenting known problem sewers, those sewers previously marked as priorities, as well as those generally known to be in poor condition, will be inspected under an aggressive three year inspection process. Unless information is available to the contrary, those sewers that have recently been rehabilitated under the old IIRP are assumed to be in good condition and will not be inspected again as part of the initial evaluation. The remaining sewers requiring inspection will be prioritized based upon the age and construction type of each sewer.

Upon completion of the initial condition assessment and prioritization of required rehabilitation, the sewer system will be placed on a regular inspection cycle. Sewers that are marked as priorities due to potential failures will be inspected on a three year cycle until such time that the defects are corrected or the entire sewer is lined. Sewers with minor defects or defects that are not expected to compromise the integrity or operation of the sewer in the foreseeable future will be inspected on a 5 to 10 year cycle.

Routine inspections performed on the various active and passive assets are handled in much of the same manner as those for the collection system. Upon completion of the initial inspection performed on these various assets, a condition assessment and prioritization of required maintenance is established and then placed on a regular inspection schedule. The schedule for inspection is dictated by the asset vulnerability. Preventative and corrective maintenance for repair or replacement of parts is addressed by District staff.

3.2.2 Inspection Methods

The most commonly used method for sewer inspections around the world is closed-circuit television (CCTV). CCTV is a relatively inexpensive inspection method with a high production rate and is satisfactory for most of the inspections that will be required during the initial assessment and follow-up inspections. For priority sewers, or those found to be in very poor condition via CCTV inspection, advanced inspection technologies may be appropriate. These technologies include digital scanning, laser profiling, sonar, electro-scanning, and multi-sensor technologies. Each advanced technology has advantages over CCTV for certain types of inspections and can be applied based upon the needs and concerns of each individual sewer. Due to access difficulties, the deep tunnels may require unique methods of inspection which will be discussed below.

3.2.2.1 CCTV

CCTV is the most common inspection method due to both its low cost and its versatility. CCTV allows for the inspection of virtually any size and material pipe greater than 6" in diameter. The technology allows the user to locate defects and create a video record of the inspection for permanent files and comparative use in subsequent inspections. CCTV can successfully locate sags and deflections, joint separations, root intrusion, sediment and debris build-up, cracks and leaks, and service connections. The drawback of CCTV is that it cannot observe the condition of the pipe below the waterline. While there are instances of corrosion and other problems below the water line, the majority of pipe failures occur in the upper portions of the pipe. A sewer found to be in very poor condition through CCTV inspection can be subsequently inspected with a supplementary technology if greater detail below the water line is required. Recent CCTV work performed for the District under various contracts has cost approximately $1.50 per linear foot.

3.2.2.2 Digital Scanning

Digital scanning is a relatively new inspection method. The inspection is carried out the same way as CCTV, with the instrument being transported through the sewers on self-propelled crawlers. Rather than using a single lens video recorder, as is used in CCTV, digital scanning instruments use high resolution digital cameras with wide angle lenses. The instrument may contain one or two cameras, as needed, with one typically in the front and one in the back of the instrument. The wide angle lenses take digital photographs on preset intervals that can be later viewed individually or digitally stitched together to provide a continuous view of a section of pipe. Viewing the photographs individually provides results comparable to CCTV while viewing the stitched photographs, also called the "unfolded" view, provides a continuous view of the length of the pipe. Like CCTV, though, digital scanning is limited to the pipe above the waterline.

In addition to the option for either standard or unfolded views, digital scanning is advantageous because it produces higher resolution images and can be performed with much greater rates of production than CCTV. The high production rate is due to the fact that there is no identification of defects on-site during the inspection. Defects are identified and coded later in the office using the associated software and a complete record of the entire pipe is stored electronically for viewing in the future. CCTV records are limited to the operator's panning and tilting to inspect perceived defects and do not necessarily cover the entire pipe.

While digital scanning can be used with any pipe material, the quality of the digital results declines with pipe size. This technology is improving as manufacturer's improve software and lighting technologies; however, the District should consider this technology for sewers no greater than 40 inches at this time. Additionally, since this technology is only an incremental improvement over traditional CCTV in terms of quality of results, it would not be an appropriate supplemental technology but can be used in place of CCTV.

3.2.2.3 Laser Profiling

Laser profiling is an inspection technology that can detect changes in shape of the sewer pipe. The laser scanner projects laser images on the pipe walls and those images are detected by a camera to create a profile of the pipe. Like CCTV and digital scanning, the laser profiling technology cannot scan portions of the pipe below the waterline.

There are two types of laser scanning: 2-D and 3-D (LADAR) technologies. The 2-D laser scans are the more common and basic types of laser scans, but this technology has drawbacks. Because the scanner typically projects a circular image on the pipe wall, the calibration of the laser and its position along the longitudinal axis of the sewer can affect the quality of the results. Poor calibration can yield inaccurate results and deviations from the axis can suggest pipe deformations that do not really exist. The 3-D or LADAR technology uses point lasers, rather than a circular image, and has a built in receiver and two way transmitter that can develop accurate profiles and cross sections regardless of the alignment on the longitudinal axis. It is generally recommended that the 2-D laser technology be limited to 36" diameter pipes.

This type of technology can be employed as a supplemental technology, or performed in conjunction with other technologies (see multi-sensor technologies section) to obtain profiles of the sewers believed to be subject to deformation based upon CCTV results. Since CCTV does not yield profiles or cross sections, any perceived deformation can be verified and quantified using laser based technology. This technology may also be appropriate for the verification and final inspection of newly lined sewer.

3.2.2.4 Sonar

Sonar, also called ultrasonic technology, is different from the previously described CCTV, digital scanning, and laser profiling inspection methods in that it is used to inspect those portions of pipe below the water line. Sonar is effective in sewers greater than 12" in diameter and provides information on pipe geometry, pipe wall deflections, pits, voids, and cracks.

Like CCTV, digital scanning, and laser profiling, this technology can be used on any material pipe but, unlike the others, this technology can also be used in force mains. The ability to deploy the instrumentation without having to depressurize the force mains and take them out of service makes sonar technology a valuable tool for such inspections.

Fine tuning of the sonar technology for each individual sewer is required as there are various frequencies that can be used with sonar technologies. The varying frequencies can yield different information and should be selected depending on the type of information that is sought, pipe materials, pipe size, and levels of suspended solids in the pipe. For example, a higher frequency sensor, such as 2 MHz, will provide greater accuracy when depicting pipe geometry and/or sediment build up. The same high frequency sensor would provide less accurate information about pipe wall integrity since the high frequency signals do not penetrate the pipe walls as effectively as a lower frequency sensor, such as 650 KHz. One option that allows for a more complete sonar scan is to utilize instrumentation equipped with multiple sonar sensors each operating at different frequencies.

This type of technology is best suited for use in force mains, sewers that run full or nearly full and for which bypassing would be extremely difficult, and sewers expected to have high sedimentation levels. This technology may also be appropriate for use in conjunction with other technologies (see multi-sensor technologies section) to obtain information below the water line while other technologies examine the areas above the water line.

3.2.2.5 Multi-Sensor Technologies

In order to capitalize and the strengths of the various technologies, and to avoid their shortcomings, multi-sensor platforms have been established and combine technologies like CCTV, laser, and sonar scanning. Depending on the individual make-up of the sewer, as well as the desired result, these robotic platforms can be fitted with multiple technologies in order to provide the best possible results in a single inspection.

While the individual technologies commercially used in these multi-sensor units are not brand new, the combination of them into one unit has really only taken off in the past decade. These units, though innovative, still have the same challenges as other technologies and the District's experience with one application has had only limited success. The use of these systems is generally cost prohibitive as the large amount of data generated requires expensive post-processing efforts before the data is useful.

3.2.2.6 Pigging

For cases in which force mains cannot be diverted or shut down, the use of pigging can be an effective tool for force main inspections. Though "pigging" is a generic term, there are various types of pipeline inspection gauges (pigs), which can be run through a pipe to provide useful condition data. The types of pigs include simple cleaning pigs that scour the pipes, caliper pigs that detect deformation, ultrasonic pigs to detect leakage, and magnetic flux leakage pigs that detect cracks, pitting, and weld defects.

Despite the advance in pigging technologies, the use of pigging has physical limitations. Installing the pigs can be tricky if the pipelines contain only 90 degree cleanout ports. Wye connections or dedicated pigging ports are more appropriate. Also, force mains containing valves that do not maintain the clear opening of the full pipe diameter will interrupt the passage of the pigs and may make pigging impossible. A review of the condition of the force mains to be inspected will be required to determine if pigging is feasible and/or desired or if other means should be investigated.

3.2.2.7 *Manned Entry*

In the event that the previously described technologies do not provide sufficient information for an accurate assessment of the sewer's condition or in the event of inspecting the various active and passive structures associated with the collection system, it may be necessary to perform manned entry inspections. Manned entry inspections generally consist of a visual examination of the condition of a sewer or structure, looking for signs of deterioration or maintenance needs.

For manned entry sewer inspections, the use of a sounding hammer or other small tools is typical utilized but it may be necessary to employ more detailed testing. These tests can be either non-destructive, such as ground penetrating radar (GPR) or can be of the destructive nature, in which a sample of the sewer is taken by coring and then evaluated later in a laboratory.

While performing inspections on other structures, manned entry is used to offer a visual examination of the maintenance needs. For confined or unreachable inspection points, the use of manhole cameras is utilized to retrieve visual details about this inspection point. M&O staff members are trained on the techniques and procedure required for a thorough condition assessment for all structures.

3.3 Condition Assessment

While the means and methods of obtaining inspection data are the usual focus of sewer inspection discussions, the proper gathering, categorizing, and interpreting of data obtained are extremely important aspects of the sewer inspection process. Over the years many different means for categorizing and interpreting data have been developed, most of which are developed by and for specific utilities. Such fragmentation throughout the industry creates inefficiencies in the development of new technology as equipment manufacturers are developing repair methods that address specific needs of individual agencies rather than focusing their efforts on improving a single system. There are also inefficiencies as contractors who implement rehabilitation work identified by inspections are forced to operate with different information from different utilities operating in close proximity to one another.

Another problem with this fragmentation is that agency turnover ensures that each new generation of engineers and technicians will interpret data differently and categorize and prioritize it according to their interpretation. Understanding that these sewer systems are designed for 50 to 100 year life spans, the idea that the reviewers and interpretations of data from the inspections will change countless times over the facilities life should be a cause for concern. Standardized categorization techniques and interpretation of inspection data will provide agencies with the ability to confidently evaluate historical information for use in evaluating trends and the current integrity of the sewer systems.

One such standardization that has been adopted across Europe and is being widely implemented across the United States is the National Association of Sewer Service Companies' (NASSCO) Pipeline Assessment and Certification Program (PACP). The NAASCO PACP is a program which standardizes condition categorization, inspection forms, and coding of observations and defects found in pipelines. There is also the MACP, or Manhole Assessment and Certification Program, which provides similar training for the inspection of manholes.

NASSCO offers training courses for the PACP and MACP in order to ensure that the reviewers of the inspection data know what to look for and catalog and categorize defects properly. It is recommended that two or three staff members, as well as the supervisor, obtain the required training, and maintain it current, to perform the condition assessments in order to ensure redundancy and to allow for rotation of staff into various responsibilities within the group. This type of redundancy and rotation prevents staff from becoming burned out due to continued observation of video tape and other inspection results.

The sewer inspection contractor will utilize NASSCO type inspection forms to document the defects and conditions identified during the inspection. The District's NASSCO trained staff will review the results of the various inspection methods and classify and categorize the observed defects per NASSCO guidelines in order to ensure a uniform and consistent review of inspection data. The results of this classification will be considered along with any prioritization information to develop a prioritization hierarchy for sewer rehabilitation. NASSCO addresses issues like prioritization by allowing for the introduction of modifiers when determining the overall needs of the pipeline/manholes. The District will use a means of prioritization as the "modifier" and this prioritization will be introduced in the following chapter.

4 Categorization and Prioritization

4.1 Categorization

For the purposes of categorizing both the severity of a defect and the condition of the pipe, NASSCO's PACP defect codes provide a good outline of the different conditions. The PACP defect coding includes five levels of defects: Immediate Action, Poor, Fair, Good, and Excellent. In addition to categorizing the severity of defects found, these codes also offer a glimpse into the expected remaining life of the sewers without some type of repairs or rehabilitation. The following are descriptions of the different defect codes and what can be expected for each category.

> **Immediate Action** - Defects/pipelines identified for immediate action are generally scored a five (5) on the point scale. As the title suggests, these defects/pipelines require immediate attention to either correct a failure that has already occurred or an expected imminent failure. Often times these issues are discovered when it is too late and a visible failure has occurred.
>
> **Poor** – Defects/pipelines identified as poor are those which are anticipated to deteriorate to Immediate Action status in the foreseeable future and are likely to fail within 5-10 years. These defects/pipelines require prompt attention to prevent further deterioration and eventual failure. A score of four (4) is generally given to these defects/pipelines.
>
> **Fair** – Defects/pipelines identified as fair are generally in moderate condition. Failure to rehabilitate the sewer will allow the progression of defects and the overall condition to deteriorate to Poor and eventually Immediate Action status, with pipe failure expected to occur sometime within 10 to 20 years. These defects/pipelines should be addressed when possible, but are not likely to immediately fail as a result of a lack of rehabilitation. A score of three (3) is generally given to these defects/pipelines.
>
> **Good** – Defects/pipelines identified as good are generally in a good enough condition that defects and the overall condition are not anticipated to progress in the foreseeable future. Defects are present, but they have not begun to deteriorate and are not anticipated to pose a failure risk to the pipeline within the next 20 years. No immediate action is required on these sewers. A score of two (2) is generally given to these defects/pipelines.
>
> **Excellent** – Defects/pipelines identified as excellent are generally in like-new condition. The pipeline may contain minor defects with failure of the pipe not anticipated within the foreseeable future. These sewers require no action. A score of one (1) is generally given to these defects/pipelines.

The categories and scores assigned to defects must be taken into context of the entire pipe segment. Where some pipelines may have a few immediate action defects, they may otherwise be in good condition. This is a stark contrast to a pipeline that is generally in poor condition throughout. The urgency and rehabilitation efforts for the two pipelines may vary significantly as a result of not only the severity of the defects, but the extensiveness as well. NASSCO provides various ways to assign pipe ratings to overall segments to ensure that an accurate accounting of the entire segment is considered during investigation.

4.2 Prioritization

Categorizing pipelines by the observed condition is an important step in the development of a rehabilitation program, but it is only one of the factors that must be considered. In order to establish a reliable, economically feasible, and practical rehabilitation plan, one must utilize a risk based approach to prioritize the pipelines as well. Each of the sewer segments will be evaluated and assigned a consequence of failure score based upon the consequences associated with a potential failure. The determined score will be based on a number of factors including, but not necessarily limited to, location of the sewer (proximity to major roads, waterways, passing beneath structures, etc.), visibility and impact of an eventual failure, public safety, accessibility for repairs and importance to the function of the overall system.

In considering the consequence of failure score associated with an individual sewer segment's failure, the user is allowed to assign either greater or lesser importance to the condition of a sewer based on the assigned score. Giving consideration to the sewer segments' consequence of failure scores will allow the District to prioritize rehabilitation work in a more practical manner. For instance, a sewer in very poor condition that runs beneath a stretch of undeveloped property may be given a lower overall priority than a sewer in slightly better condition that happens to run adjacent to residential properties. While the first sewer would score higher during the assessment phase, there would be less of an impact due to a failure of that sewer than the one adjacent to the residential properties. In a perfect world any sewer in poor condition would immediately be slated for rehabilitation; however, the reality of time and budget constraints often necessitate tough decision making. Considering the whole picture of condition versus consequences aids in that decision making and promotes economically and socially responsible decisions.

In a typical risk assessment, a matrix is developed that includes both the probability of failure of an asset and the consequence of such a failure. In this case, the probability of failure is established during the condition assessment phase, also taking into account factors such as age and construction type, and is assigned a numerical score from one to five. The consequence of failure is determined by considering additional factors such as location, importance to the function of the overall system, public safety, accessibility for repairs, etc..., and is also assigned a numerical score from one to five. Consideration of these two factors generates an overall risk score utilizing the following formula:

Risk = Probability of Failure x Consequence of Failure

Use of such a risk based system is consistent with other recent evaluations performed by the District for the TARP system and pump stations and would provide consistency in our approach towards inspection and evaluation of sewer system conditions.

5 Rehabilitation Methods

5.1 Point Repair Methods

For larger sewers, typically those greater than 60" in diameter, it may be necessary or desirable to perform point repairs in response to the identification of a problem. For sewers with a high consequence of failure, or in cases where sewer integrity problems have caused sink holes or settlement issues, there may not be sufficient time to allow for the development of a full rehabilitation project for the relevant section of sewer. In these instances, a temporary point repair is required in order to ensure that the sewer will maintain its integrity until a full rehabilitation can be performed on the affected section. The point repair method also allows for the prompt repair of any affected streets, sidewalks, landscaping, or other structure that may have been damaged or undermined by the sewer failure.

While point repairs can take many forms, a typical point repair on a large sewer would consist of an application of chemical grout to the hole or crack, which would then be secured by a steel plate. See Table 1 for a more detailed list of repair methods for specific situations.

5.2 Full Structural Replacement

5.2.1 Cured in Place Pipe (CIPP)

Cured in place pipe, or CIPP, is a relatively non-invasive trenchless technology for rehabilitation of sewer and water pipes. The technology consists of inserting a resin impregnated felt tube, or bag, into the damaged pipe creating a pipe-within-a-pipe. The felt bag is typically installed in an upstream manhole or insertion pit and inverted, or pulled, downstream to another manhole or access point. The bag is inverted through the host pipe using either water or air pressure and is then cured by one of various methods including, steam, hot water, ambient air, or even UV light.

Aside from the non-invasive qualities of CIPP, other benefits of this method include a seamless and jointless installation, a range of application from 4" to approximately 72" in diameter, and full structural replacement of the host pipe, The structural properties of a CIPP liner can be designed for the desired application but are typically such that the liner itself can carry the full structural load of the original pipe, without assistance from the host pipe. Care must be taken during installation to prevent wrinkling of the bag and it is often required that alternate lining methods be used on bends and turns, as the bag cannot turn corners without becoming wrinkled and misshapen. Full flow bypass is required during CIPP lining, which adds to the complexity of the installation.

5.2.2 Sliplining

Sliplining is another trenchless rehabilitation technology that is minimally invasive. The process consists of inserting a new smaller pipe into the existing host pipe. The annular space between the new and existing pipe is then grouted and the ends are sealed. This method can theoretically be used to rehabilitate any size pipe, provided sufficient access is available for the pipe's insertion. While this method is relatively cost effective and requires no specialized equipment or labor, a major drawback of this method is the significant reduction in cross-sectional area of the sewer upon completion. This technology is better suited to larger sewers with sufficient capacity to absorb the loss of cross-sectional area.

Sliplining can be performed either continuously or segmentally. Continuous sliplining requires the use of flexible pipes, such as HDPE or PVC, that can be fused together at the surface and pulled into the host pipe in one continuous length. For larger sections, segments of pipe can be installed within the host pipe. These segments can be made of various materials, including GRP panels from companies like Channeline or centrifugally cast fiberglass reinforced polymer mortar (CCFRPM) panels from Hobas Pipe.

5.2.3 Spray Applied Products

Another approach to trenchless rehabilitation is the use of spray applied materials. Various types of materials are available for this method including shotcrete, epoxy, and urethane resins. These materials can be hand applied or centrifugally cast by mechanical means. The optimal materials and application techniques depend on various factors such as the size of the sewer or structure, sewer conditions, and available access to the sewer. Spray applied materials are attractive in that they generally require less staging area and, as many of the technologies use truck based installation, the staging areas are easily broken down at the end of a shift, minimizing the impacts to the public. Spray applied products are also particularly useful in rectangular or irregularly shaped sewer structures and in non-round sewer installations, as their use is not dependent upon any particular host pipe shape.

5.2.4 Open Cut Removal and Replacement

If a particular section of sewer is found to be in such condition that lining or other rehabilitation methods cannot be employed, the pipe may be excavated and replaced within the existing trench. It may be possible to construct new portions of pipe adjacent to the areas where the most damage exists, acting as a bypass around the original damaged section. Total replacement of the sewers will only be considered as the method of last resort when no other methods can be practically employed due to the high cost and disruptions created by the excavation.

6 Implementation of Rehabilitation Projects

6.1 Emergency Work / Spot Repairs

During the condition assessment phase, there may be times when a sewer defect is found that is so substantial and carries a high enough consequence of failure score that an emergency spot repair may be warranted. These instances may be discovered during CCTV or other types of inspections, or may be identified by sink holes or other settlements above and adjacent to a particular sewer. The District's normal contracting procedure for sewer rehabilitation projects is not conducive to performing emergency repair work, as the lengthy process can span many months; therefore, it is imperative to maintain an avenue for the prompt performance of emergency spot repairs.

Emergency contracts or Job Order Contract (JOC) task orders are the most efficient means for addressing emergency repairs. Developing and awarding an emergency contract or JOC task order can be done relatively quickly. The District could simultaneously negotiate the emergency contract or JOC task order with the contractor and obtain ROW in order to save time. Most JOC work is pre-priced, so the costs for such work would be relatively stable; however, the uniqueness of each emergency repair or failure could potentially add significant dollars to pre-priced items. Emergency contracts are normally expensive and are not subject to receiving bids. A major disadvantage of utilizing JOC is that the District actually has to maintain a JOC contract. The District has maintained a JOC contract on and off over the past decade, but adopting this option as the plan for emergency work would require the District to maintain JOC contracts for the long-term.

6.2 Large Scale Rehabilitation Projects

The intent of the condition assessment program is to identify problem areas within the sewer and TARP system and have them addressed as soon as possible, with emergency repairs being made as necessary along the way. As the sewers are inspected and graded based upon both their condition and failure consequences, the risk score that is developed will provide a prioritization of rehabilitation projects. It is the District's intent to line entire sewer segments, where possible, rather than perform piecemeal repair work. While it may make sense logistically to focus on one particular area of the District at a time, utilizing the prioritization should also prevent the District from performing too much work in one area and burdening the local residents with extensive road closures and extended construction activities.

The projects will be developed in the normal long form contract format. The projects will be developed with the intent of rehabilitating entire sewer segments; however, consideration will be given to ensure that a single project's costs do not become so extensive as to create budgetary problems. In these cases, individual segments may be broken into separate projects to allow for multiple projects to be ongoing at once so that the worst sewer segments are always being worked on.

7 Asset Field Inspections

7.1 Overview

The District's Maintenance and Operations Department performs regular field inspections on District assets including various passive structures (manholes, drop structures, inverted siphons, etc.) and active control structures (sluice gates, valves, pumps, reservoirs, etc.) to ensure the integrity of the collection system. Preventative and corrective maintenance is performed on assets as required. If the structure requires extensive rehabilitation, the inspection information is evaluated and repairs are typically performed under capital improvement projects.

Condition assessments and inspection schedules are assigned to each asset to better prioritize maintenance and rehabilitation needs. A comprehensive risk assessment was developed to gauge an understanding of the frequency at which to examine each structure. The condition assessment is used as a baseline for future inspections and also for comparison purposes while prioritizing rehabilitation and maintenance of other structures.

District staff members who regularly perform field inspections receive training through a variety of sources which includes in-house training, seminars, conferences and webinars. Offering the appropriate training helps provide guidance for thorough, accurate and consistent inspections. Additionally, since many inspections require a visual examination within confined spaces, staff is frequently trained in safety-related topics such as confined space entry and CPR.

Currently, the District requests and processes all repair work in the maintenance management system (MMS) as described in Section 2.2.2. After completing an inspection and if any repair or maintenance needs are required, inspectors will identify the components of the asset that needs repair and creates a work request in the MMS system for the maintenance to be performed.

The District has recently put into production an enhanced GIS system to catalog District infrastructure. The goal is to leverage the tools available with GIS and enhance the maintenance management system to help improve planning and tracking of maintenance activities in day-to-day operations. District staff is actively involved in providing updates to the GIS management teams as well as performing quality control and assurance checks of data submitted.

7.2 Tide Gates

Tide gates are used to prevent surface water from flowing into the collection system at an outfall. The flow that exits the tide gate is typically combined sewer overflow (CSO). Most of the District's tide gates are made of wood, but there are a few metal gates in the system. The gates open when the hydraulic head differential is greater on the interceptor side of the gate than the outfall side.

Tide gates associated with the collection system are inspected based on a condition assessment made for the asset. Inspections are then scheduled and prioritize accordingly. The inspection includes the gates associated with TARP control structures as well as gates located on outfall sewers owned and maintained by local municipalities. The condition of structural members and timbers, depending on the gate construction, is visually inspected. Gates are exercised and lubricated to ensure proper operation.

Many of the tide gates have proximity switches to send a signal to alert operators when the gates are opened. Inspectors test the alarms to ensure that they are working properly. Since information from these alarms is used to quantitatively report CSOs and trigger mobilization of boats to remove floatables from the waterways, it is important to that the alarms are working as designed. Repairs are made by trades if it is found that the alarms are not working properly.

Inspectors also examine the gate's hardware to look for signs or corrosion or defects. Corroded or damaged hinges will prevent the gate from opening and closing properly. The gate's alignment is also examined to make sure it is seated correctly. Misaligned gates or debris obstructions can prevent the gate from relieving a CSO. Since most gates are constructed from timber, it is also important to check for the gates for leaks or signs of excessive deterioration.

Appendix F lists all of the tide gates and their attributes. Inspection results are collected and the asset is evaluated for repair needs. Corrective actions are recorded in the District's maintenance management system.

7.3 Drop Manholes and Connecting Structures

Typical local sewer systems are at higher elevation than the District interceptor requiring a drop manhole to connect to the District interceptor. There are two types of drop connections: a drop manhole or a standard manhole with an external drop connection. A typical drop manhole has two discharge points, one that is at the same invert as the District interceptor and a second overflow at the higher elevation of the local system. The higher discharge serves as a relief if the drop pipe becomes plugged or restricted.

Identifying the specific components of the manhole and connecting structures through a comprehensive condition assessment is critical at examining the overall condition of the structure. Ensuring that manhole covers are properly aligned and sealed is important for preventing stormwater and other debris from entering the collection system. The supporting mechanism, the frame, must also be thoroughly inspected to ensure that the cover is properly supported and is not interfering with street traffic.

The chimney and cone section of the manhole are designed as the transitional portion between the manhole frame and the sewer barrel. Inspection of this portion of the manhole is especially important to look for signs of corrosion, infiltration and root intrusion. Concrete spalling and deterioration are common symptoms that a manhole and sewer are being exposed to high concentrations of hydrogen sulfide gases. Infiltration and root intrusion in the chimney or cone are introductory signs of deterioration. Manholes are often lined or coated if corrosion, infiltration or root intrusion are excessive.

Manhole rungs or steps are part of the chimney and cone section allowing structure access. Rungs and steps are also susceptible to hydrogen sulfide corrosion and require a thorough inspection to ensure that the rungs are safe to use. If corroded and deemed unsafe to use, manhole steps are removed and new ones are epoxied into the manhole as a replacement.

Observing blockages in the drop pipe is also critical for a comprehensive drop manhole inspection. Obstructions in the drop pipe can cause hydraulic problems and inhibit flow conveyance. Obstructions also tend to cause higher odors, exposure to hydrogen sulfide and increase the chances of corrosion and erosion from flow out the relief pipe. If an inspector observes a blockage, the conditions are noted and the obstruction is removed by either in-house crews or with assistance from a jetter truck.

Similar to drop manholes, connecting structures are used as a connection point between local sewers and the District's interceptors. Many of the District's connecting structures are regulated to manage local flow into the intercepting system. Inspection of connecting structures is important to ensure that flow is being conveyed into the District's interceptor as designed.

A visual inspection of the connecting structure is performed to make observations of flow obstructions, concrete deterioration and to ensure that regulating structures are working properly. After a storm event, rags, logs and other debris often collect and impede flow from the local sewers to the District's intercepting system. If an inspector observes a blockage, the conditions are noted and the obstruction is removed by either in-house crews or with assistance from a jetter truck.

Some connecting structures are equipped with regulating gates to control flow into the District's intercepting system while others are equipped with weirs or orifices. Additional flow that cannot be conveyed into the District's interceptor is diverting to the TARP system for collection. If the structure contains a regulating gate, inspectors check the gates to make sure they are appropriately positioned and that dry weather flow is properly being conveyed into the system.

Appendix G lists all of the drop manholes and connecting structures and their attributes. Inspection results are collected and the asset is evaluated for repair needs. Corrective actions are recorded in the District's maintenance management system.

7.4 Inverted Siphons

An inverted siphon is applied to pipes that must dip below an obstruction to form a "U" shaped flow path. Unlike sewers, siphons flow under pressure and must maintain a velocity of 3 ft/s to keep material suspended. To maintain adequate velocity, the inverted siphon uses a smaller diameter pipe than the main interceptor. Typical inverted siphons at the District consist of at least two barrels, one for dry weather flow and the second for wet weather flow. The specific design and number of pipes depends on the conditions at each location. There are locations that have three or more barrels and in some cases a "V" pipe is used instead of the typical "U" pipe.

Since inverted siphons are designs to flow under pressure to convey flow under low areas, making sure that the siphon is operating properly is critical to maximize flow conveyance in the siphon. Assessing the conditions of upstream and downstream chambers will typically provide the inspector a good idea as to the state of the siphon. Blockages that are observed in the chambers suggest that the siphon flow conveyance within the siphon is hindered. If a blockage is suspected, the use of jetting is employed to remove debris within the siphon. If there is a TARP drop shaft associated with the siphon, inspectors will check the shaft for dry weather flow as this will offer an indication that there may be a blockage within the siphon.

Flow impediment does not necessarily preclude that a blockage is present within the structure or siphon; it may also be a result of a collapsed line. In such instances, the use of sonar can be used to identify potential defects in the pipe. This technology, as described in section 3.2.2.4, is utilized for inspection of fully or partially submerged sewer lines. Inspecting the siphon using traditional CCTV can also be performed by isolating the flow to the upstream and downstream chambers. The siphon is then dewatered and televising can be used to identify defects or signs of a collapse.

Appendix H lists all of the District's inverted siphons and their attributes. Inspection results are collected and the asset is evaluated for repair needs. Corrective actions are recorded in the District's maintenance management system.

7.5 TARP and Control Structures

The District maintains below grade structures that control flow from the sewer system into the 109 miles of tunnels that make up the four TARP systems: the Upper Des Plaines, Mainstream, Des Plaines and Calumet. Proper operation of the TARP system is vital to maximizing the capture of CSOs in the CSO communities. TARP structures are used to divert CSO flow that would otherwise overflow to the waterways. When the TARP system begins to fill, operators monitor the elevations of the tunnels to maximize conveyance to the tunnels preventing and reducing CSO occurrences while protecting public health and safety.

Since situated below grade, these structures require heaters and dehumidifiers to maintain climate conditions. Heaters are used to prevent freezing in the winter months while dehumidifiers are used to prevent excessive moisture from accumulating within the structure. Both types of equipment are inspected for proper operation. Additionally, many structures are equipped with sump pit systems to collect infiltration and act as a discharge point for the dehumidifiers. Sump pit pumps are also inspected and tested to ensure adequate operation.

Checking alarms is part of routine maintenance for each control structure. TARP control structures are equipped with entry alarms to notify operators when the access hatch is opened, adding security and alerts District personnel of any unauthorized entry. Inspectors also frequently test the communication signals between the TARP structures and the control rooms. Confirming that accurate information is being relayed back to the control room is essential. Communication failures can lead to misinformation about the position of sluice gate structures which may impact operations. The affirmation that the gate position and alarm are working properly is important to the overall operation of the TARP system.

In addition to entry alarms, inspectors verify that high water and vault flood alarms are working properly. These alarms are used to notify operation staff that the TARP or control structure is experience infiltration or sump pump failure. Alarm failure or neglect in maintenance will lead to miscommunication and significantly impact the operation of the controlling structure; restricting operation of control gates and requiring emergency dewatering. Therefore, it is important to ensure that the communication of high water and vault flood alarms are working properly.

A physical examination of the sluice gate mechanism, including the stem and actuator, is important during inspection. Since the sluice gates are remotely operated and frequently used, inspectors must examine the stem for adequate lubrication and alignment. Gate stems that are not properly lubricated or out of alignment can cause permanent defects in the stem and restrict the operation of the gate. The actuator, or operating motor used to adjust the gate position, is also examined during a condition assessment. Inspectors will typically test the actuator by exercising the gate during the inspection to ensure the system is working properly.

Preventive maintenance and corrective work orders are scheduled and documented in detail in the District's maintenance management system . Appendix I lists all of the TARP and control structures maintained by the District.

7.6 Pump and Lift Stations

Pumps stations, also called lift stations, are used to move wastewater from lower to higher elevations to allow the collection system to operate by gravity. Most of the District's pump stations are used for the conveyance of dry weather flow while other pump stations reserve the capability to discharge combined sewer overflow to the waterways when all other systems are at capacity.

Inspection for pump and lift station requires a broad knowledge of electrical, mechanical and hydraulic components. Pump stations are usually situated within a dedicated facility which also requires a knowledge of general building maintenance such as landscaping, façade maintenance and pavement repair. However, more detail is usually dedicated to the operations of the facility which includes the alarms, controls and screen systems.

All of the outlying pump stations are unmanned and are equipped with entry alarms to notify District personnel of unauthorized entry. Inspectors commonly test these alarms as part of routine maintenance. Additionally, each pump or lift station is equipped with level sensors to monitor wet well or sewer elevations. High level and low level alarms water are required to trigger pump operation based on the elevations of the wet well. The inspection of these controls is important to ensure that pumps are operated appropriately to prevent flooding and pump cavitation.

Inspections on the main pumps and sump pumps are also regularly performed. Inspectors keep records in MMS of manufacturers' recommendations for parts replacement, oil changes and bearing lubrication as a reference for when maintenance needs are required for each component. Preventative maintenance schedules are enforced as a proactive approach for keeping the pumps fully functional. At many stations, pump activity and elevation log sheets are acquired at the time of inspection. This information is important so that historical operation data is available to District personnel. Finally, ancillary equipment such as heaters, dehumidifiers, compressors and emergency generators are stationed inside many of the pump station facilities. Such equipment is routinely tested during a normal inspection.

Inspectors will either test the pumps or investigate their run times to ensure adequate operation. The basic inspection will consist of verifying that the control system is operating properly. Inspectors may run the pumps, if idle, to check for signs of excessive vibrations and to verify that suction and discharge pressures are acceptable. Pumps in operation are examined for excessive heat and noise. If the inspector deems that corrective action is needed on the pump system, the information in entered in MMS and work is scheduled accordingly.

Many pump stations are equipped with influent screens installed at the intake to prevent floatables and course debris from entering the wet well. Some pump stations are equipped with collection rake systems that continuously or periodically clean the screens to preclude a buildup of debris. Keeping screens clean helps equalize the upstream and downstream sides of the screen which prevents suction lift complications for the main sewage pumps. Therefore, screens are physically examined to make sure they are free of debris.

Appendix J lists all of the pump stations and their attributes. Inspection results are collected and the asset is evaluated for repair needs. Corrective actions are recorded in the District's maintenance management system.

7.7 Reservoir and Dams

The District maintains and operates flood reservoirs to alleviate overbank flooding in local streams. Stormwater spills into the reservoirs when streams are flowing full and the water is pumped to the streams after storms when stream capacity is available. The reservoirs capture water from natural streams and not CSO from tunnels. The District shares the responsibility for maintenance and inspections for many of the reservoirs with local municipalities. Inspections are jointly performed with local municipalities, the National Resources Conservations Service and the Army Corps of Engineers.

Typical reservoir inspections involve a comprehensive evaluation of the entire site which includes the principle spillways, diversion structures, pumping station and other ancillary components. Inspectors check the spillways for signs of seepage, joint or crack impairments and any blockages or obstructions. During inspections, the riprap surrounding the spillway is closely examined. Rip rap is used for erosion prevention along the sidewalls of the spillway. Undesirable vegetation growth is also looked for and general conditions of the conduits and culverts are noted.

Some reservoirs are dewatered using excavated pumpout. These reservoirs are equipped with pump stations to convey the collected stormwater to the local stream when capacity is available. The pump stations are checked to make sure the inlet and screens are free of obstructions, and both the mechanical and electrical controls are functioning. Additionally, the pump station outlets are checked for joint repair needs and signs of erosion.

The District is responsible for the inspection of five dam structures located in the Cook County area. Inspections are performed annually with joint efforts between the M&O and Engineering Department along with representatives from the Natural Resources Conservation Service and local municipalities. Dam inspection follows much of the same protocol as those for reservoirs. Surface and structural cracks are examined as well as erosion, spalling and undesired vegetation growth. Maintenance needs are reported in MMS and repairs are made by trades. For more extensive rehabilitation work, the use of Job Order Contracts is employed to address maintenance needs.

General conditions of the reservoir grounds and dam structures are also part of the semi-annual inspection performed by MWRD staff. Inspectors regularly check for potential safety hazards and signs of graffiti or vandalism. Entrance and service roads are checked for surface conditions.

There are 33 flood control reservoirs and dam structures within the District Boundaries. Appendix K lists the flood control structures within District boundaries and notes the facilities inspected by MWRD staff. Inspection results are collected and the asset is evaluated for repair needs. Corrective actions are recorded in the District's maintenance management system.

APPENDIX 3A

AMBIENT WATER QUALITY MONITORING – QUALITY ASSURANCE PROJECT PLAN

AMBIENT WATER QUALITY MONITORING QUALITY ASSURANCE PROJECT PLAN

Revision 2.4
Effective Date: September 20, 2013

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

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

Telephone: (312) 751-5190

GROUP A: PROJECT MANAGEMENT

A1: Approval Sheet:

Date 3/4/14

Thomas C. Granato
Director of Monitoring and Research

Date 10/30/13

Thomas Liston
Assistant Director of Monitoring and Research
Analytical Laboratories Division

Date 2/25/14

Heng Zhang
Assistant Director of Monitoring and Research
Environmental Monitoring and Research Division

Date 10/30/13

John McNamara
Quality Assurance Coordinator
Environmental Monitoring and Research Division

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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 Director of Monitoring and Research (M&R).

As this document will be updated periodically, the reader is advised to check with the Project Manager for the latest revision if his copy is more than one year old. Revision 2.1 has been prepared following the United States Environmental Protection Agency (USEPA) 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
Director of Monitoring and Research

Project Manager:
Heng Zhang
Assistant Director of Monitoring and Research
Environmental Monitoring and Research Division

IEPA Project Manager:
Gregg Good
Surface Water Section Manager

Project Coordinator:
Jennifer Wasik
Supervising Aquatic Biologist

Environmental Monitoring Manager:
Nicholas Kollias
Assistant Aquatic Biologist

Stickney Analytical Laboratory Manager:
Donna Coolidge
Supervising Environmental Chemist

Calumet Analytical Laboratory Manager:
Victor Olchowka
Supervising Environmental Chemist

Industrial Waste Analytical Laboratory Manager:
Robert Polis
Supervising Environmental Chemist

Egan Analytical Laboratory Manager:
John Chavich
Supervising Environmental Chemist

Analytical Microbiology Laboratory Manager:
Auralene Glymph
Senior Environmental Microbiologist

Organic Compounds Analytical Laboratory Manager:
Anna Liao
Supervising Instrumentation Chemist

Data Review and Reporting Manager:
Zainul Abedin
Biostatistician

Quality Assurance Officer:
John McNamara
Quality Assurance Coordinator

IEPA Quality Assurance Officer:
Michelle Rousey
Quality Assurance Officer, Bureau of Water

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.

The Project Director is responsible for the execution of the entire project. The Project Manager has many responsibilities including planning the scope of the project, execution, and reviewing project reports. The Project Coordinator coordinates project activities, prepares project reports, and completes QAPP revisions. The Quality Assurance (QA) Officer is responsible for oversight of quality control for the project.

The Illinois Environmental Protection Agency (IEPA) Project Manager coordinates the efforts of both agencies to ensure that project data will be usable by the IEPA for assessment of water quality. He is assisted by the IEPA QA Officer, who oversees project activities and project quality control.

The Environmental Monitoring Manager is responsible for the execution of field activities and assists with QAPP revisions. The sampling teams collect and preserve samples, make field measurements, and transport the samples to the District laboratories. Several District laboratories analyze project samples. Participant laboratories include the Stickney Analytical Laboratory (SAL), Egan Analytical Laboratory (EAL) the Industrial Waste Analytical Laboratory (IWAL), the Calumet Analytical Laboratory (CAL), the Analytical Microbiology Laboratory (AML), the Organic Compounds Analytical Laboratory (OCAL), and the Aquatic Ecology and Water Quality Section (AEWQ). All project data is maintained in the District laboratory information management system (LIMS) database.

The SAL Manager is responsible for collection of project test results and data verification for SAL and IWAL data. The Data Review and Reporting Manager maintains the District project database in SAS® software, reviews project data, checks and reports violations of water quality standards, prepares quarterly water quality exceedance reports, and prepares annual summary reports for the project.

A5: Background

The District routinely collects and analyzes water samples from the District service area waterways. "Waterways" as used in this document will mean natural and modified rivers or streams, and man-made canals. This monitoring has been undertaken by the District to determine water quality on an ongoing basis and establish a historical record. A historical water quality database exists back to project inception in 1970.

The Illinois Pollution Control Board (IPCB) designates District service area waterways based on their recreational and aquatic life use potential. Recreational use designations in these waterways include: General Use, Primary Contact Recreation, and Incidental Contact Recreation. Aquatic Life Uses are General Use, Chicago Area Waterway System (CAWS) Aquatic Life Use A, and CAWS Aquatic Life Use B.

The IPCB has established separate water quality standards to support the designated uses for each waterway. Comprehensive assessments of the water quality data from this project are made annually using all applicable water quality standards established by the IPCB.

The water quality data collected from this project have been used, often in conjunction with data from other monitoring studies, to evaluate the impact of District operations and projects, including the WRPs, the pretreatment program, the flood and pollution control Tunnel and Reservoir Plan, the Sidestream Elevated Pool Aeration Stations and the Instream Aeration Stations.

The water quality data provide a broad surveillance of significant discharges to the waterways. The data also may have potential use for evaluation of other factors affecting water quality, including intermittent stormwater releases and release of pollutants from bottom sediment in the waterways.

Another goal of this project is to coordinate the waterway monitoring performed by the District with the waterway monitoring performed by the IEPA's Bureau of Water. The District will review key aspects of its program, including sampling locations, sampling frequency, sampling methods, parameters analyzed, and analytical capability, to determine how to best provide water quality data usable by both agencies.

This QAPP will address how to conduct the monitoring of the waterways in a manner that will efficiently utilize available resources and produce water quality data that will meet or exceed the measurement quality objectives for all intended uses of the data.

A6: Project/Task Description

Monitoring is conducted on 13 waterbodies at 28 sampling stations. The total number of river miles monitored is approximately 225. The following rivers, creeks, man-made channels, and a canal are monitored for water quality.

Des Plaines River System

- Higgins Creek
- Salt Creek
- Des Plaines River
- West Branch DuPage River

Chicago River System

- North Branch Chicago River
- North Shore Channel
- Chicago River
- South Branch Chicago River
- South Fork South Branch Chicago River
- Chicago Sanitary and Ship Canal

Calumet River System

- Grand Calumet River
- Little Calumet River
- Calumet-Sag Channel

Figure 2 is a map showing the waterways in the Chicago metropolitan area and the current sampling locations. Also shown on Figure 2 are the waterway reaches that have been classified as secondary contact waters.

A description of the 28 monitoring stations is provided in Tables 1, 2, and 3. Table 1 lists all current and discontinued sampling locations with their project location number and IPCB use classification. Table 2 shows the latitude and longitude of each sampling station. Table 3 shows the United States Geological Survey quadrant, township, range, section, and quarter section of each sampling station.

All locations are sampled monthly. Grab samples taken at the surface are collected at each sample location for the analysis of most measured analytes. These water samples are analyzed for a wide range of parameters, including alkalinity, solids, ammonia, nitrate, phosphorus, total metals, dissolved metals, cyanide, phenol, fecal coliform, organic priority pollutants, nonylphenols, gross alpha radioactivity, and gross beta radioactivity. A special sampling device is used to collect samples at a depth of 3 feet for dissolved oxygen analysis and bacterial analysis. Water temperature and pH are measured onsite at each sampling location.

Following collection, the samples are transported to the Cecil Lue-Hing Research and Development Complex at the Stickney WRP and the OCAL at the John E. Egan WRP for login. After login, metals samples are transported to EAL for analysis, and the rest of the samples are analyzed at SAL. The waterways monitoring data are maintained in computer databases. Exceedances of water quality standards are reported quarterly. Annual summary reports are prepared that assess compliance with applicable IPCB water quality standards and identify long-term trends in water quality.

A7: Quality Objectives and Criteria for Measurement Data

Many analytes measured for this project are present in low concentrations throughout the waterway systems. Analyte concentrations will vary as discharged effluents and stormwater runoffs are introduced into the waterways. All analytes are subject to chemical, biological, and physical processes that will alter their presence in the waterway. It is the intent of this project to employ methods of measurement that will detect and quantify all analytes of interest wherever possible.

Although there are several intended and potential uses of the data, minimum measurement criteria will be established at the lowest analyte concentration required for actual uses of the measurement data. Where no minimum measurement criteria can be identified, the water samples will be analyzed to the lowest concentration readily achievable by District laboratories.

Currently, except for the IPCB water quality standards, there are no other specified minimum measurement criteria for waterways monitoring data. Therefore, this project will use the most restrictive water quality standard applicable to waterways within the District's service area to establish the minimum measurement criteria for each parameter. The minimum measurement criteria will apply for all samples irrespective of the IPCB waterway designation in order to maintain uniform measurement objectives for the project.

The monitored parameters and the established minimum measurement criteria are shown in columns 1 and 3 of Attachment A. Analytes not subject to an IPCB water quality standard will not have specified minimum measurement criteria. The minimum measurement criteria will be adjusted accordingly when IPCB water quality standards are changed or as dictated by other planned uses of the data.

Column 2 of Attachment A gives the Reporting Limits (RLs) for the project, which are established by ALD.

RLs are mathematically derived from MDLs. The relationships between MDLs and RLs can be referenced in the Quarterly Interlaboratory Database Report. The actual RLs for the participating laboratories are presented in Section B4, "Analytical Methods." For parameters where RLs are not applicable, such as pH, temperature, and dissolved oxygen, the minimum measurement criteria shown in column 3 of Attachment A are the sensitivity to be obtained by the measurement method. Sensitivity of a method shall be defined as the difference in concentration that can be distinguished by measurement.

A8: Special Training/Certification

1. Sample collection personnel shall be trained in proper sample collection methods by their supervising Aquatic Biologist.

2. Microbiological analysis shall be performed by analysts who have been certified as competent by the Illinois Department of Public Health (IDPH).

3. Each section of the Analytical Laboratories Division (ALD) has successfully maintained accredited status as certified by the IEPA following the NELAC Institute (TNI) standards.

4. The laboratory contracted to perform radiochemical analyses shall possess National Environmental Laboratory Accreditation Program accreditation and maintain certification for the examination of radiochemical parameters from any state within the United States.

A9: Documents and Records

1. The Project Coordinator and QA Officers for the District and the IEPA shall retain copies of all annual updates and revisions of this QAPP.

2. The Analytical Laboratory Managers and QA Officers for the District and the IEPA shall retain copies of all analytical procedures used for analysis of project samples.

3. The Project Coordinator shall retain copies of all laboratory analytical reports and correspondence with the laboratories.

4. The Project Coordinator shall retain copies of all communications to and from outside agencies and other interested parties.

5. All the records and reports listed above will be retained for 10 years at the Cecil Lue-Hing R&D Complex located at the Stickney WRP.

GROUP B: DATA GENERATION AND ACQUISITION

B1: Sampling Process Design (Experimental Design)

Selection of Sampling Locations. The 28 sampling locations have been previously identified in Tables 1, 2, and 3. Criteria for selecting sampling locations include:

1. Downstream of the point at which major tributaries enter the District's service area.

2. Near the intake control structures where water is diverted into the waterways from Lake Michigan.

3. Upstream and downstream of District facilities, including WRPs, aeration stations, and pumping stations.

4. At the confluence of significant waterway branches.

5. At the Lockport control facility where most flow from the District service area leaves the waterways system.

6. Near the downstream end of a reach designated by the IEPA as a waterbody segment or assessment unit.

Sampling locations must be readily accessible and judged safe for all sampling activities. Bridges over the waterways have provided ideal sampling locations. For locations where bridge access or height will not allow for safe sampling, samples may be collected by boat.

The IEPA utilizes water quality data to prepare its annual water quality report as required by Section 305(b) of the Clean Water Act. For this purpose, the IEPA assesses conditions for waterbody segments and has defined these segments for all waters in the state. In 2000, the District began reviewing the IEPA's definition of segments for waters in the District's jurisdiction. As a result of this review and discussions with the IEPA, some of the segments were redefined by the IEPA in a meeting held in July 2001. The District provides coverage of all IEPA segments located in waterways impacted by District operations.

Sampling locations may be added or removed from the monitoring network based upon periodic assessments of monitoring needs and resources available. Recent changes to sampling locations are footnoted in Table 1.

Sampling Frequency. All 28 sampling locations are monitored monthly. The sampling frequency for each parameter is shown in Attachment B. This schedule provides sampling through seasonal changes and a sufficient number of samples to adequately characterize water quality annually and to identify long-term trends over many years. Monthly sampling may also detect an abrupt degradation of water quality, allowing the opportunity for the District to respond appropriately.

Water quality samples are collected weekly at the Lockport Powerhouse and Lock because this facility controls the release of water from the Chicago Sanitary and Ship Canal, which contains, at that location, the combined flow from the Chicago and Calumet Waterway Systems. Most of the treated wastewater originating in the District's service area flows through the Lockport Powerhouse and Lock.

Sampling frequency may be modified if there is a specific need to acquire additional data.

Selection of Sampling Methods. Sampling of the waterways could be accomplished by either collection of a single sample at each sampling location or by the use of cross-sectional sampling methods whereby multiple samples would be collected at each sampling location.

Cross-sectional sampling typically involves taking samples at specified collinear locations across a body of water. Each transect may include a single sample, multiple samples taken at various depths, or a single depth-integrated sample. Cross-sectional samples may be analyzed individually or composited into one or more samples depending upon the objectives of the project.

The use of cross-sectional sampling methods in a flowing channel does not always ensure that a more representative composite sample will be obtained. In a uniformly mixed channel, no number of samples taken within a cross-section can be more representative than a single sample taken at any point within the channel. Also, the interpretation of composite samples derived from cross-sectional sampling may be confounded by several factors, including the variations of flow velocity occurring within the channel and the length of time required to obtain all samples in the cross-sectional sampling grid.

Cross-sectional sampling methods are not utilized for this project because of their complexity, because of the additional time and personnel required to obtain cross-sectional samples, and because cross-sectional sampling is not required to obtain representative samples. The District waterways are in fact cross-sectionally well mixed because they are generally long and narrow channels having "plug-flow" characteristics. This means that analytes introduced at any point in a waterway are quickly dispersed and moved forward with the channel flow. Sampling for this project is performed by taking a single surface water grab sample at the center of the waterway.

Uniformity of mixing in the Chicago area waterways has in fact been evaluated in annual studies since September 1998 using cross-sectional dissolved oxygen (DO) measurements performed at numerous locations throughout the waterways system. These studies have consistently verified cross-sectional uniformity.

If additional evidence of uniform mixing should ever be required, the District will devise and carry out additional testing as appropriate. If warranted, sampling methods will be changed as necessary to ensure that representative samples are being collected.

Selection of Parameters for Monitoring. Parameters selected for analysis are those that have IPCB water quality standards, and other parameters that have been used to characterize in-stream water quality. Periodically, the parameters monitored are reviewed. A parameter may be dropped from monitoring if the parameter is found to be non-essential for the goals of the project or if the parameter is judged too resource intensive to analyze. If parameters are needed for a monitoring purpose, they will be added to the project. Recent changes in parameters analyzed are footnoted in Attachment A.

B2: Sampling Methods

Manual sampling from bridges is conducted on each Monday of the month. When a Monday is a District paid holiday the sampling will be performed on the following Tuesday. Two person teams, each comprised of Pollution Control Technicians or available personnel, perform the sampling under the direction of either the supervising PCOII or Assistant Aquatic Biologist.

The eleven locations on the Des Plaines River System are sampled on the first Monday of each month. The four most northern sampling locations on the Chicago River System are sampled on the second Monday of each month. The remaining six locations on the Chicago River System are sampled on the third Monday of each month. The six sampling locations on the Calumet River System are sampled on the fourth Monday of each month. The Lockport sampling location on the powerhouse forebay catwalk is sampled weekly.

The surface water grab samples are collected using a stainless steel bucket. The bucket is lowered into the waterway from the upstream side of the bridge at the most central location of the waterway. The bucket is submerged, filled, and then raised to the top of the bridge. The water temperature and pH are measured immediately from the stainless steel bucket with a calibrated pH/temperature probe. The contents of the bucket are then discarded and the bucket is lowered and refilled as necessary to provide sample for the individual sample aliquots. A separate water sample is taken for measurement of DO using a special sampling device that prevents aeration of the sample during collection. The sterile sample container for bacterial analysis is filled separately in the waterway to prevent contact of the sample with non-sterile surfaces.

There is, however, one exception to sampling at the upstream side of the bridge: Sampling location 48, the Stephen Street Bridge. This location is sampled from the District Pollution Control Boat from the center of the waterway. Sampling from the bridge is not possible because the Stephen Street Bridge no longer exists.

The individual sample containers are filled in accordance with the sampling procedures described in Appendix I. The individual containers for sample collection are prepared by the laboratory performing the sample analysis. Chemical preservatives as necessary are placed in the containers by the laboratory of origin before sample collection. Specific information regarding sample containers and chemical preservatives is found in Table 4.

Preprinted adhesive sample labels with unique LIMS identification numbers are placed on each container prior to filling. The sampling team completes the sample collection sheet (Appendix II) in the field as each sample is collected.

B3: Sample Handling and Custody

All sample containers are chilled in an ice-filled cooler immediately after collection and kept in ice during transport to the laboratories.

All water samples are transported to the SAL after collection accompanied by sample collection sheets. The laboratory physically receives the samples from the Industrial Waste Division transporter. An environmental chemist, or a laboratory technician under the direct supervision of a environmental chemist, "receives" the samples into the District's LIMS using a barcode scanner. Each sample is inspected against the laboratory's sample receiving checklist for proper container, proper labeling, sufficient volume, and general appearance. Any missing samples or aliquots are noted on the sample receiving checklist. Sample arrival temperatures are measured using an infrared thermometer calibrated against a NIST traceable certified thermometer ("NIST" is the National Institute of Standards and Technology, United States Department of Commerce), and recorded. Since the time between sampling and arrival at the laboratory is only a few hours, samples may not always reach the 0.1 to 6 degrees C (°C) required for thermal preservation. Samples are acceptable if "evidence of chilling" has begun. Samples that require thermal preservation are refrigerated after sample acceptance in the laboratory. Samples for biological analysis and radiochemical analysis are then routed to the appropriate laboratories at the Cecil Lue-Hing R&D Complex. Samples for organics analysis are transported to the OCAL at the John E. Egan WRP. The remaining samples for inorganic analysis are received by the SAL. Following log-in at the SAL, the samples for metals analyses are transported to the Egan Laboratory, and the aliquot for sulfate and mercury analysis are transported to the CAL within 24 hours by the Maintenance and Operations courier.

Each laboratory receives the samples by logging them into the laboratory logbook and/or laboratory LIMS. Maximum holding times before analysis, as stated in applicable laboratory method standard operating procedures (SOPs), are adhered to. Parameters of particular concern, because of short maximum holding times, include: bacterial analysis (six hours), dissolved oxygen (eight hours), and hexavalent chromium (24 hours).

Copies of the sample collection sheets, along with the sample receiving checklist, are retained by the SAL. The pH and temperature for each field sample are entered into the LIMS by SAL personnel.

The original sample collection sheets are returned to Environmental Monitoring Manager for review. The Environmental Monitoring Manager is responsible for the execution of field operations and corrective actions for field related quality control problems or other nonconformance issues.

B4: Analytical Methods

The analytical methods shown in Table 5 have been selected that meet the minimum measurement criteria presented in Attachment A. Column 1 of Table 5 gives the analytes to be measured, column 2 shows the method to be used by the laboratory, and column 3 the method reference. Except for chloride, chlorophyll, and nonylphenol, all methods used by the District are USEPA approved methods listed in 40 CFR Parts 136, 141, and 145. Approved USEPA methods are not available for the determination of chlorophyll and nonylphenols.

Table 6 shows laboratory preservation and maximum holding time from the time of sampling for each analyzed parameter. Column 2 of Table 6 gives the laboratory preservation. Field pH adjustments (Table 4) are indicated in column 2 in parentheses. The maximum holding time for each parameter is given in column 3 of Table 6. Refrigeration of samples that require thermal preservation is maintained at 4°C, but temperatures in the range of 0.1 to 6°C are considered acceptable. Preservation and maximum holding times are in accord with those given in 40 CFR Part 136.

The laboratory where each analysis will be performed is identified in column 2 of Table 7. Column 3 of Table 7 identifies the laboratory method SOP. The analytical method SOPs are incorporated into this QAPP by reference in column 3 of Table 7. SOPs for analytical methods are available from the the responsible Laboratory Manager identified in Section A4.

Attachment A compares the minimum measurement criteria against the reporting limit (RL) achieved by the designated District laboratory. All analytes meet the minimum measurement criteria.

All data collected for this project will be reported to the analyte RL, as this is the reportable level established in the District's National Pollutant Discharge Elimination System (NPDES) permits. Test results less than the RL will be reported as either zero or as less than the numerical value of the RL.

B5: Quality Control

Equipment blanks will be used to verify that field samples are free of contamination. Each sampling team will prepare equipment blanks for the appropriate parameters at a sampling location on each day of sampling. The SAL will review the test results. Whenever significant contamination is found, the laboratory will initiate an investigation and implement the necessary corrective actions.

The individuals responsible for verification that proper procedures are followed in matters concerning sampling methods, sample preservation, and sample custody to the delivery of samples to the SAL will be the Environmental Monitoring Manager and his/her supervisor. For more information please see sections B2: Sampling Methods, B3: Sample Handling and Custody, and C1: Assessment and Response Actions. For any quality control or other nonconformance issue, the Environmental Monitoring Manager and his/her supervisor will submit an investigation and corrective action report to the Project Manager, who will send copies to the persons listed on the approval page.

It shall be understood that all measurements, regardless of the sample concentration, must have known and satisfactory accuracy and precision. Because various analytical procedures will be employed for sample analysis, specific criteria for accuracy and precision will not be provided in this document. Rather, satisfactory accuracy and precision shall be considered to be that which is consistent with the USEPA approved methods used to analyze the samples. All measurements must be derived in an environment of an adequate quality control program including statistical process control wherever applicable. The laboratory QAP and laboratory SOPs should be referred to for specific information relating to quality control.

The individuals responsible for verification that analytical methods and other laboratory procedures are being properly executed are the Laboratory Managers. The Laboratory Managers are also responsible for the reliability of project analytical data. For any quality control or other nonconformance issue that may have affected the reliability of project data, the responsible Laboratory Manager will submit an investigation and corrective action report to the Project Manager, who will send copies to the persons listed on the approval page.

B6: Instrument/Equipment Testing, Inspection, and Maintenance

All instrumentation and equipment used in the laboratory are maintained as required by the manufacturer's manuals and the laboratory SOPs.

Each laboratory is responsible for maintaining an adequate supply of spare parts to perform normal maintenance procedures. The three regional WRPs, at which the participating laboratories are located, maintain storerooms where frequently used supplies and consumables are inventoried. Major laboratory instrumentation is covered by maintenance/service contracts with qualified service representatives who are required to respond within 48 hours of notification. Each laboratory also has an account to purchase any needed parts or consumables not inventoried in the WRP storeroom or in an emergency or other unforeseen situation.

The YSI Model 63 handheld pH/temperature meters used for field measurements (or similar model) are maintained by the Aquatic Ecology and Water Quality Section (AEWQ). These instruments are calibrated for pH in the laboratory on the first day of the week before use. Calibration records are kept by the AEWQ laboratory. Sample collection personnel sign out a calibrated instrument on the day of sampling and return it on the same day after sampling. The meter operation and calibration are checked when each instrument is returned to the laboratory. The temperature calibration is verified at least annually against a NIST traceable thermometer. The SAL is responsible for stocking spare parts for these meters, performing routine maintenance, and securing service from qualified service representatives as needed.

B7: Instrument Calibration and Frequency

All instrumentation used for testing shall be calibrated each day of use as directed by manufacturer's manuals and laboratory SOPs. General guidelines and requirements regarding calibration of laboratory equipment are contained in the laboratory QAPs. Laboratories that participate in an accreditation program also will comply with the requirements for calibration maintained by the accreditation program.

All instrumentation is uniquely identified by serial number or other means. Wherever possible, NIST traceable standards are used for calibration of instruments. Calibration records are kept each time laboratory instrumentation and equipment are calibrated, and the calibration records and quality control samples are unmistakably identified for each batch of test results.

B8: Inspection/Acceptance of Supplies and Consumables

Supplies and consumables shall be inspected by the laboratories and accepted in accordance with all laboratory procedures and specifications contained in laboratory QAPs or SOPs. The laboratory section supervisors are responsible for verifying that supplies and consumables meet the specifications contained in the method SOPs.

B9: Non-direct Measurements

Non-direct measurements are not required for this project.

B10: Data Management

The District maintains several networked servers. The network may be accessed by personal computers and workstations from any District facility. Computer software used for this project includes a fully networked LIMS and Excel® software and SAS® software on selected workstations. The Thermo LabSystems SMW (SampleManager for Windows) 2003 R1 is customized to incorporate procedures employed at District laboratories. The District LIMS supports numerous features including: barcode usage, prelogging of samples by either the sample submitter or laboratory personnel, label generation, sample login, sample receiving of prelogged samples, sample batching, instrument interfacing, manual data entry, automated calculations, control limit checking for each laboratory control sample, control chart maintenance, NPDES limit checking, industrial waste limit checking, facilitated data handling, and data reporting. The LIMS is utilized by all laboratories participating in this project.

Most chemical analytical data have resided in the District LIMS since 1996. Historical data back to 1970 are stored in Excel® spreadsheet files and SAS® files. Whenever data are manually entered into a software file from hardcopy reports, each number is verified to ensure accuracy of manual entry.

As the waterways are sampled routinely, the samples are prelogged into the District's LIMS. Environmental Monitoring Manager generates sample labels for sample containers before sample collection. The labels contain information including sample location, sample type, and unique sample ID with barcode. Each sample container has a unique sample ID comprised of the sample number and aliquot designation.

The AML, AEWQ, and the OCAL follow documented procedures for sample login, sample acceptance, analysis, and data verification. Test data from the AML and AEWQ are manually entered into LIMS, while OCAL data is automatically uploaded from instrument to LIMS.

Water samples for radiochemical analysis are received and logged in by the SAL. Samples are preserved by AEWQ staff and picked up by the contracted laboratory, who completes a chain of custody form. The analytical results are reviewed and manually entered into LIMS by an Aquatic Biologist.

While the SAL employs the most computerized system for sample tracking and data handling, all participating laboratories follow similar procedures. The analyst assigned to receive the samples in the SAL uses a barcode scanner to log as received the "general chemistry" samples. All samples are checked and any missing sample containers are noted in the sample log. The analyst checks to make certain that sample acceptance criteria, including appropriate sample containers and thermal preservation, are satisfactory.

After the laboratory receives the samples, sub-samples are poured as required. The samples are then distributed to the appropriate analytical sections for analysis. As analyses are completed, the test results are entered into the LIMS generally by data file upload from the laboratory instrument. Test results are reviewed and verified by each analytical section supervisor. Water quality limits are checked for each sampling station for the applicable General Use or Secondary Contact water quality limit. An exceedance of these limits prompts retesting for confirmation. The highest confirmed value is reported.

Retesting for analytes with regulatory limits is only done for a confirmed QC problem in the execution of analysis or if the regulatory limit has been exceeded. No retesting will be performed on the basis of historical limits or multi-day limits without consulting first with the sample submitter for information about any unusual conditions that would corroborate the test results. When such information is not available and a retest is requested, the sample submitter's authorization to conduct the retest should be in writing for documentation purposes. In those instances where retesting is performed for reasons other than a QC failure or to confirm a regulatory limit exceedance, then the highest confirmed value is reported unless otherwise specified above.

As sample analysis in the Analytical Laboratories Division (ALD) Laboratories is completed each month, the approved test data are collected from the LIMS Oracle® database and transferred into an Excel® spreadsheet. To simplify data handling, this spreadsheet is also used to collect field test data (pH and temperature) and test data from the AML (fecal coliform) and the radiochemistry analyses (gross alpha and gross beta radioactivity). The ALD Excel® spreadsheet includes all parameters, except for organics data. Generally, analytical data from any month is expected to be completed and available to data users within 30 days after the end of that month.

The monthly spreadsheet from the ALD laboratories is checked for completeness and atypical test data. This review is performed by the SAL Senior Environmental Chemist and the Supervising Environmental Chemist (Laboratory Manager). When atypical test data are found, they are reported to the appropriate analytical section supervisor for further investigation. If the investigation does not reveal a reason for the atypical data, the section supervisor is requested to reanalyze the sample provided that sufficient sample is available and the maximum holding time has not been exceeded. The retest result is reported as the valid result except when the original test result exceeds a water quality standard. If a water quality standard is exceeded by the original test result, and no error is found that invalidates the original test result, then the highest test result (original or retest) is reported.

Following final approval of ALD laboratory data, the ALD Excel® spreadsheet file is sent to the Biostatistician who creates a file in SAS® (Statistical Analysis Software) from the Excel® data file. A second Excel® file from the Organic Compounds Analytical Laboratory containing the organics test data for BETX is sent to the Biostatistician, and it is also uploaded into SAS®. SAS® is the statistical analysis software used to review and analyze the data.

All project data are checked by the Biostatistician for compliance with applicable IPCB water quality limits. Currently, limit exceedance reports are produced quarterly, and a comprehensive water quality report is produced annually. The quarterly limit exceedance reports summarize IPCB water quality limit exceedances by parameter for each major waterway system and IPCB designated use classification. These reports also assess compliance with target limits for certain parameters that do not currently have IPCB water quality limits. In addition, each exceedance is listed with location, date, and applicable water quality limit or target limit.

The annual water quality report presents the following:

1. Annual average parameter concentrations for the sampling stations immediately upstream and downstream of the District's seven WRPs.

2. Rates of compliance for parameters with water quality standards in each waterway system.
3. Annual parameter averages at each sampling location for each of the previous 11 years.
4. Annual exceedance counts for each limited parameter at each sampling location for each of the previous eight years.

GROUP C: ASSESSMENT AND OVERSIGHT

C1: Assessment and Response Actions

Random surveillance of a sampling team is conducted by the Environmental Monitoring Manager to verify that water samples are being collected properly and sampling procedures are followed. The results of each surveillance are documented by the Environmental Monitoring Manager. As stated in Section B5, the Environmental Monitoring Manager and his/her supervisor will submit investigation and corrective action reports for all quality control and other nonconformance problems dealing with field procedures to the Project Coordinator with copies to the persons listed on the approval page of this QAPP.

All laboratories maintain internal quality control programs that are described in their quality assurance plans. The ALD Laboratories maintain statistical process control for most analytical procedures. Laboratory assessment activities require investigation and corrective actions for all quality control problems and other nonconformance issues. As stated in Section B5, when the reliability of project data may have been affected by a quality control problem or other nonconformance issue, the responsible Laboratory Manager will submit a copy of the investigation and corrective action report to the Project Coordinator with copies to the persons listed on the approval page of this QAPP.

Also, the responsible Laboratory Manager shall make certain that the project data associated with any quality control or other nonconformance issue is made available to data users with the appropriate data qualification. When data previously released to data users may have been affected by a quality control problem or other nonconformance issue, the Manager shall notify data users of the problem and put in the appropriate data qualifiers in databases used by the District for storage of project data.

The SAL, CAL, EAL, and IWAL participate in three proficiency-testing studies each year. Two proficiency-testing studies are the semi-annual Water Pollution Study and the third is the National Pollutant Discharge Elimination System (NPDES) Discharge Monitoring Report Quality Assurance (DMR-QA) Study. The NPDES DMR-QA Study may be a combined study with one of the Water Pollution Studies. Systematic investigations are conducted for all unacceptable results. The investigation and corrective action reports prepared by the Laboratory Manager and his/her staff are reviewed by the ALD Assistant Director of M&R, by the QA Coordinator, and often by the Director of M&R.

The Organic Compounds Analytical Laboratory participates in two proficiency-testing studies each year and conducts investigations for unacceptable results in a manner similar to that followed by the other ALD Laboratories.

The AML is certified by the IDPH and must successfully pass a biannual on-site audit conducted by the IDPH.

All District laboratories have implemented annual internal audits.

C2: Reports to Management

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

Project-related systems audits or special data quality assessments are undertaken on a random basis.

GROUP D: DATA VALIDATION AND USABILITY

D1: Data Review, Verification, and Validation

The laboratory data are reviewed and verified as described in Section B10, Data Management. The Biostatistician also reviews the data after it is transferred into the SAS® software. If errors are discovered, the Biostatistician reports them to the Supervising Environmental Chemist of the SAL or Supervising Instrumentation Chemist of the OCAL for investigation and resolution.

D2: Verification and Validation Methods

Sample collection records can be verified by the Environmental Monitoring Manager identified in Section A4. Laboratory data shall be verified as necessary by the SAL Manager identified in Section A4 and the Laboratory Manager of the laboratory that produced the data. All field and laboratory records will be kept for a minimum of five years. Laboratory records that are stored include calibration data, raw data, bench records, and data for quality control samples.

When verification of data results in a change to the project-related data, the Project Manager shall inform data users of the problem and make certain that all databases known to contain the affected data are corrected as necessary.

The person designated as the Data Review and Reporting Manager (Section A4) has all calculations used for checking applicable IPCB water quality standards. He should be consulted regarding any questions pertaining to compliance with water quality standards and the reporting of data in the annual waterways water quality report. All data handling and calculations for the water quality report are performed using SAS® software and SAS® user programs.

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 shall adhere to the procedural requirements of the QAPP and ensure that subordinate personnel do likewise.

This QAPP shall be reviewed annually by the Project Coordinator to ensure that the project will achieve all intended purposes. The annual review shall address every aspect of the program including:

1. The adequacy and location of sampling stations.
2. The adequacy of sampling frequency at each location.
3. Sampling procedures.
4. The appropriateness of parameters monitored.
5. Changes in data quality objectives and minimum measurement criteria.
6. Whether the data obtained met minimum measurement criteria.
7. Analytical procedures.
8. The quarterly violations reports and the annual project report.
9. Corrective actions taken during the previous year for field and laboratory operations.
10. Coordination of the project with the IEPA.
11. 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. Changes or deviations in the operation of the project shall not be made without authorization by the Project Director. The need of a change in project operation should be conveyed by the appropriate responsible person to the Project Coordinator. Data users and other interested persons may also suggest changes to the project to the Project Coordinator.

The Project Coordinator shall evaluate the need for the change, consult with other responsible persons as appropriate, and make a recommendation to the Project Director for approval. The Project 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 Project Coordinator and distributed to those on the approval list, as well as the other Assistant Directors of the M&R Department. Approved changes shall be considered an amendment to the QAPP and shall be incorporated into the QAPP when it is updated.

The Project Coordinator will prepare a QAPP update if major changes have taken place.

REFERENCES

"1999 Annual Summary Report, Water Quality Within the Waterways System of the Metropolitan Water Reclamation District of Greater Chicago," Report No. 01-12, Metropolitan Water Reclamation District of Greater Chicago, October 2001.

Environmental Protection Agency, "Guidelines Establishing Test Procedures for the Analysis of Pollutants," Code of Federal Regulations, Volume 40, Part 136, March 26, 2007.

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, DC, 18th ed., 1992.

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, DC, 20th ed., 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: AMBIENT WATER QUALITY MONITORING PROJECT ORGANIZATION CHART

Project Director
(Planning, decision making, and ultimate execution of project)

IEPA Project Manager
(IEPA coordination)

IEPA QA Officer
(IEPA oversight, QA/QC)

Project Manager
(Project planning, execution, and reporting)

QA Officer
(Project QA/QC)

Project Coordinator
(Project coordination and reporting)

Environmental Monitoring Manager
(Execution of field activities)

Sampling Teams
(Sample collection and preservation, field measurements and transport of samples)

Laboratories
Stickney Analytical Laboratory
Industrial Waste Analytical Laboratory
Calumet Analytical Laboratory
Egan Analytical Laboratory
Analytical Microbiology Laboratory
Organic Compounds Analytical Laboratory
Aquatic Ecology and Water Quality Section
(Analysis, data verification, and data storage of LIMS)

(continued on next page)

FIGURE 1 (Continued): AMBIENT WATER QUALITY MONITORING PROJECT ORGANIZATION CHART

```
          |  |              |                  |
   (to Project Manager)

      |      (to Project Coordinator)
      |        |
      |        |       (to Laboratories)
      |        |                   |
      |        |                   |
      |        O---- Stickney Analytical Laboratory Manager
      |        |       (Excel® spreadsheet, data review and exceedance reporting)
      |        |                           |
      |        |                           |
      O----- O---------- Data Review and Reporting Manager
                           (SAS® database, data review, violation checking, and annual reports)
```

FIGURE 2: AMBIENT WATER QUALITY MONITORING PROGRAM WATERWAY SAMPLE STATIONS

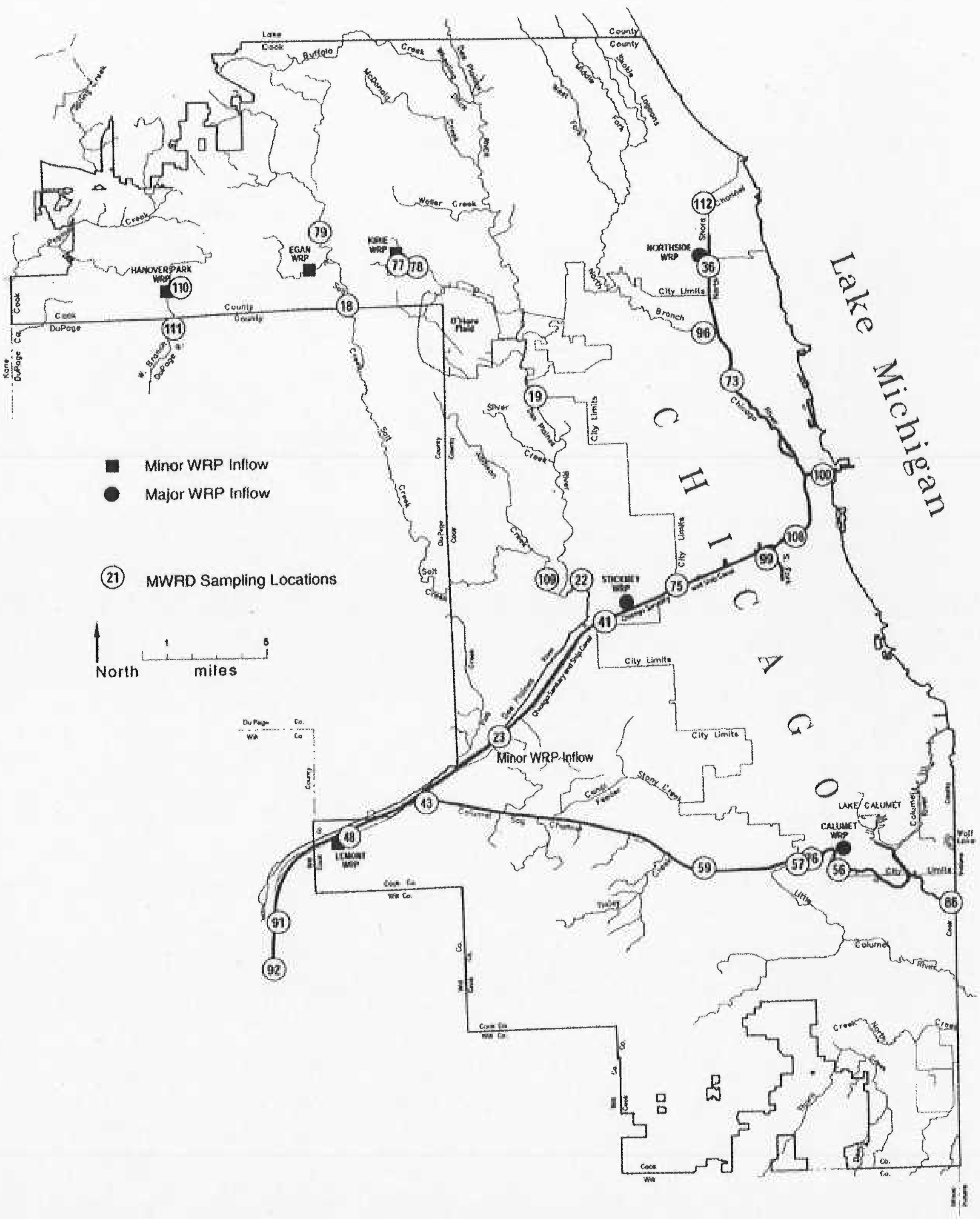

TABLE 1: SAMPLING LOCATIONS

Station[1]	Location	IEPA Classification
Chicago River System		
106	Dundee Road, West Fork North Branch of Chicago River[3]	General Use
103	Golf Road, West Fork North Branch of Chicago River[3]	General Use
31	Lake-Cook Road, Middle Fork North Branch of Chicago River[3]	General Use
104	Glenview Road, Middle Fork North Branch of Chicago River[3]	General Use
32	Lake-Cook Road, Skokie River[3]	General Use
105	Frontage Road, Skokie River[3]	General Use
34	Dempster Street, North Branch of Chicago River[3]	General Use
96	Albany Avenue, North Branch of Chicago River	General Use
35	Central Street, North Shore Channel[3]	General Use
102	Oakton Street, North Shore Channel[3]	General Use
36	Touhy Avenue, North Shore Channel	Secondary Contact
101	Foster Avenue, North Shore Channel[3]	Secondary Contact
37	Wilson Avenue, North Branch of Chicago River[3]	Secondary Contact
73	Diversey Parkway, North Branch of Chicago River	Secondary Contact
46	Grand Avenue, North Branch of Chicago River[3]	Secondary Contact
74	Lake Shore Drive, Chicago River[3]	General Use
100	Wells Street, Chicago River	General Use
39	Madison Street, South Branch of Chicago River[3]	Secondary Contact
108	Loomis Street, South Branch of Chicago River	Secondary Contact
99	Archer Avenue, South Fork South Branch of Chicago River	Secondary Contact
40	Damen Avenue, Chicago Sanitary and Ship Canal[3]	Secondary Contact
75	Cicero Avenue, Chicago Sanitary and Ship Canal	Secondary Contact
41	Harlem Avenue, Chicago Sanitary and Ship Canal	Secondary Contact
42	Route 83, Chicago Sanitary and Ship Canal[3]	Secondary Contact
48	Stephen Street, Chicago Sanitary and Ship Canal	Secondary Contact
92	Lockport Powerhouse Forebay	Secondary Contact
112	Dempster Street, North Shore Channel	General Use
Calumet River System		
49	Ewing Avenue, Calumet River[3]	General Use
50	Wolf Lake, Burnham Avenue[3]	General Use
55	130th Street, Calumet River[3]	General Use
86	Burnham Avenue, Grand Calumet River	Secondary Contact

TABLE 1 (Continued): SAMPLING LOCATIONS

Station[1]	Location	IEPA Classification
Calumet Waterway System (Continued)		
56	Indiana Avenue, Little Calumet River	Secondary Contact
76	Halsted Street, Little Calumet River	Secondary Contact
52	Wentworth Avenue, Little Calumet River[3]	General Use
54	Joe Orr Road, Thorn Creek[3]	General Use
97	170th Street, Thorn Creek[3]	General Use
57	Ashland, Little Calumet River	General Use
58	Ashland Avenue, Calumet-Sag Channel[3]	Secondary Contact
59	Cicero Avenue, Calumet-Sag Channel	Secondary Contact
43	Route 83, Calumet-Sag Channel	Secondary Contact
Des Plaines River System		
12	Lake-Cook Road, Buffalo Creek[3]	General Use
13	Lake-Cook Road, Des Plaines River[3]	General Use
17	Oakton Street, Des Plaines River[3]	General Use
19	Belmont Avenue, Des Plaines River	General Use
20	Roosevelt Road, Des Plaines River[3]	General Use
22	Ogden Avenue, Des Plaines River	General Use
23	Willow Springs Road, Des Plaines River	General Use
29	Stephen Street, Des Plaines River[3]	General Use
91	Material Service Road, Des Plaines River	General Use
110	Springinsguth Road, West Branch of DuPage River	General Use
89	Walnut Lane, West Branch of DuPage River[3]	General Use
111	Arlington Drive, West Branch of DuPage River[2]	General Use
79	Higgins Road, Salt Creek	General Use
80	Arlington Heights Road, Salt Creek[3]	General Use
18	Devon Avenue, Salt Creek	General Use
24	Wolf Road, Salt Creek[3]	General Use
109	Brookfield Avenue, Salt Creek	General Use
77	Elmhurst Road, Higgins Creek	General Use
78	Wille Road, Higgins Creek	General Use
Fox River		
90	Route 19, Poplar Creek[3]	General Use

[1]Refer to Figure 2 for locations of all current sampling stations.
[2]Arlington Drive (111) replaced Lake Street (64) in 2011.
[3]Sampling location discontinued in August, 2012.

TABLE 2: LATITUDE AND LONGITUDE OF SAMPLING LOCATIONS

Station	Description	North Latitude	West Longitude
18	Salt Creek @ Devon Ave.	41° 59.546'	87° 59.924'
19	Des Plaines @ Belmont Ave.	41° 56.236'	87° 50.975'
22	Des Plaines River @ Ogden Ave.	41° 49.256'	87° 48.654'
23	Des Plaines River @ Willow Springs Rd.	41° 44.135'	87° 52.901'
36	North Shore Channel @ Touhy Ave.	42° 00.690'	87° 42.600'
41	Chicago Sanitary & Ship Canal @ Harlem Ave.	41° 48.263'	87° 48.104'
43	Calumet-Sag Channel @ Route 83	41° 41.790'	87° 56.480'
48	Chicago Sanitary & Ship Canal @ Stephen St.	41° 40.750'	88° 00.683'
56	Little Calumet River @ Indiana Ave.	41° 39.136'	87° 35.828'
57	Little Calumet River @ Ashland Ave.	41° 39.099'	87° 39.633'
59	Calumet-Sag Channel @ Cicero Ave.	41° 39.282'	87° 44.284'
73	North Branch Chicago River @ Diversey Ave.	41° 55.920'	87° 40.940'
75	Chicago Sanitary & Ship Canal @ Cicero Ave.	41° 49.169'	87° 44.616'
76	Little Calumet River @ Halsted St.	41° 39.440'	87° 38.476'
77	Higgins Creek @ Elmhurst Rd.	42° 01.287'	87° 56.436'
78	Higgins Creek @ Wille Rd.	42° 01.120'	87° 56.201'
79	Salt Creek @ Higgins Rd.	42° 01.880'	88° 00.679'
86	Grand Calumet River @ Burnham Ave.	41° 37.870'	87° 32.352'
91	Des Plaines River @ Material Service Rd.	41° 35.794'	88° 04.112'
92	Chicago Sanitary & Ship Canal @ Lockport Powerhouse Forebay	41° 34.256'	88° 04.704'
96	North Branch Chicago River @ Albany Ave.	41° 58.475'	87° 42.375'
99	South Fork, South Branch Chicago River @ Archer Ave.	41° 50.331'	87° 39.849'
100	Chicago River Main Stem @ Wells St.	41° 53.259'	87° 38.045'
108	South Branch Chicago River @ Loomis St.	41° 50.752'	87° 39.642'
109	Salt Creek @ Brookfield Ave.	41° 49.370'	87° 50.494'
110	West Branch DuPage River @ Springinsguth Rd.	42° 00.495'	88° 07.142'
111	West Branch DuPage River @ Arlington Drive	41° 58.500'	88° 08.316'
112	North Shore Channel @ Dempster St.	42° 02.460'	87° 42.583'

TABLE 3: QUADRANT, TOWNSHIP, AND RANGE OF SAMPLING LOCATIONS

Station	Description	Quadrant	TWP	Range	Sec.	¼ Sec
18	Salt Creek @ Devon Ave.	Elmhurst	41N	11E	33	SW
19	Des Plaines @ Belmont Ave.	River Forest	40N	12E	22	SE
22	Des Plaines River @ Ogden Ave.	Berwyn	38N	12E	1	NE
23	Des Plaines River @ Willow Springs Rd.	Calumet-Sag Bridge	38N	12E	33	SW
36	North Shore Channel @ Touhy Ave.	Evanston	42N	13E	26	SE
41	Chicago Sanitary & Ship Canal @ Harlem Ave.	Berwyn	38N	12E	7	NW
43	Calumet-Sag Channel @ Route 83	Calumet-Sag Bridge	37N	11E	14	SE
48	Chicago Sanitary & Ship Canal @ Stephen St.	Romeoville	37N	11E	20	NW
56	Little Calumet River @ Indiana Ave.	Lake Calumet	37N	14E	34	SW
57	Little Calumet River @ Ashland Ave.	Blue Island	37N	14E	32	SW
59	Calumet-Sag Channel @ Cicero Ave.	Blue Island	37N	13E	34	NW
73	North Branch Chicago River @ Diversey Ave.	Chicago Loop	40N	14E	30	SW
75	Chicago Sanitary & Ship Canal @ Cicero Ave.	Englewood	38N	13E	3	NW
76	Little Calumet River @ Halsted St.	Blue Island	37N	14E	33	NW
77	Higgins Creek @ Elmhurst Rd.	Arlington Hts.	41N	11E	25	NW
78	Higgins Creek @ Wille Rd.	Arlington Hts.	41N	11E	25	NW
79	Salt Creek @ Higgins Rd.	Palatine	41N	11E	20	NW
86	Grand Calumet River @ Burnham Ave.	Lake Calumet	36N	15E	5	SW
91	Des Plaines River @ Material Service Rd.	Joliet	36N	10E	22	SW
92	Chicago Sanitary & Ship Canal @ Lockport Powerhouse	Joliet	36N	10E	27	SW
96	North Branch Chicago River @ Albany Ave.	Chicago Loop	40N	13E	12	SW
99	South Fork, South Branch Chicago River @ Archer Ave.	Englewood	39N	14E	29	SW
100	Chicago River Main Stem @ Wells St.	Chicago Loop	39N	14E	9	SW
108	South Branch Chicago River @ Loomis St.	Englewood	39N	14E	28	NW
109	Salt Creek @ Brookfield Ave.	Berwyn	39N	12E	35	SW
110	West Branch DuPage River @ Springinsguth Rd.	Streamwood	41N	10E	26	SW
111	West Branch DuPage River Arlington Drive	West Chicago	40N	10E	6	SE
112	North Shore Channel @ Dempster St.	Evanston	41N	13E	14	SE

TABLE 4: SAMPLE CONTAINERS AND FIELD PRESERVATION

	Parameter	Container and Field Preservation
1.	Dissolved oxygen	300 mL glass stoppered bottle, sample is fixed immediately after collection with manganous sulfate solution, alkali-iodide solution and sulfuric acid. Chill sample with ice and protect from light. See Appendix AI page AI-5 for the correct procedure.
2.	Fecal coliform	125 mL square polypropylene bottle, sterilized and sealed with 0.45 mL of 15% disodium salt of EDTA adjusted to pH of 6.5, and 0.15 mL of 10% sodium thiosulfate. Chill sample with ice. See Appendix I page AI-4 and AI-5 for the correct procedure.
3.	General chemistry[1] (see footnote for parameters)	1 gallon polyethylene bottle. Chill sample with ice.
4.	Metals, total	250 mL polyethylene bottle with 2.5 mL conc. HNO_3 to adjust pH<2. Chill sample with ice.
5.	Metals, dissolved	900 mL certified clean polyethylene bottle. Chill sample with ice. (Sample filtered in laboratory with 0.45 μm membrane filter into a 250 mL certified clean polyethylene bottle and acidified with 1 mL of conc. HNO_3.)
6.	Mercury	4 – 40 mL vials. Do not put sample on ice.
7.	Cyanide, total and chlorine amenable	½ gallon plastic bottle with 5 mL 10% NaOH to adjust pH>12. Chill sample with ice.
8.	Phenol	1 quart glass bottle with 2 mL of conc. H_2SO_4 to adjust pH<2. Chill sample with ice.
9.	n-Hexane extractable materials	2-1 quart glass bottles. Chill sample with ice.
10.	Alkalinity, chloride	250 mL polyethylene bottle. Chill sample with ice.
11.	Sulfate	250 mL polyethylene bottle. Chill sample with ice.

TABLE 4 (Continued): SAMPLE CONTAINERS AND FIELD PRESERVATION

Parameter	Container and Field Preservation
12. Total Phosphorus, Total Kjeldahl Nitrogen	250 mL polyethylene bottle with 0.3 mL of sulfuric acid to acidify sample. Chill sample with ice.
13. Ammonia, NO_2+NO_3, Fluoride	250 mL polyethylene bottle. Chill sample with ice.
14. Carbon, total organic	500 mL wide-mouth glass bottle with 1 mL H_2SO_4 to adjust pH<2. Chill sample with ice.
15. Radiochemistry	1 liter polyethylene bottle.
16. Chlorophyll	1 liter HDPE Nalgene amber, wide-mouth bottle with 1 mg powdered $MgCO_3$. Chill sample with ice.
17. Volatile organics, BETX (benzene, ethyl benzene, toluene, and xylene)	Three 40-mL vials with screw caps, each with 25 mg ascorbic acid, filled to overflowing with no air bubbles. Chill sample with ice.
18. Base/neutral and acid extractable compounds, pesticides, PCBs, OPPs and nonylphenols[2]	1 gallon glass with 0.7 mL of 50% sodium thiosulfate solution. Chill sample with ice.

[1]General chemistry parameters include total dissolved solids, total suspended solids
[2]Nonylphenol analyzed from same container as OPPs.

TABLE 5: ANALYTICAL METHODS

Parameter	Method	Method Reference
Dissolved oxygen	Titration	SM 4500-O C
Temperature	Electrode	SM 2550 B
pH	Electrode	SM 4500-H^+ B
Ammonia nitrogen	Colorimetric	EPA 350.1
Ammonia nitrogen, un-ionized[1]	Calculation	
Nitrate and nitrite nitrogen	Colorimetric	EPA 353.2 R.2.0
Kjeldahl nitrogen	Colorimetric	EPA 351.2 R.2.0
Phosphorus, total	Colorimetric	EPA 365.4
Sulfate	Colorimetric	EPA 375.2
Total dissolved solids	Gravimetric	SM 2540 C
Suspended solids	Gravimetric	SM 2540 D
Volatile suspended solids	Gravimetric	SM 2540 E
Alkalinity	Titration	SM 2320 B
Chloride	Potentiometric	SM 4500-Cl D
Fluoride	Potentiometric	SM 4500 F-C
Organic carbon, total	UV-Oxidation	SM 5310 C
Phenol	Colorimetric	EPA 420.2
Cyanide, total	Colorimetric	EPA 335.3
Cyanide, chlorine amenable	Colorimetric	SM 4500-CN G
Barium, total	ICP	EPA 200.7, SM 3120 B
Boron, total	ICP	EPA 200.7, SM 3120 B
Calcium, total	ICP	EPA 200.7, SM 3120 B
Chromium, trivalent[2]	ICP	EPA 200.7, SM 3120 B
Chromium, hexavalent	Colorimetric	SM 3500-Cr B
Magnesium, total	ICP	EPA 200.7, SM 3120 B
Manganese, total	ICP	EPA 200.7, SM 3120 B
Mercury, total; General Use	Cold vapor AFS	EPA 1631 E
Mercury, total; Secondary Contact	Cold vapor AA	SM 3112 B
Selenium, total	ICP	EPA 200.7, SM 3120 B
Silver, total	ICP	EPA 200.7, SM 3120 B
Arsenic, dissolved	ICP	SM 3030 B, SM 3120 B
Cadmium, dissolved	ICP	SM 3030 B, SM 3120 B
Chromium, dissolved	ICP	SM 3030 B, SM 3120 B
Copper, dissolved	ICP	SM 3030 B, SM 3120 B
Iron, dissolved	ICP	SM 3030 B, SM 3120 B
Lead, dissolved	ICP	SM 3030 B, SM 3120 B
Mercury, dissolved	Cold vapor AA	SM 3030 B, SM 3112 B
Nickel, dissolved	ICP	SM 3030 B, SM 3120 B
Silver, dissolved	ICP	SM 3030 B, SM 3120 B
Zinc, dissolved	ICP	SM 3030 B, SM 3120 B
Fecal coliform	Membrane	SM 9222 D

TABLE 5 (Continued): ANALYTICAL METHODS

Parameter	Method	Method Reference
n-Hexane extractable materials	Gravimetric	EPA 1664, Rev. A
Gross alpha radioactivity	Gas proportional	SM 7110
Gross beta radioactivity	Gas proportional	SM 7110
Chlorophyll	Colorimetric	SM 10200 H
BETX (Benzene, ethyl Benzene, toluene, xylene)	Purge and trap GC/MS	EPA 624
Organic Priority Pollutants		
Volatile organic compounds	Purge and trap GC/MS	EPA 624
Base/neutral and acid extractable compounds	GC/MS	EPA 625
Pesticides	GC/ECD	EPA 608
PCBs	GC/ECD	EPA 608
Nonylphenols	GC/MS	GCMS004[3]

[1]Calculated from pH, temperature, and ammonia nitrogen.
[2]Trivalent chromium measured as total chromium.
[3]USEPA Region V Method, Revision 1 dated June 6, 2003.

TABLE 6: LABORATORY PRESERVATION AND MAXIMUM HOLDING TIME

Parameter	Laboratory Preservation[1,2]	Maximum Holding Time
Dissolved oxygen (Fixed)	Refrigerate	8 hours
Temperature	NA	0.25 hours
pH	NA	0.25 hours
Ammonia nitrogen	(a) Refrigerate, (b) with H_2SO_4 to pH<2	24 hours, 28 days
Ammonia nitrogen, Un-ionized[3]	NA	NA
Nitrate and nitrite nitrogen	(a) Refrigerate, (b) with H_2SO_4 to pH<2	24 hours, 28 days
Nitrite	Refrigerate	48 hours
Kjeldahl nitrogen	(a) Refrigerate, (b) with H_2SO_4 to pH<2	24 hours, 28 days
Phosphorus, total	(a) Refrigerate, (b) with H_2SO_4 to pH<2	24 hours, 28 days
Sulfate	Refrigerate	28 days
Total dissolved solids	Refrigerate	7 days
Suspended solids	Refrigerate	7 days
Volatile suspended solids	Refrigerate	7 days
Turbidity	Refrigerate, store in dark	48 hours
Alkalinity	Refrigerate	14 days
Chloride	None required	28 days
Fluoride	None required	28 days
Organic carbon, total	Refrigerate, H_2SO_4 to pH<2	28 days
Phenol	Refrigerate, H_2SO_4 to pH<2	28 days
Cyanide, total	Refrigerate, NaOH to pH>12	14 days
Cyanide, chlorine amenable	Refrigerate, NaOH to pH>12	14 days
Chromium, hexavalent	Refrigerate	24 hours
Metals, total (excluding mercury)	HNO_3 to pH<2	6 months
Mercury, total	HNO_3 to pH<2	28 days
Metals, dissolved (excluding mercury)	Filter, HNO_3 to pH<2	6 months
Mercury, dissolved	Filter, Refrigerate, HNO_3 to pH<2	28 days
Fecal coliform	Refrigerate	6 hours

TABLE 6 (Continued): LABORATORY PRESERVATION AND MAXIMUM HOLDING TIME

Parameter	Laboratory Preservation[1,2]	Maximum Holding Time
n-Hexane extractable materials	Refrigerate, H_2SO_4 to pH<2	28 days
Gross alpha radioactivity	HNO_3 to pH<2	None
Gross beta radioactivity	HNO_3 to pH<2	None
Chlorophyll	Refrigerate	30 days
BETX (Benzene, ethyl benzene, toluene, xylene)	Refrigerate	7 days
Organic priority pollutants	Refrigerate	7 days
Nonylphenols	Refrigerate	7 days

NA = Not applicable.
[1]All samples stored in ice after collection and in transport to laboratory. Thermal preservation and chemical field preservation checked at arrival. Field preservation shown in parentheses.
[2]Refrigeration at 4°C.
[3]Calculated from pH, temperature, and ammonia nitrogen.

TABLE 7: RESPONSIBLE LABORATORIES AND METHOD STANDARD OPERATING PROCEDURE IDENTIFICATION

Parameter	Laboratory	Method SOP ID
Dissolved oxygen (Fixed)	Industrial Waste	IW-DO-WINKLER
Temperature	Field measurement	M90 Oper. Instr.
pH	Field measurement	M90 Oper. Instr.
Ammonia nitrogen	Stickney	ST-NH3
Ammonia nitrogen, un-ionized[1]	Calculation	NA
Nitrate and nitrite nitrogen	Stickney	ST-NO3/NO2
Kjeldahl nitrogen	Stickney	ST-TKN
Phosphorus, total	Stickney	ST-TP
Sulfate	Calumet	CaSO4
Total dissolved solids	Stickney	ST-TDS
Suspended solids	Stickney	ST-TSS/VSS
Volatile suspended solids	Stickney	ST-TSS/VSS
Alkalinity	Stickney	ST-Alk
Chloride	Stickney	ST-Cl
Fluoride	Stickney	ST-F
Organic carbon, total	Industrial Waste	IW-TOC
Phenol	Industrial Waste	IW-PHENOL-A
Cyanide, total	Industrial Waste	IW-CN-AUTO
Cyanide, chlorine amenable	Industrial Waste	CN_AM_A
Chromium, hexavalent	Industrial Waste	ST-Cr+6
Metals, total and dissolved (except mercury)	Egan	ST-ICPPE
Mercury, total and dissolved	Calumet	ST-CVAAS
Fecal coliform	Microbiology	
n-Hexane extractable materials	Industrial Waste	IW-FOG-SPE
Gross alpha radioactivity	Contracted Lab	A/B.TSD
Gross beta radioactivity	Contracted Lab	A/B.TSD
Chlorophyll	Aquatic Ecology	
Benzene, ethyl benzene,	Organic Compounds Analytical	SOPEPA624
		toluene, xylene
Organic priority pollutants	Organic Compounds Analytical	SOPEPA624[2] SOPEPA625[3] SOPEPA608[4]
Nonylphenols	Organic Compounds Analytical	GCMS004[5]

[1]Calculated from pH, temperature and ammonia nitrogen.
[2]Volatile organic compounds.
[3]Base/neutral and acid extractable compounds.
[4]Pesticides and PCBs.
[5]USEPA Region V Method, Revision 1 dated June 6, 2003.

AMBIENT WATER QUALITY MONITORING PROJECT
QUALITY ASSURANCE PROJECT PLAN

APPENDIX I

SAMPLING PROCEDURES

WATERWAY SAMPLING
Revision:

Bridge Sampling Procedures

1. Before sample collection day, scrub the stainless steel sampling bucket, stirrers, and DO sampling device with a solution of non-interfering residue-free critical cleaning liquid detergent and water. Rinse with de-ionized water.

2. Only take samples from the upstream side of the bridge with the exception of sampling WW_48, which will be sampled by the District's Pollution Control Boat.

3. Take the samples from a representative location - the center of the river at the deepest point. <u>DO NOT SAMPLE FROM THE BANK OF THE WATERWAY</u>.

4. If boat traffic is encountered when sampling from a navigable body of water, delay sampling until the unnatural turbulence caused by the vessel's wake subsides. Indicate in the "Remarks" section of the sample collection sheet that sampling was interrupted due to a passing vessel.

5. Upon arrival at each prescribed sampling location, the following steps should be followed:

   a. Collect samples routinely collected from pail. See Section A.

   b. Collect DO and bacterial samples with modified DO sampler. See Section B.

   c. When required, collect equipment blanks from pail. See Section C.

   d. When required, collect organics samples from pail. See Section D.

6. Complete the sample collection sheet as appropriate at each sampling location.

   a. Sample collection date.

   b. Sampler's name(s).

   c. Weather conditions during sampling (Example: Clear, Cloudy, Rain, Snow, Air Temperature, if possible).

   d. Type of aliquots obtained.

e. Time aliquots were obtained.

f. Sample pH as obtained with the handheld meter.

g. Sample temperature as obtained with the handheld meter.

h. Sample storage temperature.

i. In the "Remarks" column, describe visual observation of sample (Clear, Semi-Clear, Lt. Sed., etc.), indicate if there was any passing boat traffic and any unusual observations of the waterway quality, such as oil, discoloration, or debris. Also provide the LIMS number.

j. At the bottom of the collection sheet, a space is available for additional remarks.

7. Upon completion of the sampling assignment, immediately transport the samples to the laboratory for analysis.

8. Upon relinquishing the samples to the laboratory analyst record the following pertinent information on the sample collection sheet to complete chain-of-custody requirements (Appendix II).

   a. Signature of transporter.

   b. Signature of the person who relinquished the sample.

   c. Signature of the laboratory analytical staff member who received the sample.

   d. Time sample relinquished.

Section A: Routine Samples Collected in Pail

1. Properly identify (label) each sample container and arrange in order specified on sample trays.

2. Lower the clean stainless steel bucket into the river/stream water. Retrieve the bucket and immediately obtain a pH and temperature reading with the handheld meter.

3. Empty the bucket, lower and retrieve it two more times rinsing thoroughly to acclimate it to the waterway.

4. When sampling during precipitation events (rain or snow), cover the sample bucket at all times with the lid provided, except when the bucket is being raised or lowered from the bridge.

5. Whenever the sampling bucket is being raised or lowered from the bridge, give special attention to insure there is no contact with the bridge structure. If there is contact, discard the sample and start over. Also, make sure that the rope does not come in contact with the ground. Place the rope into the gray, plastic container.

6. Only after acclimating the sampling bucket three times should the actual sample be obtained. After the sample is obtained, stir the sample with the stirring rod 5x in one direction and then 5x in the other direction. Pour it into the individual sample aliquot bottles filling the aliquot bottles half way from right to left. Then stir the sample water in the bucket with the same procedure as above to ensure a homogeneous distribution of suspended solids and finish filling the bottles from left to right.

7. Samples to be collected and order in trays:

   a. General chemistry sample: 1-gallon (wide-mouth plastic) container.

   b. Alkalinity, chloride sample: plastic 250 mL container, fill to shoulder.

   c. Cyanide sample: fill the plastic half-gallon container (containing 5 mL of 10% NaOH preservative) to shoulder.

   d. Phenol sample: fill the glass sample bottle to the shoulder; exercise CAUTION as bottle contains 2 mL sulfuric acid as a preservative. Do not breathe the vapors that may be emitted by the sulfuric acid preservative.

   e. Radiochemistry sample: fill 1 liter plastic bottle to shoulder. Do not overfill.

   f. Dissolved metals sample: fill a 900 mL certified clean, plastic bottle.

   g. Total organic carbon: fill a 500-mL glass bottle.

   h. Trace metals sample: fill 8 oz. plastic bottle. Leave approximately 1/4-inch air space at top of bottle. NOTE: The bottle contains 2 mL of nitric acid. (Overfilling may cause a loss of preservative.)

   i. Sulfate: fill a 250 mL square plastic bottle.

j. Total Phosphorus, Total Kjeldahl Nitrogen: fill a 250 mL plastic bottle to the shoulder; exercise CAUTION as bottle contains 0.3 mL sulfuric acid as a preservative. Do not breathe the vapors that may be emitted by the sulfuric acid preservative

k. Ammonia, NO_2+NO_3, Fluoride: fill a 250 mL plastic bottle to the shoulder.

l. Chlorophyll: fill an opaque, brown 1-liter bottle (obtained from Room LE213). Leave approximately 1/2-inch air space at top of bottle.

m. n-Hexane extractable materials sample: fill two glass quart jars.

8. After all the sample aliquots have been poured-off, rinse the sample bucket and stirring rod with de-ionized water.

9. Place each sample aliquot into the 72-quart thermal ice chest filled from 1/3 to 1/2 full of ice cubes. Insure the sample bottles are surrounded in ice.

Section B: Dissolved Oxygen and Bacterial Samples

The DO sample and bacterial sample are collected at the same time using a DO sampler that has been modified to hold the bacterial sample container. The DO and bacterial samples are collected as follows:

1. The bacterial container is a sterilized 4 oz. plastic bottle with foil covered plastic screw cap. The DO container is a 300-mL glass bottle.

2. Do not open bacterial bottle until sampling, and replace foil covered plastic cap as soon as possible.

3. Care should be taken not to touch the neck or the mouth of the bacterial bottle, or the inside of the plastic cap to prevent contamination of the sample.

4. Do not remove foil from plastic cap.

5. Insert bacterial bottle into the compartment attached to the outside of the DO sampling can making sure not to allow the top of the bottle to touch any part of the sample can.

6. Place a 300-mL DO glass bottle into the special DO sampling device.

7. Slowly lower the DO sampling device with the bacterial bottle and DO bottle into the waterway to the depth of approximately 3 feet from the surface taking care to prevent turbulence and the formation of air bubbles while filling.

8. Raise the sampling device when all the air bubbles have stopped rising.

9. Remove the bacterial bottle from the DO sampling device.

10. Obtain a second bacterial bottle, label, and then remove the foil-covered lid.

11. Care should be taken not to touch the neck or the mouth of the bottle, or the inside of the plastic cap to prevent contamination of the sample.

12. Do not remove foil from plastic cap.

13. Pour the aliquot obtained with the DO sampling device into the second bacterial bottle. Fill the bottle approximately 80 percent full. DO NOT OVERFILL.

14. Place the sample into the cooler on ice.

15. Return the bacterial bottle used to collect the sample to the Microbiology Laboratory.

16. Place the sample into the cooler on ice.

17. Remove the DO bottle. Replace the glass stopper and pour off excess water at the top of the bottle.

18. Remove the glass stopper and add 1 mL of manganous sulfate (use Reagent Dispenser #1). Then, add 1-mL potassium hydroxide – potassium iodide solution (alkali-iodide-azide reagent) (use Reagent Dispenser #2). NOTE: The tips of the Reagent Dispensers, #1 and #2, should be at the surface of the liquid in the DO bottle when the reagents are added. Add reagents slowly, allowing them to run down the inside of the bottle neck, to avoid introducing air into the sample. This prevents the introduction of extraneous oxygen into the sample.

19. Replace the glass stopper on the DO bottle carefully to exclude air bubbles.

20. Rinse the bottle with river water or fresh water, if available.

21. Mix the sample by inverting the bottle several times until dissolution is complete. NOTE: The initial precipitate, manganous hydroxide, combines with the DO in the sample to form manganic hydroxide, a brown precipitate. Place the bottle in an area protected from direct sunlight while precipitate is settling.

22. When the precipitate settles approximately half way in the sample, add 1-ml sulfuric acid (Reagent #3), by removing the glass stopper on the sample bottle and placing the tip of the Reagent Dispenser #3 in the inside neck of the bottle above the level of the sample. This allows the acid to run down the inside of bottleneck, and mix with the sample. Once again, this eliminates the introduction of extraneous oxygen into the sample.

23. Replace the glass stopper on the DO bottle.

24. Rinse the bottle with river water or fresh water if it is available.

25. Mix the sample by inverting bottle several times.

26. Place sample into cooler on ice. (Protect from sunlight.)

27. Complete appropriate entries on sample collection sheet.

Section C: Equipment Blanks. If sampling is occurring at one of the following stations, then equipment blanks must be obtained: WW_78, WW_23, WW_110, WW_36, WW_108, WW_41, and WW_57. Equipment blanks are collected as follows:

1. Properly identify (label) each sample container and arrange in order specified on sample trays.

2. Fill the stainless steel bucket two-thirds full with reagent water obtained from the laboratory.

3. Proceed with the filling of the sample containers as is done in Section A, steps g through i, refilling the bucket as necessary to fill all sample containers.

4. Complete sample collection sheet as appropriate.

Section D: Organics Samples. Organic priority pollutants (OPP), nonylphenol, and BETX (benzene, ethylbenzene, and total xylenes) samples are collected as follows:

1. The amber colored glass containers provided by the OCAL must be used for BETX and OPP/nonylphenols samples. These containers contain a preservative and should not be rinsed prior to filling.

2. OPP/nonylphenol samples require one (1) gallon bottle and three (3) vials per sampling location.

3. BETX samples require three (3) vials per sampling location.

4. Each sampling team will transport a clearly marked, "Trip Blank" sample, consisting of two (2) amber vials filled with Milli-Q de-ionized water, with the other organic samples collected during the sampling trip.

5. Obtain a water sample in the stainless steel pail and fill sample containers.

6. When filling the containers care should be taken to minimize air bubbles in the sample container. Gallons and vials are to be filled to the top with minimal overflow. A slight bulge of water at the neck of the container caused by surface tension should be evident at the time the cap is tightened to insure elimination of excess air.

7. Place samples into cooler on ice.

8. Complete sample collection sheet as appropriate.

9. After transport to the laboratory, store the samples in the laboratory cooler for later transportation to the Organic Compounds Analytical Laboratory by the night transporter.

Section E: Low Level Mercury Samples. Low level Mercury (LLHg) samples and field blanks are collected as follows:

1. Obtain the labeled LLHg sampling kit provided by CAL. The sampling kit contains four pairs of clean gloves, four 40 mL sample vials, two empty 40 mL field blank vials, and three 40 mL field blank vials filled with reagent water.

2. Do not expose the sample to anything that may contain significant amounts of mercury. Potential contamination sources: Sampling equipment, bailers, sampling tubing (including peristaltic pump tubing), gloves, clothing, bottles, exhaled breath from mercury amalgam fillings, precipitation, dirt, dust and airborne vapor.

3. Collect LLHg samples according to the following procedure:

   a. Obtain a water sample in the stainless steel pail.

   b. Sampler #1: Put on clean gloves and sufficient protective clothing to ensure dust and debris is not transferred from the person to the sample.

   c. Sampler #2: Put on clean gloves and sufficient protective clothing to ensure dust and debris is not transferred from the person to the sample. Do not touch anything that may contaminant your gloves.

d. Sampler #1: Set up sampling equipment, open cooler, remove double bagged bottle kit from cooler and its bubble pack bag, open outer bag and hold it open so sampler #2 can reach inside.

e. Sampler #2: Do not touch the outer bag. Open the inner bag, remove one 40 mL vial from the bag, remove the cap and fill with water sample to the top, screw cap onto vial and return filled vial to the innermost bag. There is no need to rinse the bottle or add a preservative. Repeat until 4 vials have been filled from the same sampling point. Close the zip-lock seal most of the way, squeeze the inner bag to expel most of the air, complete the seal, push the inner bag inside the outer bag.

f. Sampler #1: Close the outer bag zip-lock seal most of the way, squeeze the bag to expel most of the air, complete the seal. Place the double-bagged bottle kit in the bubble pack bag, remove the adhesive strip cover and seal the bubble bag closed. Place the kit in the cooler. NOTE: LLHg samples should not be placed on ice.

4. Collect LLHg field blanks according to following procedure:

a. Sampler #1: Put on clean gloves and sufficient protective clothing to ensure dust and debris is not transferred from the person to the sample.

b. Sampler #2: Put on clean gloves and sufficient protective clothing to ensure dust and debris is not transferred from the person to the sample. Do not touch anything that may contaminant your gloves.

c. Sampler #1: Open cooler, remove double bagged kit labeled field blank bottle kit from cooler and its bubble pack bag, apply client label to the outer zip-lock bag, open outer bag and hold it open so the clean hands person can reach inside.

d. Sampler #2: Do not touch the outer bag. Open the inner bag, remove one full 40 mL vial from the bag, and one empty 40 mL vial, remove the caps and pour the reagent water from one vial into the other under the same conditions to which regular samples were exposed, screw caps onto vials and return filled vial to the innermost bag discard the empty vial. There is no need to rinse the bottle or add a preservative. Repeat until 2 vials have been filled. There is an extra filled reagent water vial in case a spill occurs, discard if not needed. Close the zip-lock seal most of the way, squeeze the inner bag to expel most of the air, complete the seal, push the inner bag inside the outer bag.

e. Sampler #1: Close the outer bag zip-lock seal most of the way, squeeze the bag to expel most of the air, complete the seal. Place the double-bagged bottle kit in the bubble pack bag, remove the adhesive strip cover and seal the bubble bag closed. Place the kit in the cooler. NOTE: LLHg field blanks should not be placed on ice.

5. Complete Sample collection sheet as appropriate.

Materials Required for Sampling

1. Labels - Electronically generated adhesive backed labels with identifying LIMS barcode.

2. Bottles (per station, note: an equipment blank will require an additional set of sample containers a through l).

   a. Gallon (polyethylene) – General chemistry.

   b. 250-mL rectangular (polyethylene) – Alkalinity, chloride.

   c. 1/2 Gallon (polyethylene) – Cyanide.

   d. Quart (glass) – Phenol.

   e. Quart (polyethylene) – Radiochemistry.

   f. 900 mL (polyethylene – certified clean) – Dissolved metals.

   g. 500-mL (glass) – Total organic carbon.

   h. 8 oz. (polyethylene) – Trace metals (total).

   i. 250-mL rectangular (polyethylene) – Sulfate.

   j. Two quarts (glass) – n-Hexane extractable materials (2).

   k. 250-mL rectangular (polyethylene) – Ammonia, NO2 + NO3, Fluoride.

   l. 250-mL rectangular (polyethylene) - Total Phosphorus, Total Kjeldahl Nitrogen

m. Mercury Kit (General Use waters only; see Appendix I, Section E).

n. 1 liter brown, opaque (plastic) – Chlorophyll.

o. Two 4 oz. (polypropylene w/foil covered stopper) – Fecal coliform.

p. 300 mL (narrow-mouth glass w/ ground glass stopper) – Dissolved oxygen.

q. Three 40-mL vials (amber colored glass) – BETX.

r. Three 40-mL vials (amber colored glass); and 1 gallon (glass) – Organic priority pollutants and nonylphenols.

3. Sampling Devices.

a. 13 quart stainless steel bucket and lid.

b. Stainless steel DO sampling device equipped with a lid and a fill tube that extends into the glass 300 mL DO sample bottle stopping just below the bottom. This device is designed to bleed sample into the bottle through the tube and the bottle is filled to overflowing inside the device to prevent turbulence and the formation of air bubbles while filling. Attached to this device is a stainless steel holder for a bacti-bottle.

c. Portable handheld electronic pH and temperature meter.

d. Sufficient length of 3/8-inch nylon rope (approximately 100 feet).

4. Miscellaneous.

a. Waterway Field Collection Sheet, for locations to be sampled.

b. 72-quart ice chests as needed.

c. Ice.

d. DO reagents.

e. Gray plastic container for storage of sampling rope during sampling events.

f. Wood tray to hold sample bottles with each compartment labeled with name of the sample bottle in the order the aliquot will be poured off.

g. Stainless steel stirring rod.

h. Two carboys of reagent water provided by the SAL.

Safety

1. DO NOT park District vehicle on a bridge. Attempt off-road parking, if possible.

2. Use rotating lights on the vehicle when stopped.

3. When parking on the road, use safety cone markers.

4. Wear red warning vests and life vests.

5. Wear gloves and eye protection when handling DO reagents. Do not allow reagents to come into contact with each other outside of the DO bottle since they are extremely reactive.

6. When sampling during winter months, do not attempt to sample if the waterway is frozen. Do not walk on the ice. Indicate the circumstances on the sample collection sheet.

AMBIENT WATER QUALITY MONITORING PROJECT
QUALITY ASSURANCE PROJECT PLAN

APPENDIX II

SAMPLE COLLECTION SHEET

(Week number)

(Watershed Name)

DATE COLLECTED: ____________ COLLECTED BY: ____________ WEATHER: ____________

DATA CODE	LOCATION	TIME	TEMPERATURE	GEN. CHEM. (gallon)	F.O.G. (glass quart x2)	ALK / CL (250mL plas)	CYN. (1/2 gallon)	PHEN. (glass quart)	T.M. (8oz cylinder preserved x2)	SOL. T.M. (500mL)	BACT (4oz w/ foil x2)	D.O. (300mL w/ glass stopper)	RAD. (quart)	TOC (500mL glass)	PRIORTIY POLL. (amber gallon O-NP, 40mL vials x3 BETX)	SO4 (250mL rectangular)	CHLOROPHYLL. a (1L opaque brown)	LACHAT (250mL rect. 250mL preserved rect.)	LOW LEVEL HG (LLHg Kit)	pH	REMARKS
																				6.5-9.0	LIMS#
																				6.5-9.0	LIMS#
	EQUIPMENT BLANK																				LIMS#
																				6.5-9.0	LIMS #
																				6.5-9.0	LIMS #
																				6.5-9.0	LIMS #

STORED AT 4°C YES ______ NO ______

TRANSPORTED BY: ____________

RELINQUISHED BY: ____________

RECEIVED BY LABORATORY: ____________

RELINQUISHED BY SAL LAB: ____________

IN CUSTODY OF ____________

DATE: ________ TIME: ________

DATE: ________ TIME: ________

RECEIVED BY CAL LAB: ____________

METER # ____________

VEHICLE # ____________

ATTACHMENT A: LABORATORY REPORTING LIMITS AND ILLINOIS POLLUTION CONTROL BOARD MINIMUM MEASUREMENT CRITERIA

Parameter	Reporting Limit (RL)	Minimum Measurement Criteria
Dissolved oxygen	NA	0.1 mg/L[1]
Temperature	NA	0.1 degree C[1]
pH	NA	0.1 pH unit[1]
Ammonia nitrogen	0.1 mg/L	15.0 mg/L
Ammonia nitrogen, un-ionized[2]	NA	0.1 mg/L[3]
Nitrate and nitrite nitrogen	0.15 mg/L	No standard
Kjeldahl nitrogen	1 mg/L	No standard
Phosphorus, total	0.2 mg/L	No standard
Sulfate	5 mg/L	500 mg/L
Total dissolved solids	60 mg/L	No standard
Suspended solids	4 mg/L	No standard
Volatile suspended solids	NA	No standard
Alkalinity	10 mg/L	No standard
Chloride	10 mg/L	500 mg/L
Fluoride	0.1 mg/L	10 mg/L[4]
Organic carbon, total	1 mg/L	No standard
Phenol	0.005 mg/L	0.1 mg/L
Cyanide, total	0.005 mg/L	0.1 mg/L[3]
Cyanide, chlorine amenable	0.001 mg/L	0.022 mg/L
Arsenic, total	0.02 mg/L	0.36 mg/L
Barium, total	0.004 mg/L	5.0 mg/L
Boron, total	0.05 mg/L	40.1 mg/L
Calcium, total	1 mg/L	No standard
Chromium, trivalent[5]	0.005 mg/L	1.0 mg/L[3]
Chromium, hexavalent	6 µg/L	0.016 mg/L
Magnesium, total	1 mg/L	No standard

ATTACHMENT A: (Continued): LABORATORY REPORTING LIMITS AND ILLINOIS POLLUTION CONTROL BOARD MINIMUM MEASUREMENT CRITERIA

Parameter	Reporting Limit (RL)	Minimum Measurement Criteria
Manganese, total	0.001 mg/L	1.0 mg/L[3]
Mercury, total	0.0002 mg/L	0.0006 mg/L[3]
Selenium, total	0.005 mg/L	1.0 mg/L
Silver, total	0.001 mg/L	0.005 mg/L
Arsenic, dissolved	0.02 mg/L	No standard
Cadmium, dissolved	0.001 mg/L	0.009 mg/L[4]
Chromium, dissolved	0.005 mg/L	0.55 mg/L[4]
Copper, dissolved	0.005 mg/L	0.017 mg/L[4]
Iron, dissolved	0.1 mg/L	0.5 mg/L[3]
Lead, dissolved	0.02 mg/L	0.076 mg/L[4]
Mercury, dissolved	0.0002 mg/L	0.0022 mg/L
Nickel, dissolved	0.005 mg/L	0.08 mg/L[4]
Silver, dissolved	0.001 mg/L	No standard
Zinc, dissolved	0.01 mg/L	0.12 mg/L[4]
Fecal coliform	10 cfu/100 mL	200 cfu/100 mL
n-Hexane extractable materials	3 mg/L	15 mg/L[3]
Gross alpha radioactivity	3 pCi/L[6]	No standard
Gross beta radioactivity	4 pCi/L[6]	100 pCi/L
Chlorophyll	1 µg/L	No standard
Benzene	2 µg/L	310 µg/L
Ethyl benzene	2 µg/L	150 µg/L
Toluene	2 µg/L	2,000 µg/L

ATTACHMENT A: (Continued): LABORATORY REPORTING LIMITS AND ILLINOIS POLLUTION CONTROL BOARD MINIMUM MEASUREMENT CRITERIA

Parameter	Reporting Limit (RL)	Minimum Measurement Criteria
Xylene	3 µg/L	920 µg/L[7]
Organic priority pollutants[8]	Variable[9]	No standards
Nonylphenols	5 µg/L	No standard

NA = Not applicable.
[1]Required sensitivity.
[2]Calculated from pH, temperature, and ammonia nitrogen. Significant figures for pH, temperature, and ammonia nitrogen allow calculation to 0.01 mg/L.
[3]Secondary contact water quality standard.
[4]Calculated standard based on a minimum water hardness of 100 mg/L as $CaCO_3$.
[5]Trivalent chromium measured as total chromium.
[6] RL varies with total solids concentration of the sample
[7]Human Health Standard
[8]Organic priority pollutants are identified in 40 CFR Part 122, Appendix D, Table II as amended.
[9]The RLs will be provided in the data report.

ATTACHMENT B: SAMPLING FREQUENCY

Station	Description	General Sampling[1]	n-Hexane Extractable Materials	Radio-Activity	BETX[2]	OPPs	Nonyl-phenols
96	Albany Avenue, North Branch Chicago River	Monthly 2nd Mon.		Monthly 2nd Mon.	Bi-monthly	Semi-annually	
112	Dempster Street, North Shore Channel	Monthly 2nd Mon.	Monthly 2nd Mon.	Monthly 2nd Mon.	Bi-monthly	Semi-annually	Quarterly
36	Touhy Avenue, North Shore Channel	Monthly 2nd Mon.	Monthly 2nd Mon.	Monthly 2nd Mon.	Bi-monthly	Semi-annually	Quarterly
73	Diversey Parkway, North Branch Chicago River	Monthly 2nd Mon.	Monthly 2nd Mon.		Bi-monthly	Semi-annually	
100	Wells Street, Chicago River	Monthly 3rd Mon.		Monthly 3rd Mon.	Bi-monthly	Semi-annually	
108	Loomis Street, South Branch Chicago River	Monthly 3rd Mon.	Monthly 3rd Mon.		Bi-monthly	Semi-annually	
99	Archer Avenue, South Fork South Branch Chicago River	Monthly 3rd Mon.	Monthly 3rd Mon.		Bi-monthly	Semi-annually	
75	Cicero Avenue, Chicago Sanitary & Ship Canal	Monthly 3rd Mon.	Monthly 3rd Mon.	Monthly 3rd Mon.	Bi-monthly	Semi-annually	Bimonthly
41	Harlem Avenue, Chicago Sanitary & Ship Canal	Monthly 3rd Mon.	Monthly 3rd Mon.	Monthly 3rd Mon.	Bi-monthly	Semi-annually	Bimonthly
48	Stephen Street, Chicago Sanitary & Ship Canal	Monthly 3rd Mon.	Monthly 3rd Mon.		Bi-monthly	Semi-annually	Quarterly
92	Lockport Powerhouse Chicago Sanitary & Ship Canal	Weekly Every Mon.	Monthly 3rd Mon.	Monthly 3rd Mon.	Bi-monthly	Semi-annually	Bimonthly

ATTACHMENT B (Continued): SAMPLING FREQUENCY

Station	Description	General Sampling[1]	n-Hexane Extractable Materials	Radio-Activity	BETX[2]	OPPs	Nonyl-phenols
86	Burnham Avenue, Grand Calumet River	Monthly 4th Mon.	Monthly 4th Mon.	Monthly 4th Mon.	Bi-monthly	Semi-annually	
56	Indiana Avenue, Little Calumet River	Monthly 4th Mon.	Monthly 4th Mon.	Monthly 4th Mon.	Bi-monthly	Semi-annually	Quarterly
76	Halsted Street, Little Calumet River	Monthly 4th Mon.	Monthly 4th Mon.	Monthly 4th Mon.	Bi-monthly	Semi-annually	Quarterly
57	Ashland Avenue, Little Calumet River	Monthly 4th Mon.		Monthly 4th Mon.	Bi-monthly	Semi-annually	
59	Cicero Avenue, Calumet-Sag Channel	Monthly 4th Mon.	Monthly 4th Mon.		Bi-monthly	Semi-annually	Quarterly
43	Route 83, Calumet-Sag Channel	Monthly 4th Mon.	Monthly 4th Mon.		Bi-monthly	Semi-annually	
19	Belmont Avenue, Des Plaines River	Monthly 1st Mon.		Monthly 1st Mon.	Bi-monthly	Semi-annually	
22	Ogden Avenue, Des Plaines River	Monthly 1st Mon.		Monthly 1st Mon.	Bi-monthly	Semi-annually	Quarterly
23	Willow Springs Road, Des Plaines River	Monthly 1st Mon.		Monthly 1st Mon.	Bi-monthly	Semi-annually	
91	Material Service Road, Des Plaines River	Monthly 1st Mon.		Monthly 1st Mon.	Bi-monthly	Semi-annually	
110	Springinsguth Road, West Branch DuPage River	Monthly 1st Mon.		Monthly 1st Mon.	Bi-monthly	Semi-annually	

ATTACHMENT B (Continued): SAMPLING FREQUENCY

Station	Description	General Sampling[1]	n-Hexane Extractable Materials	Radio-Activity	BETX2	OPPs	Nonyl-phenols
111	Arlington Drive, West Branch DuPage River	Monthly 1st Mon.		Monthly 1st Mon.	Bi-monthly	Semi-annually	Quarterly
79	Higgins Road, Salt Creek	Monthly 1st Mon.		Monthly 1st Mon.	Bi-monthly	Semi-annually	Quarterly
18	Devon Avenue, Salt Creek	Monthly 1st Mon.		Monthly 1st Mon.	Bi-monthly	Semi-annually	
109	Brookfield Avenue, Salt Creek	Monthly 1st Mon.		Monthly 1st Mon.	Bi-monthly	Semi-annually	
77	Elmhurst Road, Higgins Creek	Monthly 1st Mon.		Monthly 1st Mon.	Bi-monthly	Semi-annually	Bimonthly
78	Wille Road, Higgins Creek	Monthly 1st Mon.		Monthly 1st Mon.	Bi-monthly	Semi-annually	Bimonthly

[1]The parameters included in the general sampling performed monthly include temperature, pH, dissolved oxygen, fecal coliform, total metals, soluble metals, hexavalent chromium, ammonia nitrogen, combined nitrate and nitrite nitrogen, Kjeldahl nitrogen, total phosphorus, total cyanide, cyanide amenable to chlorination, phenol, alkalinity, chloride, fluoride, turbidity, total dissolved solids, total suspended solids, total organic carbon, and chlorophyll. General sampling excluded oil and grease, radioactivity, E.Coli, BETX, priority organics, and nonylphenol.

[2]BETX is the sum of benzene, ethyl benzene, toluene, and xylene.

APPENDIX 3B

CONTINUOUS DISSOLVED OXYGEN MONITORING PROGRAM – QUALITY ASSURANCE PROJECT PLAN

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 4/4/11

Thomas Granato
Acting Director of Monitoring and Research

Date 3/23/11

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

Date 3/21/11

John McNamara
Quality Assurance Coordinator
Monitoring and Research

A2: TABLE OF CONTENTS

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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)

Project Manager
(Project planning, staffing, execution and reporting)

QA Officer
(Project QA/QC, review of QAPP)

Network Coordinator
(Coordination of project activities, review of M&R reports, review of monitoring data, preparation of QAPP, provide data to IEPA)

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)

Environmental Monitoring Manager
Aquatic Ecology and Water Quality Section (AEWQ)
(Troubleshoot database issues, prepare M&R annual reports, and supervise data review)

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.)

FIGURE 2: CURRENTLY ACTIVE CONTINUOUS DISSOLVED OXYGEN MONITORING STATIONS

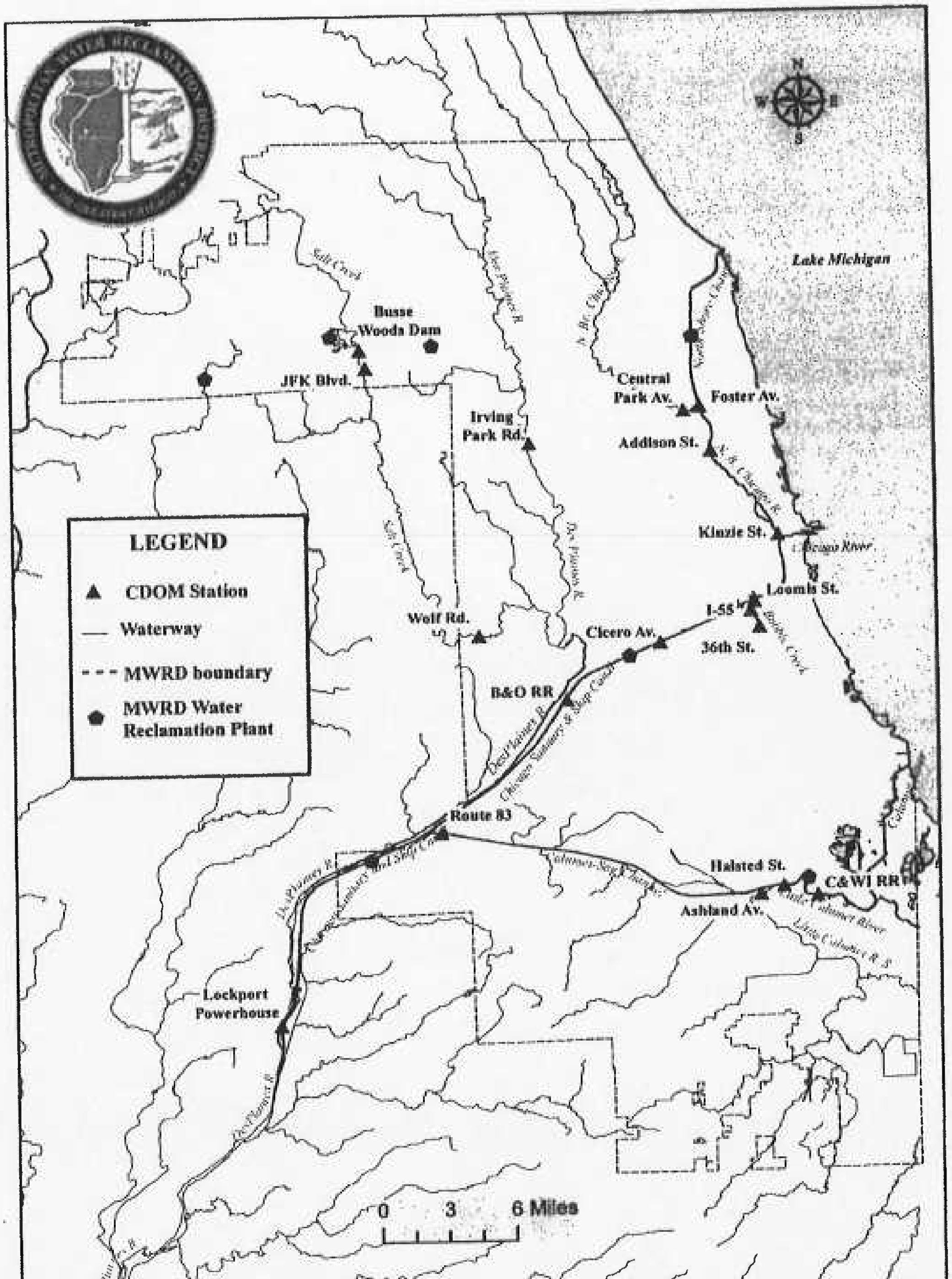


TABLE 1: SAMPLING HISTORY AT EACH MONITORING LOCATION

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)			Percent of DO Values Above Standard
				Min	Max	Mean	
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

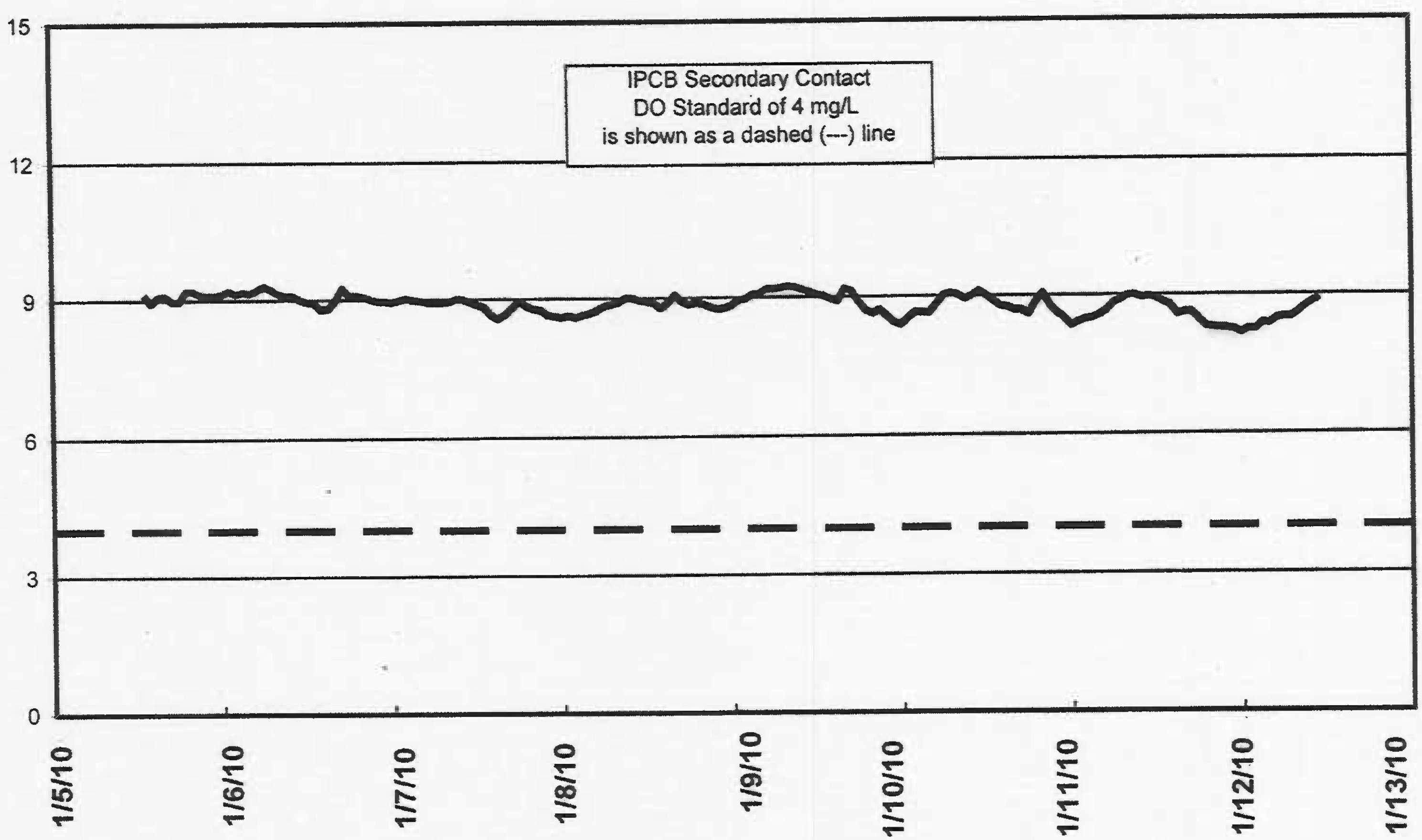


TABLE 3: ILLINOIS POLLUTION CONTROL BOARD USE CLASSIFICATION AND DISSOLVED OXYGEN STANDARD AT EACH MONITORING LOCATION

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)			Percent of DO Values Above Standard
				Min	Max	Mean	
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

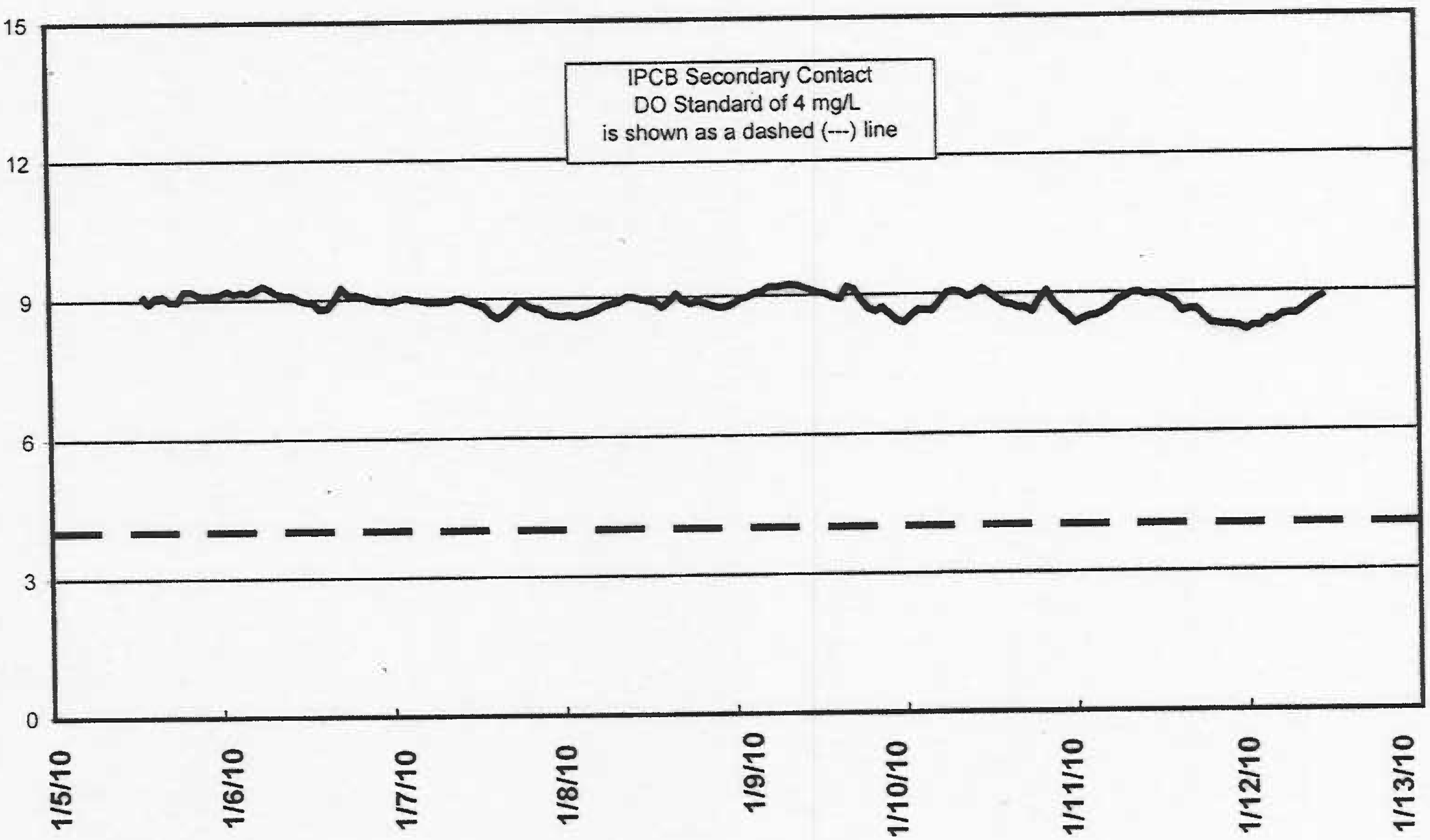
[1]Parameter was measured hourly using a YSI Model 6920 or Model 6600 continuous water quality monitor.

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



APPENDIX 3C

NBPS AND 95TH STREET PUMP STATION SAMPLING PROTOCOLS

PROTOCOL FOR SAMPLING
NORTH BRANCH PUMPING STATION
(NPDES PERMIT REQUIREMENTS)

Purpose of Sampling Program

As part of its National Pollutant Discharge Elimination System (NPDES) permit for the O'Brien Water Reclamation Plant (OWRP), the Metropolitan Water Reclamation District of Greater Chicago (District) is required to sample all discharges from the North Branch Pumping Station (NBPS) into the North Branch of the Chicago River.

Personnel from the Industrial Waste Division (IWD) North Office will be assigned to sample these discharges.

Program Start Date and Duration

This program will commence March 1, 2002 and continue, year round, until further notice.

Notification of a Sampling Event

Upon activation of the first storm pump at NBPS, the OWRP Operating Engineer will notify the Systems Dispatcher. The Systems Dispatcher will notify the Area Supervisor, or his designee, who will assign IWD-North personnel to sample the NBPS.

NBPS Sampling Point

A District Medeco key must be taken from the North office key box to gain entry to the NBPS.

Samples will be obtained from the automatic sampler unit located at the south wall of the lower level of the NBPS building.

A silent intrusion alarm will be activated upon entry to NBPS. Contact the OWRP Operating Engineer at (847) 568-8380 or –8381 (x88380 or x88381) to identify the sampling crew and your purpose at the NBPS.

Upon arrival, the automatic sampler tubing is to be purged for at least 20 seconds. Sample is to be pumped through the sampling unit into a waste bucket and then the line is to be purged again for at least 30 seconds. The NPDES sample will then be pulled through the sampling unit and into the sample bottle.

PROTOCOL FOR SAMPLING
NORTH BRANCH PUMPING STATION
(NPDES PERMIT REQUIREMENTS)

Samples Obtained

Sampling consists of a single, one-gallon grab for general chemistry. The sample must *not be obtained any earlier than 30 minutes*, or later than 2 hours, after activation of the first storm pump.

One sample will be collected for each 24-hour period of an event. If an event continues for more than 24 hours, an additional sample will be obtained to document the next 24-hour period of the event. Subsequent sampling will be conducted as close to the start of each 24-hour period as practical.

Information regarding this sample will be recorded on a standard IWD grab logsheet, a copy of which is attached.

LIMS

The sample will be identified with a LIMS label. The label is created via use of option "$TLS" (Create Sample Using Template). The NBPS template is identified as "NPD-NBPS."

Sample Analyses

Monitoring and Research (M&R) Analytical Laboratory Division personnel at the Lue-Hing R&D Complex will report the sample results for BOD5 and SS to the Technical Services Section for permit reporting purposes.

Report Completion of Sampling

Prior to departing the NBPS, notify the OWRP Operating Engineer (telephone number listed above) and advise that the NPDES sample has been obtained and to reset the intrusion alarm upon departure of the sampling crew.

Sample Transport

The sample must be refrigerated until it is received at the Lue-Hing R&D Complex Analytical Laboratories. The sample must arrive within 24 hours of collection.

PROTOCOL FOR SAMPLING
NORTH BRANCH PUMPING STATION
(NPDES PERMIT REQUIREMENTS)

Reporting

Submit the completed sample logsheet to the Area Supervisor. Following each event, the Area Supervisor will send an e-mail to the Field Services Section Supervisor indicating the date/time/location of the samples obtained.

Program Number

All costs associated with this sampling program shall be documented under Program Number 4681—Assistance to M&O Department.

Prepared by Frank Kody, PCO III, 3/18/02. Rev 5/10/05, 11/3/05, 4/14/06, MPB, 9/23/13, GY

PROTOCOL FOR SAMPLING THE
95TH STREET PUMPING STATION
(NPDES PERMIT REQUIREMENTS)

Purpose of Sampling Program

As part of the NPDES permit for the Calumet Plant (CWRP), the District must sample all discharges from the 95th Street Pumping Station (95SPS) into the Howard Slip on the Calumet River.

Personnel from the IWD-South Office will be assigned to sample this discharge.

Notification of a Sampling Event

Upon activation of the first storm pump at the 95SPS, the CWRP Operating Engineer will notify the Systems Dispatcher. The Systems Dispatcher will notify the Area Supervisor, or his designee, who will assign IWD-South personnel to sample the 95SPS.

95SPS Sampling Point

Samples will be obtained from the 95SPS pump discharge well. The floor of the men's washroom and the adjacent room to the west at the 95SPS forms the ceiling over the discharge well. Access for sampling the channel is provided by a marked 18-inch square, hinged cover in the floor at the southeast corner of the described room west of the men's washroom. The area is located between 2 large (approx. 24-inch diameter) curved pump discharge pipes on the east wall of the room.

A CWRP Operating Engineer will staff the 95SPS whenever the pumps are activated. If the Operating Engineer is not available, access to the pump station is achieved by using a District hydraulic key. A silent intrusion alarm will be activated upon entry to the 95SPS if it is unmanned. Contact the CWRP Operating Engineer at (773) 256-3540 or -3539 (x63540 or x63539) to identify the sampling crew and your purpose at 95SPS.

Samples Obtained

Sampling consists of a single, one-gallon grab for general chemistry. The sample must not be obtained within the first 30 minutes of pumping or later than 2 hours after the pumps have been activated. A single sample will be collected for each pumping event; if a single pumping event continues from one day to the next, one sample will be obtained for each day of the event.

Information regarding this sample will be recorded on a standard IWD grab logsheet, a copy of which is attached. The logsheet must contain the temperature (deg C) and pH of each sample obtained.

LIMS

The sample will be identified with a LIMS label. The label is created via use of option "$TLS" (Create Sample Using Template). The 95SPS template is identified as "NPD-95PS", the sampling point in LIMS is designated "NPD-95PS", and the test schedule is NPD-PS.

Sampling Analyses

The sample will be analyzed for BOD5 and SS. R & D Laboratory personnel at the Stickney Plant will report the sample results to M&O for permit reporting purposes.

Report Completion of Sampling

Prior to departing the 95SPS, notify the CWRP Operating Engineer on duty at the pump station (or telephone number listed above) and advise that the NPDES permit sample has been obtained. Ask to reset the intrusion alarm upon departure of the sampling crew, if the station was unmanned during the sampling event.

Sample Transport

The sample must be packed on ice and/or refrigerated until it is received at the Cecil Lue-Hing Research and Development Complex Analytical Laboratories. The sample must arrive within 24 hours of collection.

Reporting

Submit the completed sample logsheet to the Area Supervisor. Following each event, the Area Supervisor, or his/her designee, will send an email to the Field Operations Supervisor indicating the date/time/location of the samples obtained.

Program Number

All costs associated with this sampling program shall be documented under Program Number 4681—Assistance to M&O Department.

APPENDIX 3D

LAKE MICHIGAN BACKFLOW SAMPLING PROTOCOLS

95th STREET BACKFLOW PROCEDURES
(APPENDIX 3D)

A backflow from the Calumet River into Lake Michigan occurs when the pumps at the 95th Street Pumping Station are activated. The Field Services Section will receive a call from the Systems Dispatcher when the pumping begins. The pumps discharge into the Howard Slip on the river. Samples are obtained upstream of Howard Slip at the Ewing Avenue Bridge and downstream at the 95th Street Bridge.

One general chemistry grab sample and one bacteria (*E. coli* or fecal coliform) sample will be collected within 24 hours of the onset of the backflow. The temperature (°C) must be taken and logged for each sample obtained. Bacteria samples need to be transported to the Stickney Microbiology Laboratory as soon as possible (i.e., within 6 hours.)

I. Samples will be collected from the following sample points during the backflow; contact the Systems Dispatcher by radio to determine when the pumps have been deactivated. Follow the latest bacteriological sampling procedures. The first sample to be collected with a backflow event for the season should include a field blank.

Ewing Avenue Bridge—LD-CALHBR1

95th Street Bridge—LD-CALHBR2

II. One post-backflow bacteria sample will be collected by land-based crews within 24 hours of the cessation of the backflow at the following locations, which are highlighted on the attached map (Figure 4D.4): (Note: These samples will only be collected during the Chicago Park District's Beach Recreation Season: Memorial Day through Labor Day).

Rainbow Beach—LD-CALHBR5

Calumet Beach—LD-CALHBR4

Iroquois Landing—LD-CALHBR3

These samples are to be collected at "mid-beach" locations, 10' to 20' from the water's edge at a 1' to 2' depth. Iroquois Landing samples should be collected at the south edge of the mouth of the Calumet River at the Lake, as there is no "beach" at this location.

IWD personnel performing backflow sampling should work in teams of two at each bridge. The Microbiology Laboratory at 8-3637 should be contacted and notified of the number of bacteria samples that will be delivered. Consult the latest storm event call-out listing of Environmental Monitoring and Research Division personnel and the Microbiology Laboratory personnel for available personnel. If no one is present in the Microbiology Laboratory (LC243 – LC245) to receive bacteria samples, they should be stored in the laboratory refrigerator with a copy of the LIMS receipts and sample logs.

This updated sampling plan calls for conducting sampling during the regular working periods, i.e. Monday through Friday between the hours of 7:00 a.m. and 3:30 p.m. except for holidays. For holiday, weekend or late night storm related backflow, the sampling will be scheduled on the following regular work day.

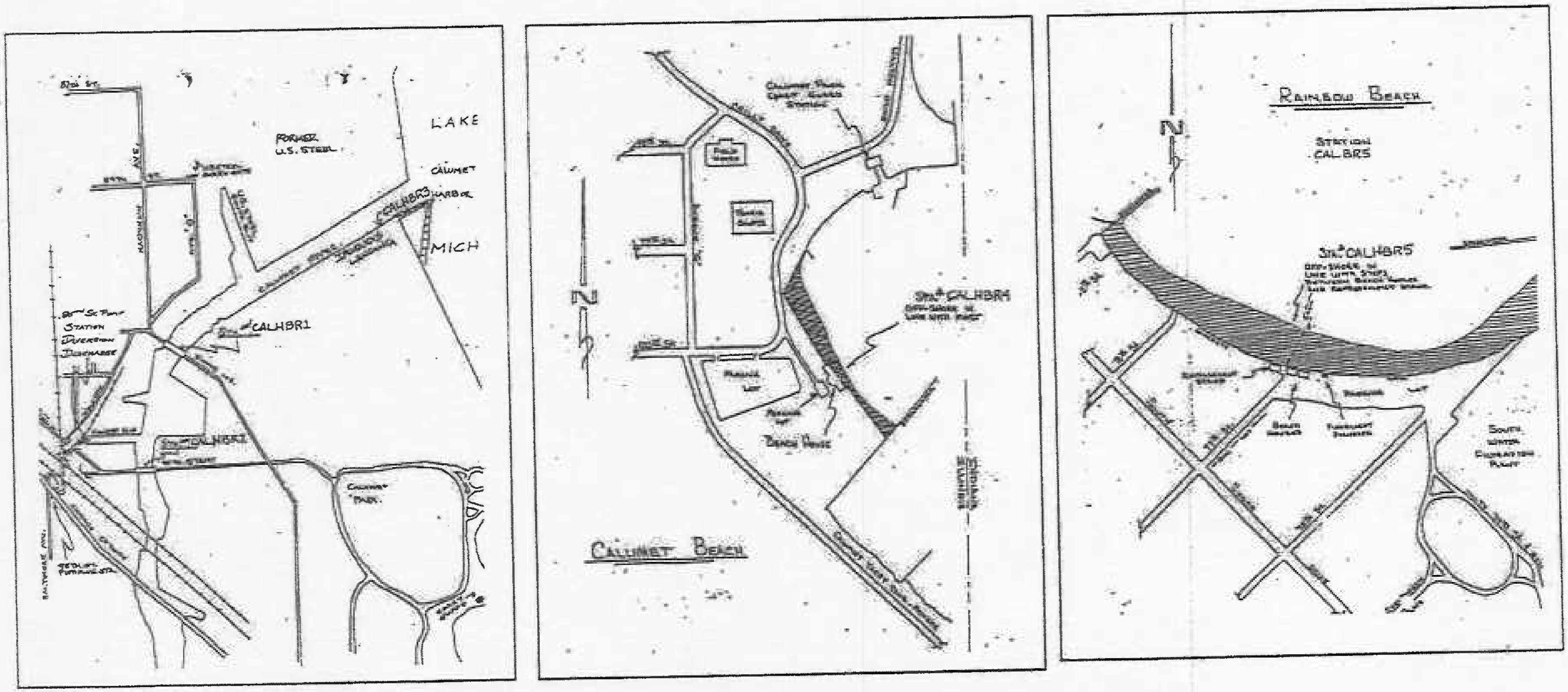
LIMS labels and receipts:

Use this procedure to create labels for backflow and post-backflow samples.

- Log into Sample Manager (LIMS)
- At the top tool bar, click on the "Samples" tab
- Place cursor over "Login," then over "Template" and click
- In the "Samples Logged In" window, type "**LD-CAL**" in the "Sample Template" box
- Enter the number of samples needed to be logged in the "Repeat Count" box
- Click on the "Login…" button
- Fill in the appropriate field for the sample point, collector's name, sample ID, time collected, etc. The test schedules for the bridges are **RIV-DIV** *(General Chemistry and Bacteriology)* and **LAKE-DIVO**). The test schedule for the beaches is **LAKE-DIVFC** *(Bacteriology sample.)* Samples will print out automatically
- To print a receipt, go to Sample Manager main page. At the top tool bar, click on the "MWRDGC" tab. Then place cursor over "IWD," then "Field Office," then click on "Print Sample Receipt." Enter the dates and your name, and click in the drop down box for "sample schedule" to indicate "yes" you wish a sample receipt.

A report must be submitted to the Assistant Directors of Monitoring and Research by the Area Supervisor, or their designee, within two weeks following backflow and post-backflow sampling. It must contain a brief summary narrative, event chronology, and sampling log sheets.

FIGURE 3D.4: CALUMET RIVER BACKFLOW TO LAKE MICHIGAN SAMPLING LOCATIONS



CHICAGO RIVER BACKFLOW PROCEDURES
(APPENDIX 3D)

When the Field Services Section receives a call from the Systems Dispatcher that backflow to Lake Michigan at the Chicago River Controlling Works has commenced, one general chemistry and one bacteria (fecal coliform or *E. coli*) sample will be collected from the lakeside backflow sampling points within 24 hours. Bacteria samples need to be transported to the Stickney Microbiology Laboratory as soon as possible (i.e., within 6 hours). Transporter personnel must be ready to pick up samples and transport them to the laboratory. Within 24 hours of the cessation of backflow, one bacteria sample will be collected from nearby beaches by land-based crews to identify the extent of bacterial contamination and pollution that were caused by the backflow event. Record collection time and temperature (°C) of all samples on the log sheet.

I. Samples will be collected from the following locations during the backflow; as shown in Figure 4D.1; contact Systems Dispatcher to determine which gates are being used. The first sample to be collected with a backflow event for the season should include a field blank. Follow the latest bacteriological sampling procedure.

DuSable Harbor Sluice Gates -- CHGHBR1

This site is accessed by entering the Chicago Yacht Club at Lake Shore Drive and Monroe Street and driving north along the lakeside bike path. The sluice gates and gatehouse are approximately 1/4 mile north of Randolph Street and the Columbia Yacht Club and are adjacent to the path. Park vehicle on the sluice gate walkway.

Inner Harbor Sluice Gates -- CHGHBRH

This site is accessed by driving east on Illinois Street from Lake Shore Drive and then turning right on Streeter Drive. Pass through two (2) gates with intercoms before reaching the sluice gates and gatehouse.

II. Post-backflow samples will be collected by land-based crews within 24 hours after the backflow ends at the following locations, which are highlighted on the attached map (Figure 4D.2): (Note: These samples will only be collected during Chicago Park District's Beach Recreation Season: Memorial Day to Labor Day).

North Avenue Beach -- CHGHBR3
Oak Street Beach -- CHGHBR4
Monroe Harbor -- CHGHBR5
12th Street Beach (Adler Planetarium) -- CHGHBR6
31st Street Beach -- CHGHBR7

These samples are to be collected at "mid-beach" locations, 10' to 20' from the water's edge at a 1' to 2' depth. Monroe Harbor samples should be collected at the east edge of the harbor bike path, as there is no "beach" at this location.

III. If reverse backflow (returning lake water to the river) occurs, samples should be collected on the opposite side of the gatehouse walkway from which backflow samples are collected. Samples to be collected are identical to the backflow sampling. Sample locations, however, are now designated CHGHBRR (DuSable) and CHGHBRB (Inner). Reverse backflow conditions can be obtained from the Systems Dispatcher.

IWD personnel performing backflow sampling should work in teams of two at each sluice gate site. Life vests must be worn while sampling. Four are stored in the padlocked green box in the IWD sampling room and more are available in the storeroom. The key to the life vest storage box is hanging in the key box (key #R39) in Room IWD 213-B. Contact the Microbiology Laboratory at 8-3637 and notify them of the number of bacteria samples to be delivered. Consult the latest storm event call-out listing of Environmental Monitoring and Research Division personnel for available personnel. If no one is in the Microbiology Laboratory (LC243 – LC245) to receive bacteria samples, store them in the laboratory refrigerator and leave a copy of the LIMS receipts and sample logs.

LIMS Labels/Receipts:

Refer to LIMS procedures to generate the proper labels and receipts.

This updated sampling plan calls for conducting sampling during the regular working periods, i.e. Monday through Friday between the hours of 7:00 a.m. and 3:30 p.m. except for holidays. For any holiday, weekend or late night storm related backflow, the sampling will be scheduled on the following regular work day.

A report must be submitted to the Assistant Directors of Monitoring and Research by the Area Supervisor, or their designee, within two weeks following backflow and post-backflow sampling. It must contain a brief summary narrative, event chronology, and sampling log sheets.

FIGURE 3D.1: CHICAGO RIVER BACKFLOW TO LAKE MICHIGAN SAMPLING LOCATIONS

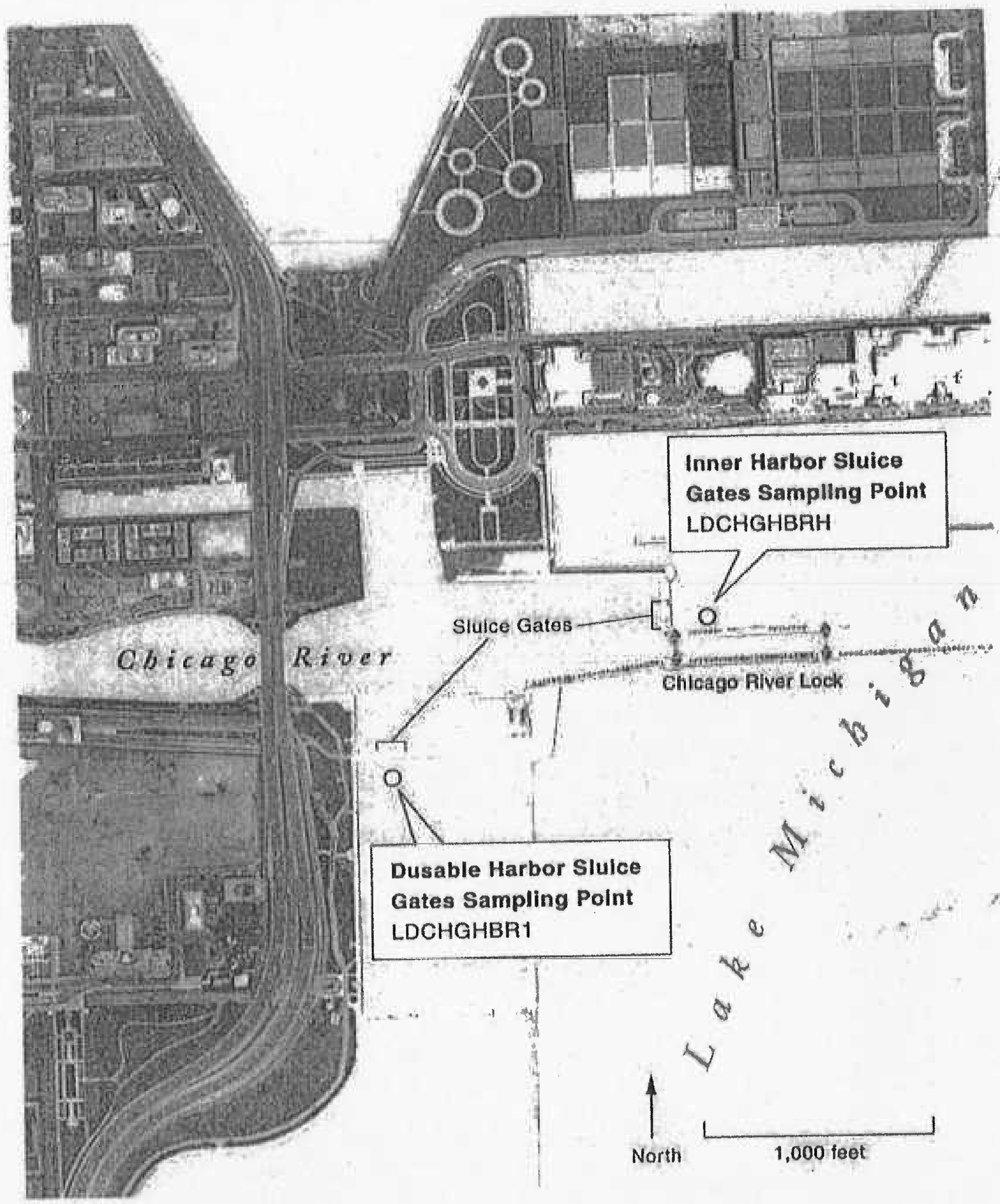
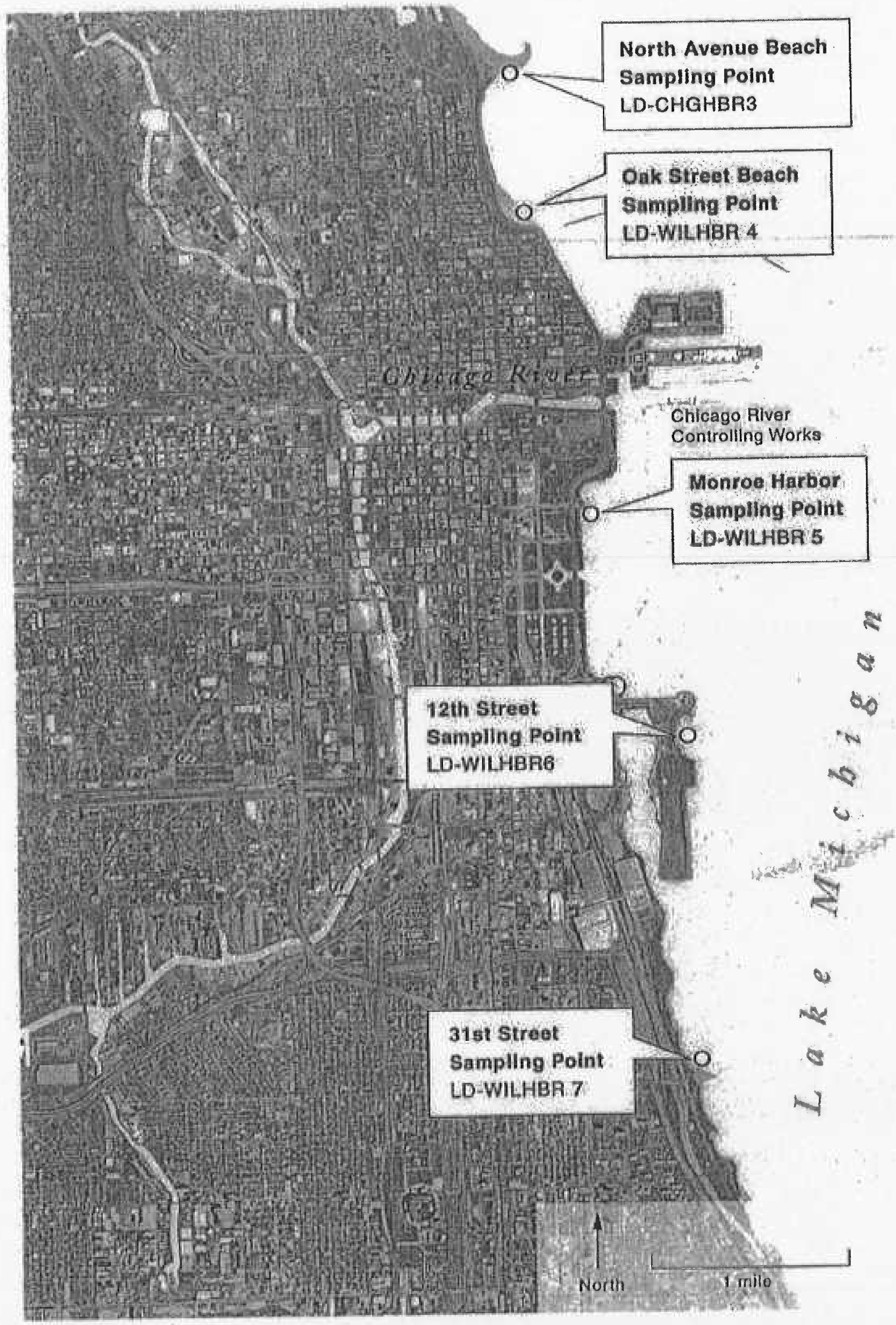


FIGURE 3D.2: LAKE MICHIGAN BEACH SAMPLING LOCATIONS



WILMETTE LOCKS BACKFLOW PROCEDURES
(APPENDIX 3D)

The Systems Dispatcher will notify the IWD-O'Brien Area Supervisor that a backflow event is imminent at the Wilmette Locks. IWD-O'Brien personnel will be assigned upon notification that an Electrical Operator has been dispatched to the site to confirm and oversee the remote operation of the sluice gates.

A minimum of two persons is required for backflow sampling. The sampling crew will sign in at the IWD-O'Brien Office and obtain two vehicles, two radios, two MWRD hydraulic keys (old one and Y1 key) to open the entry gate at the Wilmette Locks and an MWRD Medeco key to open the Pumping Station building and adjacent gate. These keys are located in the IWD-O'Brien key box outside the Area Supervisor's office. All other safety and sampling equipment, including a copy of this protocol, is stored in lockers within the pump station. The lockers are secured with an IWD "507" key, the same key used in other IWD sampling operations and which has been issued to all personnel.

Entry into the Wilmette Pumping Station will trigger a silent intrusion alarm with the Systems Dispatcher. The sampling crew must notify the Dispatcher of its presence and purpose; otherwise, OWRP Police will be dispatched to investigate the alarm. Phone the Dispatcher at (312) 787-3575 and report the IWD personnel on site, the radio call numbers for these personnel, and your purpose (backflow sampling). The telephone number to the Wilmette Pumping Station office is (847) 256-0435.

I. Sampling during the backflow will be conducted at the Wilmette sluice gates (Station LD-WILHBR 1) and Wilmette Harbor Mouth (Station LD-WILHBR-2). See attached sketch (Figure 4D.3). One General Chemistry and one bacteria (fecal coliform or *E. coli*) sample will be collected within 24 hours of the onset of the backflow. The first sample to be collected with a backflow event for the season should include a field blank. Follow the latest bacteriological sampling procedures. Record the temperature (°C) of all samples on the log sheet. Notify the M&R Stickney Analytical Laboratory and the Microbiology Laboratory of the total number of samples and the anticipated time of delivery. Bacteria samples need to be transported to the Stickney Microbiology Laboratory as soon as possible (i.e. within 6 hours).

   If the backflow event is still in progress, record the sluice gate opening measurement at the time of samples collection, in addition to the measurements at the onset of the event. This information will be available from the Electrical Operator on site. Also note that the closure of the sluice gates does not guarantee that the event has ended. If the sluice gates are closed, the Systems Dispatcher or the Area Supervisor can tell you whether or not the event has ended.

The sampling crew will return to the IWD-O'Brien Office to prepare LIMS labels and receipts for all samples. Note that the **LIMS template is LD-WIL**. Please note that these must be separate receipts: one for the general chemistry and one for the bacteriology.

II. The IWD-O'Brien Office will conduct post-backflow beach sampling within 24 hours of the cessation of the event. Obtain bacteria samples for fecal coliform or *E. coli* parameters at the following locations:

Kenilworth Beach	LD-WILHBR-3
Wilmette Beach	LD-WILHBR-4
Gillson Beach	LD-WILHBR-5
Lighthouse Beach	LD-WILHBR-6
Northwestern (Lincoln St.) Beach (if accessible)	LD-WILHBR-7
Dempster Street Beach	LD-WILHBR-8

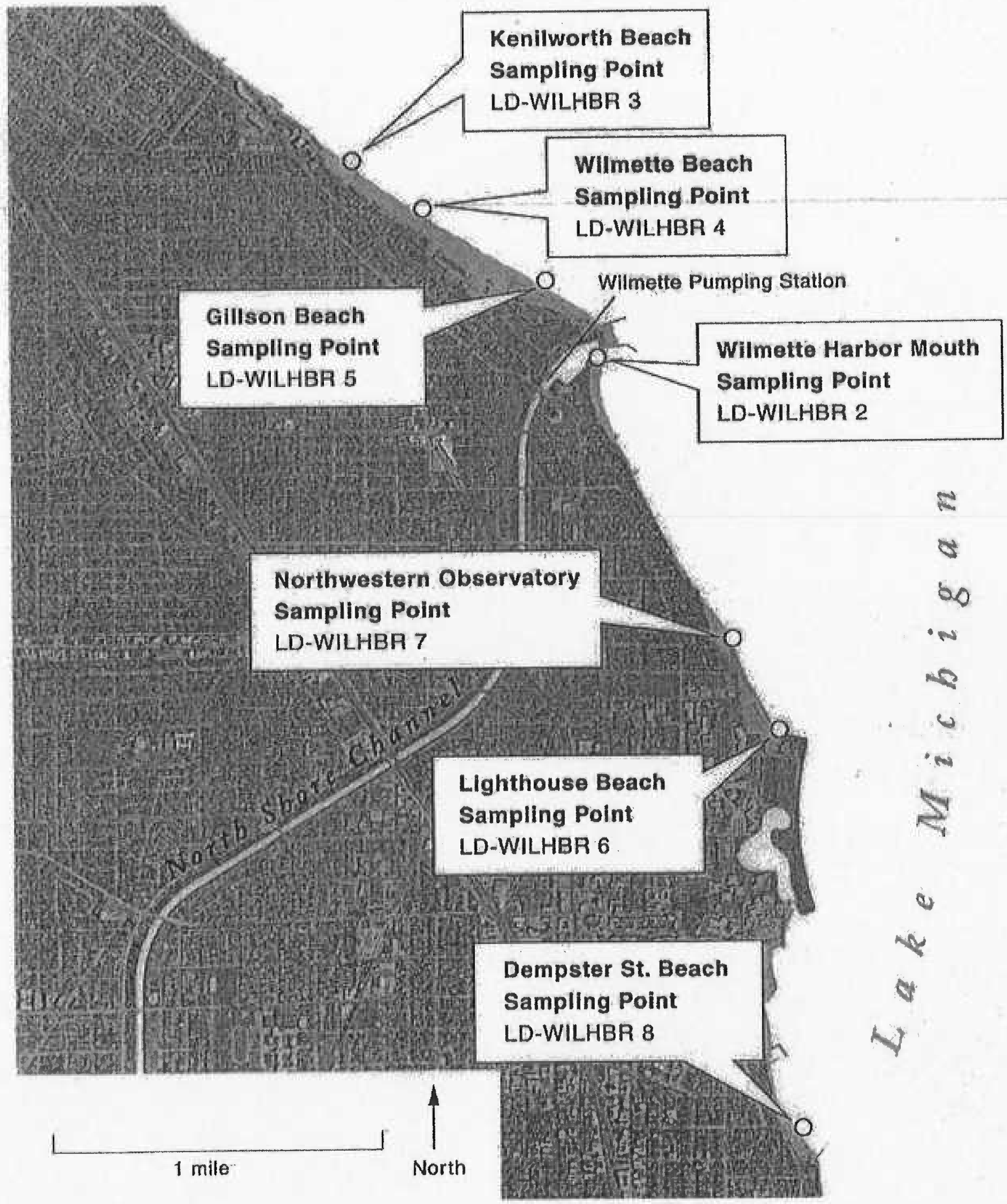
Again, notify the Microbiology Laboratory of the number of samples and the anticipated time of delivery.

This updated sampling plan calls for conducting sampling during the regular working periods, i.e., Monday through Friday between the hours of 7:00 a.m. and 3:30 p.m. except for holidays. For holiday, weekend or late night storm related backflow, the sampling will be scheduled on the following regular work day.

Please note that backflow beach sampling is performed only during the Chicago Park District's Beach Recreation Season: Memorial Day through Labor Day.

A report must be submitted to the Assistant Directors of Monitoring and Research by the Area Supervisor, or their designee, within two weeks following backflow and post-backflow sampling. It must contain a brief summary narrative, event chronology, and sampling log sheets.

FIGURE 3D.3: SAMPLING LOCATIONS FOLLOWING BACKFLOW TO LAKE MICHIGAN FROM WILMETTE PUMPING STATION



APPENDIX 3E

TARP STATUS REPORT

Protecting Our Water Environment

Metropolitan Water Reclamation District of Greater Chicago

100 EAST ERIE STREET CHICAGO, ILLINOIS 60611-3154 312.751.5600

TARP STATUS REPORT AS OF JUNE 1, 2014

This report presents construction progress, cost, and State/Federal grant and revolving loan funding information on the Tunnel and Reservoir Plan (TARP). Figures 1 through 4 are maps showing TARP facilities, and Tables I through III contain data on TARP contracts. Project reference numbers appearing in Table II correspond to the numbers shown on Figures 2, 3, and 4.

TARP Phase I

TARP, or "Deep Tunnel," was selected in 1972 as the Chicago area's plan for cost-effectively complying with Federal and State water quality standards with respect to the 375 square mile combined sewer area consisting of Chicago and 51 suburbs. TARP's main goals are to protect Lake Michigan – the region's drinking water supply - from raw sewage pollution; improve the water quality of area rivers and streams; and provide an outlet for floodwaters to reduce street and basement sewage backup flooding. TARP Phase I projects are primarily for pollution control. These projects capture and enable treatment of about 85% of the combined sewer overflow (CSO) pollution from TARP's service area. TARP Phase I includes 109.4 miles of deep, large diameter, rock tunnels. Construction of TARP Phase I was completed in 2006 and the entire system is now in operation. The table below summarizes the tunnel system.

TARP SYSTEM	TUNNEL LENGTH	TUNNEL VOLUME	TUNNEL DIAMETER
Mainstream	40.5 mi.	1,200 MG	8 to 33 ft.
Calumet	36.7 mi.	630 MG	9 to 30 ft.
O'Hare (UDP)	6.6 mi.	70 MG	9 to 20 ft.
Des Plaines	25.6 mi.	405 MG	10 to 33 ft.
TOTALS	109.4 mi.	2,305 MG	8 to 33 ft.

TARP Phase II/CUP

TARP Phase II/CUP consists of reservoirs intended primarily for flood control for the Chicagoland combined sewer area, but it will also considerably enhance pollution control benefits being provided under Phase I. The U.S. Army Corps of Engineers' Chicagoland Underflow Plan (CUP), Final Phase I General Design Memorandum (GDM) of 1986 defined the Federal interest in TARP Phase II based on the Federal National Economic Development Plan criteria. The three reservoirs proposed under TARP Phase II/CUP are the Gloria Alitto Majewski Reservoir, the Thornton Reservoir, and the McCook Reservoir.

Gloria Alitto Majewski Reservoir

As the local sponsor of TARP Phase II/CUP, the MWRDGC acquired land rights for the reservoir. The U.S. Army Corps of Engineers (USACE) designed and constructed the reservoir, which was completed in 1998. The District has since assumed its operation, and to date the reservoir has yielded over $295 million in flood damage reduction benefits to the three communities it serves.

Thornton Reservoir

The Thornton Reservoir will be constructed in two stages. The first stage, a temporary flood control reservoir called the Thornton Transitional Reservoir, was completed in March 2003 in the West Lobe of the Thornton Quarry. This reservoir provides overbank flood relief for 9 communities, and has captured 29.9 billion gallons of flood water during 45 fill events.

The second stage is a permanent combined NRCS/CUP reservoir, called the Thornton Composite Reservoir, being constructed in the North Lobe of the Thornton Quarry. The Thornton Composite Reservoir will provide 4.8 billion gallons of storage for combined sewage from the Calumet TARP Service Area, in addition to flood waters from Thorn Creek. In accordance with an agreement executed in 1998, a local mining company completed the Thornton Composite Reservoir excavation in 2013. The composite reservoir is scheduled to be operational in 2015, after which the transitional reservoir in the West Lobe will be decommissioned and returned to an active quarry. The Thornton Composite Reservoir will provide $40 million per year in benefits to 556,000 people in 14 communities.

The USACE was authorized to conduct a Limited Re-evaluation Report (LRR) to justify taking financial responsibility of the NRCS portion of the Thornton Composite Reservoir under the Water Resources Development Act of 1999. The LRR was completed in July 2003. On September 18, 2003 the USACE and MWRDGC signed a Project Cooperation Agreement (PCA) for construction of the Thornton Composite Reservoir. The USACE agreed to credit the MWRDGC $57,000,000 for money the MWRDGC spent on the relocation of Vincennes Avenue, land acquisition, and transitional reservoir facilities that will also be used by the composite reservoir. However, due to inadequate funding levels by the USACE and the need to have the Composite Reservoir operational, the MWRDGC, in June 2004, assumed responsibility for the design and construction of the reservoir, and will pursue reimbursement of funds through the Water Resources Development Act. As a result, three contracts totaling about $301,000,000 are now under construction to complete the major work required to make the Composite Reservoir operational. The last contract, to provide surface aeration, is scheduled to be awarded in 2014.

McCook Reservoir

The MWRDGC owns the land for the McCook Reservoir, which will be built within the Lawndale Avenue Solids Management Area (LASMA). A PCA with the USACE was signed on May 10, 1999. The USACE is responsible for designing and constructing the reservoir features, and the MWRDGC is responsible for providing the massive hole for the reservoir. The reservoir is planned to be completed in two stages. The first stage will provide 3.5 billion gallons of storage and is expected to be completed in 2017. The second stage has been expanded to 6.5 billion gallons and replaces the previously planned third stage. The McCook Reservoir will provide $90 million per year in benefits to 3.1 million people in 37 communities.

Ten construction contracts awarded by the USACE have been completed, including construction of a groundwater cutoff wall and grout curtain around the reservoir perimeter, a construction shaft for the connecting tunnel, initial rock wall stabilization work inside the reservoir, a retaining wall in Stage 1, distribution tunnels between the reservoir and the pumping station, and addition of pumps and motors at the pumping station. The Main Tunnel Contract, to connect the reservoir to the existing Mainstream Tunnel, the Stage 1 and 2 Slope Stabilization Contracts, and the Stage 1B Rock Wall Stabilization Contract are under construction.

In October 2003, the MWRDGC signed an agreement with a local mining company to mine out the limestone to the limits of the McCook Reservoir. The MWRDGC completed several contracts to connect the quarry to the reservoir site and procure and construct required mining equipment to crush and convey the rock to the quarry for processing. Full production mining at the site began in March 2008 and will take approximately twenty years. Over 8 million cubic yards of overburden and 73% of the Stage 1 rock has been removed from the reservoir site. Removal of the remaining overburden from the expanded stage 2 is ongoing and will be complete in 2015.

Reservoir storage volumes are presented in the table below.

PHASE II/CUP RESERVOIR	VOLUME (in billion gallons)
Majewski	0.35
Thornton	4.8 *
McCook	10.0
TOTAL STORAGE	15.15

* Does not include portion designated for non-TARP overbank flood relief.

TARP/CUP Costs

Current TARP/CUP costs, details of which are provided in Tables I through III, are summarized as follows:

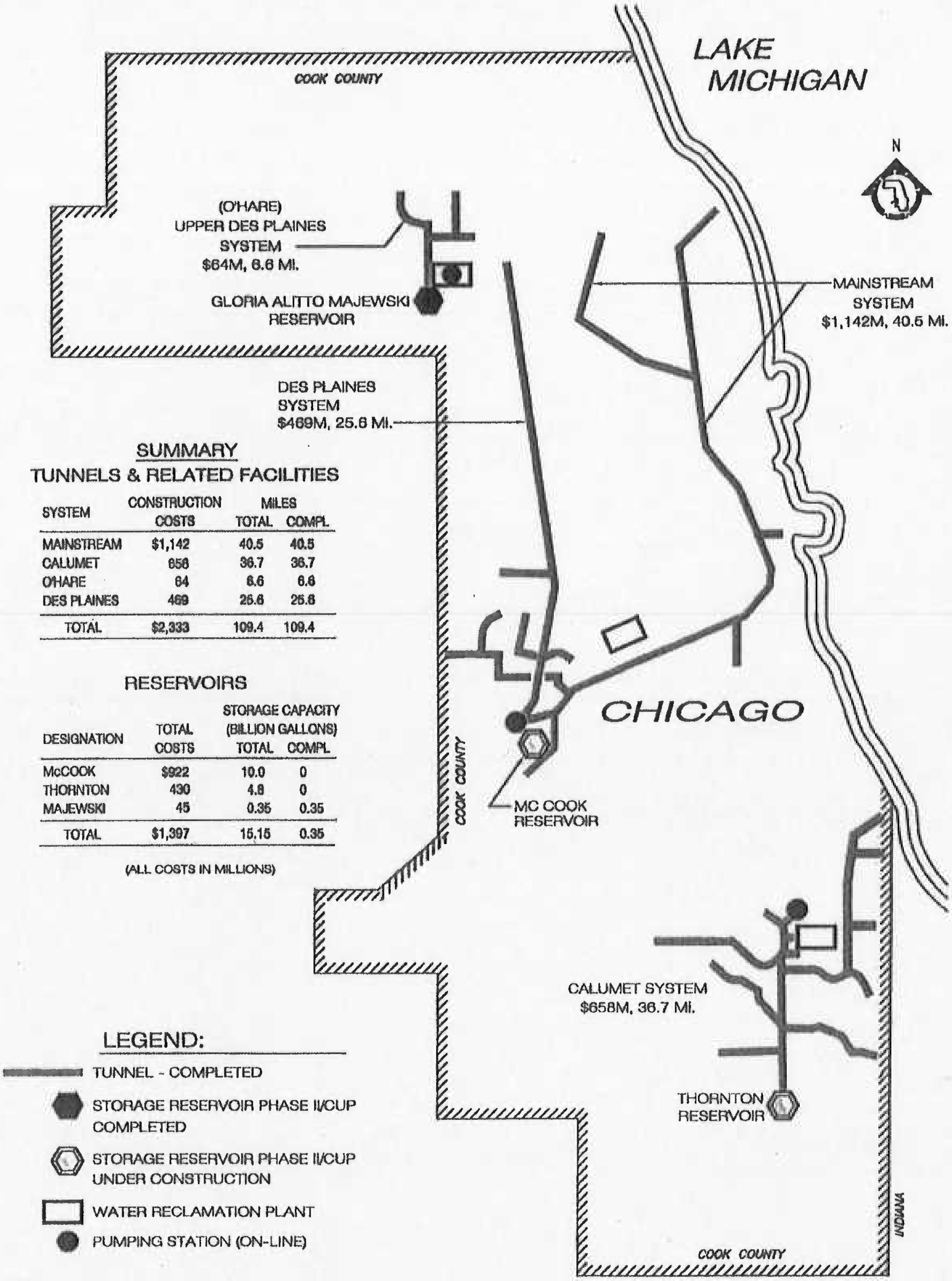
(A) Phase I Tunnels & Appurtenant Facilities (Construction Costs)	
(1) Completed	$2,332,154,822
(2) Remaining	$ 0
Total Tunnels & Appurtenant Facilities	$2,332,154,822
(B) Phase II/CUP Reservoirs (Total Project Costs)	
(1) Majewski Reservoir:	
Completed	$ 44,810,552
Remaining	$ 0
Sub-Total Majewski Reservoir	$ 44,810,552
(2) Thornton Reservoir:	
Completed/Under Construction	$ 426,000,000
Remaining	$ 4,000,000
Sub-Total Thornton Reservoir	$ 430,000,000
(3) McCook Reservoir:	
Completed/Under Construction	$ 707,000,000
Remaining	$ 215,000,000
Sub-Total McCook Reservoir	$ 922,000,000
Total Reservoirs	$1,397,000,000
Total Tunnel and Reservoir Plan	$3,729,000,000

Very truly yours,

Catherine A. O'Connor/wss

Catherine A. O'Connor
Director of Engineering

WSS:KMF
w/attachments



SUMMARY
TUNNELS & RELATED FACILITIES

SYSTEM	CONSTRUCTION COSTS	MILES TOTAL	MILES COMPL
MAINSTREAM	$1,142	40.5	40.5
CALUMET	658	36.7	36.7
O'HARE	64	6.6	6.6
DES PLAINES	469	25.6	25.6
TOTAL	$2,333	109.4	109.4

RESERVOIRS

DESIGNATION	TOTAL COSTS	STORAGE CAPACITY (BILLION GALLONS) TOTAL	COMPL
McCOOK	$922	10.0	0
THORNTON	430	4.8	0
MAJEWSKI	45	0.35	0.35
TOTAL	$1,397	15.15	0.35

(ALL COSTS IN MILLIONS)

TUNNEL and RESERVOIR PLAN PROJECT STATUS

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO
ENGINEERING DEPARTMENT
TARP & PROJECT SUPPORT KMF:JJK

Figure 1

Protecting Our Water Environment

Metropolitan Water Reclamation District of Greater Chicago

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Total Tunnels & Appurtenant Facilities	$2,332,154,822
(B) Phase II/CUP Reservoirs (Total Project Costs)	
(1) Majewski Reservoir:	
Completed	$ 44,810,552
Remaining	$ 0
Sub-Total Majewski Reservoir	$ 44,810,552
(2) Thornton Reservoir:	
Completed/Under Construction	$ 426,000,000
Remaining	$ 4,000,000
Sub-Total Thornton Reservoir	$ 430,000,000
(3) McCook Reservoir:	
Completed/Under Construction	$ 707,000,000
Remaining	$ 215,000,000
Sub-Total McCook Reservoir	$ 922,000,000
Total Reservoirs	$1,397,000,000
Total Tunnel and Reservoir Plan	$3,729,000,000

Very truly yours,

Catherine A. O'Connor /wsw

Catherine A. O'Connor
Director of Engineering

WSS:KMF
w/attachments