Metropolitan Water Reclamation District of Greater Chicago

RESEARCH AND DEVELOPMENT DEPARTMENT

REPORT NO. 09-75

ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

2008

ANNUAL REPORT

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Metropolitan Water Reclamation District of Greater Chicago
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ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

2008

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Monitoring and Research Department
Louis Kollias, Director

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ACKNOWLEDGMENTS

This 2008 Annual Report is the result of the efforts of not only the scientists and engineers who perform the monitoring and research initiatives of the Department, but also the impressive efforts of support staff and other personnel who contribute their valuable time, energy, and know-how to the production of the report. These individuals deserve special recognition and thanks.

Special thanks are due to Laura Franklin, Coleen Maurovich, Deborah Messina, Kathleen Quinlan, Barbara Sanders, and Nancy Urlacher for their immaculate typing, zealous adherence to Department formatting tradition, responsiveness to turnaround times, and dedication to moving the report forward.

DISCLAIMER

The mention of trade names of specific products does not constitute endorsement of them by the Metropolitan Water Reclamation District of Greater Chicago.

STRUCTURE AND RESPONSIBILITIES OF THE ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

The Environmental Monitoring and Research (EM&R) Division has 63 employees, and is comprised of six Sections. These are illustrated in Figure 1 and Appendix V with a breakdown of the number of employees. The six Sections are:

1. Administrative
2. Wastewater Treatment Process Research
3. Biosolids Utilization and Soil Science
4. Analytical Microbiology and Biomonitoring
5. Aquatic Ecology and Water Quality
6. Radiochemistry

The major areas of focus of the Division were as follows:

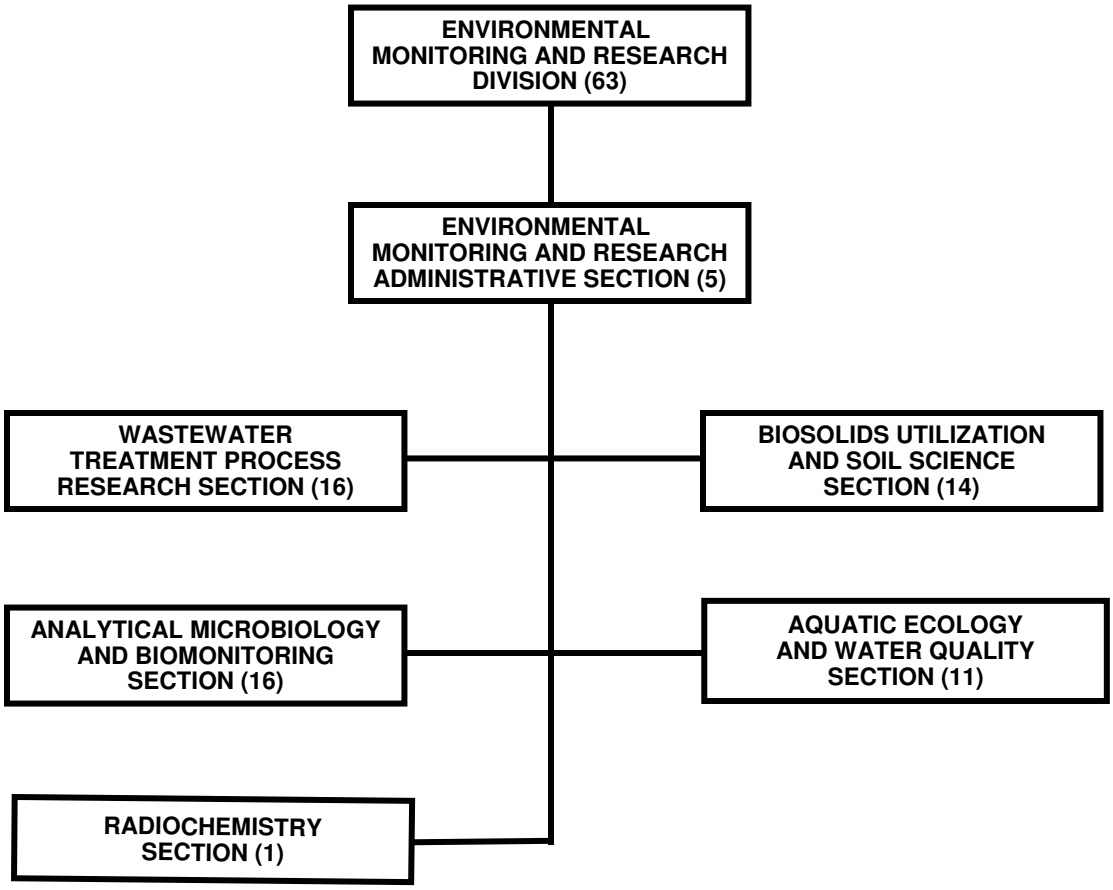
- Monitoring the environmental quality of Lake Michigan, area rivers and canals, and the Illinois River to document the effectiveness of the District's wastewater treatment program.
- Assisting in the resolution of sewage treatment and solids disposal operation problems.
- Providing technical assistance to other departments and agencies with respect to issues related to wastewater treatment; combined sewer overflow (CSO) management; waterways management; and solids processing, utilization, and marketing.
- Conducting applied and operations research to achieve improvement and cost reductions in District wastewater treatment, waterways management, and solids processing and biosolids utilization activities.
- Assessing the impacts of new or proposed regulations on District activities. Notably in 2008, the Division continued formulating the District's case in the Illinois Pollution Control Board Rulemaking R08-9 Chicago Area Waterways Use Attainability Analysis.
- Generation and transmittal of environmental monitoring reports to regulatory agencies to ensure compliance with requirements of Tunnel and Reservoir

Plan (TARP), water reclamation plant NPDES, and biosolids processing and utilization permits.

- During 2008, the EM&R Division participated in numerous Meetings and Seminars (Appendix I), presented several papers, Power Point presentations, and poster presentations (Appendix II), and also published several papers (Appendix III).

FIGURE 1

ENVIRONMENTAL MONITORING AND RESEARCH DIVISION
ORGANIZATION CHART
(WITH THE NUMBER OF EMPLOYEES)



ADMINISTRATIVE SECTION

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The Administrative Section provides technical guidance, scientific review, and administrative support for the work being carried out by the EM&R Division staff. The Section also organizes a monthly seminar series, open to all District employees, that presents information on areas of interest to the wastewater field. In 2008, 1,736 people attended these seminars. A list of the seminar topics is shown in Appendix IV.

In addition to the overall administrative and supervisory functions performed by the Administrative Section, the Experimental Design and Statistical Evaluation Group and Radiochemistry Group, which are part of the Administrative Section, provided the following support to the rest of the EM&R Division.

Experimental Design and Statistical Evaluation Group

The Experimental Design and Statistical Evaluation Group (EDSEG) is responsible for providing assistance in the design of laboratory and full-scale experiments, collection of appropriate data, development of guidelines for data collection methodology, and statistical analyses. Since 1999, Section personnel have been performing these tasks using PC computing media. They also developed programs to interconnect LATEX and Visual Basic Programs with SAS, Access, Excel, Outlook, and Power Point software programs. This computer automation has enabled the Section to produce reports, tables, and texts in suitable designs, and to respond to many requests in a shorter period of time.

Statistical and Computing Support. During 2008, EDSEG provided statistical and computing support to various projects. The following is a description of some of the most important activities.

1. Statistical support was provided to the Analytical Microbiology & Biomonitoring Section to study antibiotic resistant bacteria upstream and downstream of the plants operated by the Metropolitan Water Reclamation District of Greater Chicago system.

2. Provided statistical support for numerous scenarios for the study of dissolved oxygen (DO) behavior in the Chicago Area Waterway System (CAWS) to understand the impacts of proposed aquatic life use A, and use B water quality standards.

3. EDSEG provided data management support to produce quarterly reports on biosolids management at the District's Biosolids Management Areas in accordance with Illinois Environmental Protection Agency (IEPA) permit requirements. Drying site reports were produced for Harlem Avenue Solids Management Area, Lawndale Solids Management Area, Ridgeland Avenue Solids Management Area, Stony Island Solids Management Area, Calumet East Solids Management Area, Calumet West Solids Management Area, and Hanover Park Solids Management Area for the first, second, and third quarter of 2008.

4. Statistical support was provided to the Biosolids Utilization and Soil Science Section for their research investigating the availability of phosphorus in Biosolids.

5. Statistical support was provided to justify the reduction of sampling frequency in District's Solids Management Area.

6. Provided statistical analysis of Nu Earth Garden data compared to the current United States Environmental Protection Agency's bisolids regulations.

7. Statistical support was provided to the Biosolids Utilization and Soil Science Section for research investigating the occurrence and fate of Dioxin in biosolids amended soil.

8. Analysis of Soil Organic Carbon (SOC) Concentration and Soil sequestration of Lenzburg, Rozetta, and Rapatee soils.

9. Computational support was provided to determine carbon decaying rate by solving for the real roots of Polynomial of Degree up to n ($n<35$) to understand the fate of carbon in biosolids amended soils.

10. Support was provided to the Aquatic Ecology and Biology Section on the production of Continuous DO Monitoring Reports (Deep-Draft and Wadeable) annually.

11. Support was provided to Radiology Section on the extraction of data from LIMS and automation of preparing tables for the report.

12. Four Ambient Water Quality Monitoring Exceedance Reports were produced by this section for last quarter of 2007 and first three quarters of 2008.

13. Statistical support and consulting was provided on data management, automation of reports, etc. to various sections in the Division.

Water Quality Data. Each year, the Experimental Design and Statistical Evaluation Group summarizes results of the District's Ambient Water Quality Monitoring program for the CAWS. Surface water quality data for 2007 were evaluated regarding compliance with water quality standards set by the Illinois Pollution Control Board (IPCB). In 2007, 67 water quality parameters including dissolved oxygen; temperature; pH; alkalinity (total); chloride; turbidity; total Kjeldahl nitrogen; ammonium nitrogen; un-ionized ammonia; organic nitrogen; nitrite plus nitrate nitrogen; total solids; total suspended solids; volatile suspended solids; total dissolved solids; phenols; sulfate; fats, oils, and greases; total phosphorus; total cyanide; weak acid dissociable cyanide; fluoride; total organic carbon; fecal coliform; escherichia coli; total calcium; total magnesium; hardness; gross alpha radioactivity; gross beta radioactivity; chlorophyll a; benzene; ethylbenzene; toluene; xylene; total silver; total arsenic; total barium; to-

tal boron; total cadmium; total copper; total chromium; total hexavalent chromium; total iron; total lead; total nickel; total manganese; total mercury; low level mercury; total zinc; total selenium; soluble calcium; soluble magnesium; soluble silver; soluble arsenic; soluble barium; soluble boron; soluble cadmium; soluble copper; soluble chromium; soluble iron; soluble lead; soluble nickel; soluble manganese; soluble mercury; soluble zinc; and soluble selenium were analyzed and reported.

*General Use Water***.** In 2007, 31 water quality parameters had IPCB General Use Standards. Two parameters (benzene and total mercury) had IPCB Human Health Standards. Twenty-three water quality parameters were in total compliance with the standards in all river systems. They were temperature, ammonium nitrogen, phenols, weak acid dissociable cyanide, gross beta radioactivity, benzene, ethylbenzene, toluene, xylene, total silver, total barium, total boron, total hexavalent chromium, total manganese, total selenium, soluble arsenic, soluble cadmium, soluble copper, soluble chromium, soluble iron, soluble lead, soluble nickel, and soluble zinc. One parameter, benzene, was in total compliance with the Human Health Standard in all river systems.

Of the remaining eight parameters, one parameter, soluble mercury, was in total compliance in the Des Plaines River System and not assayed in the Chicago and Calumet River Systems. Five parameters (DO, pH, chloride, sulfate, and fluoride) had compliance rates greater than 83.0 percent in all river systems. Total dissolved solids had compliance rates of 77.0, 79.8, and 87.8 percent, respectively, in the Chicago, Calumet, and Des Plaines River Systems. Fecal coliform had the lowest compliance rate in the range of 43.4 to 47.7 percent in all river systems. The compliance rates for total mercury with Human Health Standards were 81.9, 94.8, and 89.3 percent, respectively, in the Chicago, Calumet, and Des Plaines River Systems.

*Secondary Contact Water***.** Twenty-three water quality parameters measured in the secondary contact waters during 2007 had applicable IPCB standards. Seventeen parameters were in complete compliance with the IPCB standards for the Chicago and the Calumet River Systems in 2007. They were temperature; pH; phenols; fats, oils, and greases; total cyanide; fluoride; total silver; total arsenic; total barium; total cadmium; total copper; total hexavalent chromium; total nickel; total manganese; total mercury; total zinc; and total selenium. The remaining six parameters (DO, un-ionized ammonia, total dissolved solids, total iron, total lead, and soluble iron) had compliance rates greater than 93.0 percent in both river systems.

WASTEWATER TREATMENT PROCESS RESEARCH SECTION

WASTEWATER TREATMENT PROCESS RESEARCH SECTION

The Wastewater Treatment Process Research (WTPR) Section mission is to provide technical support to the Maintenance and Operations Department (M&O) and Engineering Departments, to conduct applied research regarding both current treatment processes and new technologies, and conduct regulatory monitoring, reviews and develop technical information for pending regulations. Technical assistance is provided to M&O for solving water reclamation plant (WRP) operating problems. The investigation of current operations may originate as the result of a WRP problem, or interest in arriving at new knowledge concerning some aspect of a wastewater treatment process. Plans and specifications are also reviewed at the request of the Engineering Department for the purpose of optimizing process design criteria.

The Section is responsible for conducting basic, applied, and problem-solving research on various wastewater and sludge treatment processes currently utilized by the Metropolitan Water Reclamation District of Greater Chicago (District). This Section also investigates innovative treatment processes for potential future use. Studies of new technologies are concerned with maximizing the efficiency of an existing process at the lowest cost or the development of new processes. Investigations may take the form of surveys, literature reviews, laboratory bench-scale testing, pilot-plant studies, full-scale testing, special analyses, or a combination or progression of any or all of the above.

The major areas of study in 2008 included the following.

Technical Support to Maintenance and Operations Department

Polymer Tests at the Stickney Water Reclamation Plant. Full-scale tests at the Stickney Post-Digestion Centrifuge Complex were conducted during January 2008 for the selection and purchase of winter polymer used in the centrifugal dewatering of anaerobically digested sludge. The testing procedure is repeated twice at Stickney, once in summer and once in winter, as the change in sludge characteristics during these seasons requires different polymers at this WRP. The laboratory tests were conducted as a precursor to full-scale tests. The test procedures are described in Monitoring and Research Department (M&R) Report No. 01-13.

All polymers that do not produce a minimum of 95% solids capture are disqualified from competing for the Stickney dewatering polymer contract.

The polymer that passes the test performance criteria as described in the bid documents and has the lowest cost for conditioning per unit mass of sludge is the polymer of choice for purchase. The above full-scale and bench-scale tests are conducted once every other year, a few months before the polymer purchase contracts are up for renewal after a two-year life. A summary of the relevant information about the tests conducted at the Stickney WRP is presented in Table II-1.

Odor Management and Corrosion Control in James C. Kirie Interceptors Upper Des Plaines 14A, Upper Des Plaines 14B and Upper Des Plaines 20B. This study was initiated by the Environmental Monitoring and Research (EM&R) Division in 2008 to investigate the feasibility of odor abatement at Drop Shaft 5 (DS 5), and to address the larger issue of hydrogen sulfide (H_2S) odors, corrosive conditions, and the resulting premature aging of interceptors that lead to DS 5.

M&R conducted sampling at seven locations along Upper Des Plaines (UDP) 14 A and UDP 14B, and one sampling point along UDP 20B adjacent to DS 5 twice a week from July 22, 2008, through September 4, 2008. The grab samples for the parameters of interest were taken twice a day, once in the morning, and once in the afternoon.

Bioxide is currently injected into UDP 14 from May through October to alleviate the odors from DS 5. During the sampling for this study, Bioxide was not injected on five of the fourteen days sampled, so that a preliminary evaluation of the effectiveness of Bioxide on odors and other wastewater quality parameters could be made.

The analysis of the wastewater samples showed that the average oxidation-reduction potential (ORP) levels along both interceptors, with and without Bioxide injection, for the morning and afternoon sampling events were below -50 mV, and this was an indication of reducing conditions and a potential for emission of H_2S from the interceptors. It was also found that the headspace H_2S along the interceptors were mostly between 1 and 3 ppmv, and this level of H_2S is considered sufficient to corrode concrete conduit an estimated 1 mm/yr on average (Water Environment Research Foundation Report No. 04-CTS-1). At a location immediately upstream of the Bioxide injection point, the average H_2S concentration was 13.0 to 15.6 ppmv for the time periods reported, which could produce a corrosion rate of 2 mm/year or greater.

The significance of the effect of Bioxide on headspace H_2S and ORP and the variability of total sulfide concentration as a function of other parameters such as flow rate, five-day biochemical oxygen demand (BOD_5), and flow residence time were investigated using statistical analysis. The results of these analysis showed that the Bioxide injection had significant effect on reducing H_2S and increasing the ORP level. Furthermore, it was found that the BOD_5 concentration and Bioxide dose were strong determinants of total sulfide concentration in the interceptors.

Based on the results of this preliminary study (documented by memorandum from the Director of M&R to M&O and Engineering dated February 25, 2009), a monitoring location immediately upstream of the Bioxide injection point was found as a hot spot, where the concentration of H_2S ranged from 0 to 34 ppmv during this study. Another station just upstream of DS 5 was also considered as a hot spot for H_2S, where the H_2S level in this location ranged from 0 to 27 ppmv.

The results of this preliminary study suggested that Bioxide injection or some other odor/corrosion abatement measures should be incorporated upstream of the current Bioxide injection location.

M&R is developing a follow-up study to optimize the concentration of Bioxide in the James C. Kirie (Kirie) WRP interceptors using bench-scale experiments, and to determine the proper location(s) for injection of Bioxide.

Support for Maintenance and Operations Department Plant Operations. The WTPR Section provided support for M&O plant operations on both a routine and emergency basis. Routine support to M&O plant operations includes weekly microscopic examination of mixed liquor samples from the Stickney, Calumet, North Side, Kirie, John E. Egan (Egan), and Lemont WRPs, and weekly or monthly personal visits to the Calumet, North Side, Kirie, and Lemont WRPs. Table II-2 shows that a total of 633 microscopic examinations for filament analysis of mixed liquor were performed for six WRPs in 2008. Also, emergency support to M&O plant operations included filament identification in mixed liquor to pinpoint the causes of poor settling. As shown in Table II-3, a total of 113 filament identification analyses were conducted in 2008.

Emergency support to M&O in 2008 included technical support to the Hanover Park WRP after an incident in which a tank storing approximately 2,000 gallons of sodium bisulfite failed and the flow was diverted into a drain and eventually discharged to Batteries A and B of the WRP. Technical advice was provided for the plant to cope with elevated ammonia and fecal coliform (FC) concentrations following the sodium bisulfite diversion event.

Also during 2008, the Calumet WRP exhibited a series of upsets resulting in an inhibition of nitrification. Assistance was given to M&O to establish nitrification, and in conjunction with the Industrial Waste Division it was determined that most likely the inhibition was due to a discharge of thiourea into the sewer system.

To assist M&O in dealing with foaming and elevated sludge volume index in the north aeration tank of the Egan WRP in the first few months of 2008, the WTPR Section and the Analytical Microbiology and Biomonitoring Section of the EM&R Division provided technical services by conducting more frequent microscopic analyses of mixed liquor and field profile sampling. The causes of the problems in the Egan WRP aeration tank were investigated, and a control strategy was recommended to M&O.

Comparison of John E. Egan Water Reclamation Plant South Aeration Tank Profiles. *Background.* The Egan WRP is a conventional activated sludge process with tertiary treatment. The design average and design maximum plant flows are 30 million gallons per day (MGD) and 50 MGD, respectively. The National Pollutant Discharge Elimination System (NPDES) permit daily maximum concentration limits are 20 mg/L and 24 mg/L for carbonaceous BOD_5 and suspended solids (SS), respectively. The NH_3-N daily maximum concentration is 3.0 mg/L for April through October and 8.0 mg/L for November through March.

The Egan WRP has two aeration batteries, North and South, each with two aeration tanks. Each aeration tank has three 375-foot long passes. Each tank has a capacity of 3.2 MG. The aeration tanks are operated as a conventional plug-flow with recycle. Primary effluent and return sludge are added to each tank in the first pass. Air flow to each of the three passes is controlled

by a dissolved oxygen (DO) probe located at the end of each pass. The typical DO set points are 1 ppm, 2 ppm, and 3 ppm for Passes 1, 2, and 3, respectively.

South Battery Tanks 1 and 2 have return sludge feed ports at 10, 94, 188, and 281 feet from the beginning of the tank. The primary effluent enters the tanks at 36 feet from the beginning of Pass 1. Fine bubble spiral roll diffusers are used for aeration in all three passes. It was discovered during tank filling in 2006 and 2007 that the return sludge valves were leaking. Previously, it was thought that the entire return sludge volume was entering Pass 1 through the valve at 10 feet from the beginning of the tank. The discovery of the leaking valves led to this study. In this study South Battery Tanks 1 and 2 were evaluated to determine if both tanks had similar treatment profiles. The relative magnitude and uniformity of the return sludge flow through the four valves in the first pass were evaluated. The specific oxygen uptake rate (SOUR), DO, and nutrient profiles were compared. A follow-up study to evaluate the impact on treatment after replacing the leaky valves is planned.

Investigation Results. The aeration tanks were simultaneously sampled at seven locations along the aeration tanks at 8, 63, 125, 188, 281, 375, and 563 feet from the tank beginning. The samples were collected on weekdays between 10 AM and 1 PM, starting with the first sampling point at 8 feet and working along the tank until the 573 feet. Sampling was conducted on five different days from August 6 to September 17, 2008. The temperature, DO, and oxygen uptake rate (OUR) were determined on-site. The mixed liquor samples were filtered with 20–25 µm cellulose fiber filters and then analyzed for the nutrient concentrations. Unfiltered mixed liquor samples were analyzed for mixed liquor SS and mixed liquor volatile SS (MLVSS) and total phosphorus (TP).

The SOUR was calculated by dividing the OUR by the MLVSS concentration. The SOUR facilitates comparison of microbiological oxygen consumption for different mixed liquor samples collected at different tank locations and times. A larger SOUR value indicates a higher food-to-mass ratio and is expected at the beginning of the tank. Conversely, a smaller value indicates a low food-to-mass ratio and is expected at the end of the tank after the substrate is depleted. Figures II-1 and II-2 show the SOUR profiles for each sampling event for Tanks 1 and 2, respectively.

Differences in return sludge flow through the different valves in the first pass of the two aeration tanks would be seen in the SOUR profiles. The profiles for both tanks are very similar when comparing the profiles for each day. This indicates the return sludge flow and other process parameters are very similar for Tanks 1 and 2.

The TP profiles were also evaluated to determine if there was a difference between Tanks 1 and 2. The TP profiles are shown in Figure II-3.

Increasing TP between 63 and 281 feet is an indication that return sludge is entering through more than one valve. There are three distinct increases in the TP concentrations. TP of a mixed liquor sample is mainly the P stored in the biomass. The primary effluent entry point (at 36 feet) dilutes the mixed liquor in the aeration tanks. The first return activated sludge (RAS)

entry point at 10 feet brings TP in the mixed liquor into the aeration tanks, which results in a relatively higher TP at the first sampling point (8 feet). The dilution of the primary effluent with the RAS from the first entry point made the TP at the second sampling point (63 feet) the lowest. Phosphorus measured for both liquid and solids phases is conservative in the aeration tanks. The increases seen at sampling locations of 125 feet and 188 feet indicate at least two more sources of TP entering the aeration tanks. The last entry point in the first pass (at 281 feet) does not appear to increase the TP concentrations significantly. This indicates that the RAS enters into the aeration tanks mainly through the first three valves, from 10 feet to 188 feet.

The total nitrogen (TN) was profiled and found to have a similar pattern to the TP profile. This was as expected since TN, which includes total Kjeldahl N and nitrite and nitrate nitrogen, is mainly from the biomass as well. The profiles for Tanks 1 and 2 are very similar, as seen Figure II-4, indicating the RAS valves are leaking with similar magnitude and uniformity in both tanks.

The NH_3-N profiles indicate the similarities of the process activity between the two tanks, as shown in Figure II-5. An increase of NH_3-N concentrations from the first to the second sampling point was a result of primary effluent entering the aeration tanks at 36 feet, which is downstream of the first sampling point.

The total SS (TSS) and volatile SS (VSS) of the mixed liquor were measured for each sample location. The nonvolatile solids, the difference between the TSS and VSS, were profiled along the aeration tanks. The nonvolatile solids are conservative in aeration tank after the entry points of primary effluent and return sludge. The profile, shown in Figure II-6, is very similar to the TP profile.

The study reinforces the visual sighting of leaking RAS valves into the first pass of the South Aeration Tanks. The conservative parameters evaluated, such as TP and nonvolatile solids, all have profiles consistent with the finding of leaking RAS valves. Tanks 1 and 2 were very similar in all the parameters evaluated. The profiled parameters that indicate the biological process activities, such as SOUR and NH_3-N, also show that Tanks 1 and 2 are very similar.

The sampling data from this study will be further evaluated and compared to those from the North Battery of the Egan WRP. The data and profiles will be used to evaluate the effect of replacing the leaking RAS valves with permanently closed pipes. The South Battery has historically performed well. Change of return sludge pattern on the functioning tanks may have unintended consequences. Further study is needed to document the impact.

Technical Support to Engineering Department

Ultraviolet Disinfection Study at the Hanover Park Water Reclamation Plant. The District is conducting a side-by-side evaluation of three different ultraviolet light (UV) disinfection technologies at the Hanover Park WRP manufactured by three leading manufacturers (Trojan Technologies, Inc., ITT Wedeco, Inc., and Severn Trent Water Purification, Inc.) under Engineering

Department Contract No. 07-527-AP. Systems from ITT Wedeco, Inc., and Severn Trent Water Purification, Inc., were installed in October 2008 outside the tertiary treatment building at the Hanover Park WRP. These two systems became operational in November 2008. The Trojan Technologies system was installed in April 2009.

Each system is designed to treat 0.5 MGD of secondary unfiltered effluent (approximately 4.2% of the 12 MGD average design plant flow). Manual grab and plant composite samples are collected from upstream and downstream sampling points for physical, chemical, and microbial analysis. Sampling began November 18, 2009, for two systems, and on March 23, 2009, for the Trojan system. In addition to the plant data, records have been kept on such factors as power requirements and maintenance costs in order to fully evaluate each system.

At the conclusion of the study, an appropriate system will be recommended and necessary design criteria will be established for full-scale system implementation.

Stickney Preliminary and North Side Sludge Settling Evaluation. Eight 80-foot diameter concentration tanks are planned for the Stickney WRP. The original concept was to use these tanks strictly for Stickney Primary Sludge (SPS). The current plan is for North Side Sludge (NSS) and SPS to be added together into a combined sludge (CS) at a ratio of 1:7 prior to settling. The tanks are intended to concentrate sludge to approximately 5% to 6% prior to anaerobic digestion. Engineering indicated concerns that the additional loading of NSS would require a larger diameter or an increased number of concentration tanks. Additionally, the septic condition of the NSS upon arrival at Stickney may cause flotation problems.

M&R completed a preliminary evaluation of the settling and thickening effects on SPS, NSS, and CS. In Spring 2008, five separate settling tests were performed on each sludge stream. The sludge was allowed to settle passively in one-liter graduated columns. One CS sample was observed to have floating problems within the designed resident time (5.6 hours). Floating and bulking problems were not observed with the SPS and NS. Except for one CS and SPS sample, the concentrated sludges did not achieve 5–6% total solids (TS). The mean %TS of raw SPS, NSS, and CS were 2.15%, 1.51%, and 2.06%, respectively. On average, SPS, NSS, and CS concentrated to 3.88%, 2.19%, and 3.98%, respectively.

A second evaluation was performed in Summer 2008 on four separate days. Settling vessels with various diameter to height (D:H) ratios were used in this evaluation. Additionally, an Imhoff cone with a conical bottom was investigated. The benchmark of 5–6% TS of concentrated sludge was not achieved in any test. On average, the raw SPS had an average %TS of 0.49% and was thickened to an average %TS of 2.63%. The raw CS had an average %TS of 0.34% and was thickened to an average %TS of 2.09%. The highest concentrated solids of 3.36% were achieved with the one-liter graduated cylinder during tests with SPS. It was observed that the conical bottom of the Imhoff cone did not enhance settling. Additionally, the highest D:H settling vessel, i.e. a two-liter beaker, had the lowest concentration of settled sludge. Furthermore, sidewall effects did not appear to inhibit settling.

A third evaluation was performed in Fall 2008 to examine the effects of increasing water columns and settling times on the sludge streams. A fourth evaluation to further examine the effects of D:H ratios and polymer addition is planned for Winter 2008–2009. The results of the third and fourth phases of this study will be provided in the Spring of 2009.

Support to the Engineering Department for the Hanover Park Water Reclamation Plant Master Plan Study. The District hired consulting firms to conduct studies on future infrastructure and process needs for the Hanover Park WRP, referred to as the Master Plan Study. The WTPR Section provided technical and logistical support to this study, including attending workshops and reviewing and commenting on draft reports for the study.

Technical and logistical coordination between M&O and three M&R Divisions was provided in order to obtain data for the study. Intensive wastewater sampling and analysis support were provided for the GPS-X model development for the Hanover Park WRP, which is an important part of the Master Plan Study. We provided an up-to-date process train schematic including all recycles and sampling locations to assist with the model development. Historical analytical data was also retrieved and provided.

Workshops attended included topics on peak flow management, odor control, static and dynamic process modeling, sustainability, liquid and solids processing, and future alternatives. The draft report reviewed was "Draft Report on Initial Assessment of Conditions and Future Needs."

Regulatory Monitoring, Reviews, and Technical Development

Odor Monitoring Programs. As part of the District's continuing odor surveillance program, the EM&R Division conducts odor monitoring at the Harlem Avenue Solids Management Area (HASMA), Vulcan, the Lawndale Avenue Solids Management Area, Marathon Solids Drying Area (SDA), and Calumet SDAs. A similar odor monitoring program was initiated in the spring of 2001 at the Stony Island and the Ridgeland Avenue Solids Management Area SDAs. The programs are a part of the NPDES permits for the solids management areas. Odor monitoring is also conducted at the Calumet WRP, the Egan WRP, the Stickney WRP, the Kirie WRP, and the North Side WRP.

A similar protocol for monitoring odors is used at each location. Either M&R or M&O personnel visit the monitoring stations at each site on a regular basis. Frequency can range from once per week (as with the Egan WRP), or daily (as with the Kirie WRP), depending on the program. The odor monitoring personnel make subjective observations regarding the character and intensity of odors at each of the stations. The odor intensities are ranked on a scale from 0, no odor, to 5, very strong odor. These data are tabulated monthly.

The objective of the program is to collect and maintain a database of odor levels within and around each WRP and associated solids processing areas. The data are used to study the

trends in odor levels associated with WRP operations, and to relate odor levels to changing conditions within the WRP, such as installation of odor control equipment.

Since several residential areas surround the WRPs in the program, the odor monitoring activities also provide early warning of odorous conditions that develop within the WRPs, to allow for corrective action before they become a nuisance to area residents.

The details of the odor surveillance program and odors detected at or near District operations have been summarized in an M&R report entitled "Odor Monitoring Program at Metropolitan Water Reclamation District Facilities during 2008" (M&R Report No. 09-45).

Estimation of Emission of Hazardous Air Pollutants. Under Section 112 of Title I of the Clean Air Act, a publicly owned treatment works (POTW) is considered a major source of hazardous air pollutants (HAPs) if it emits or has the potential to emit 10 tons per year or more of any HAP or 25 tons per year or more of any combination of HAPs.

Samples of the influent sewage to each of the District's WRPs are collected twice a year and analyzed by the Organic Chemical Analytical Laboratory for 65 of the HAP compounds of concern to POTWs. Estimates of the emissions of these HAPs from the wastewater treatment process units (grit chamber, primary settling tanks, aeration tanks, and secondary settling tanks) are made using the Bay Area Sewage Toxics Emissions (BASTE) computer model developed by CH2M Hill. The average concentration of each HAP detected in the influent sewage was used as input to the model along with the annual running average operating conditions. The physical properties of the individual compounds were taken from the United States Environmental Protection Agency (USEPA) database.

During 2008, influent samples were collected in January and July. The average influent concentrations found are presented in Table II-4 for the three major District WRPs. The estimated emissions of individual HAPs for the three major District WRPs are summarized in Table II-5.

According to the BASTE model, all of the individual HAP emissions were less than the 10 ton/year criterion. Propionaldehyde and acetaldehyde were the predominant compounds emitted from the wastewater treatment processes at the Stickney WRP. Toluene and cumene were the predominant compounds emitted from the Calumet WRP liquid stream. The HAP emissions from the North Side WRP were very low, mostly less than 0.2 ton/yr. The total measured HAP emissions were substantially less than the 25 ton/year threshold at each of the three WRPs. The wastewater treatment process units at the District's WRPs are not a major source of HAPs.

Additional Digestion Tests for Calumet and John E. Egan Water Reclamation Plants. Additional digestion tests are conducted as part of a continuous monitoring program that assesses whether the requirements for vector attraction reduction are met during the biosolids processing at the District WRPs employing Option 2 of Section 503.33(b) of the 40 CFR Part 503 Regulations (Option 2). Option 2 states that vector attraction reduction is demonstrated if

after anaerobic digestion of the biosolids the volatile solids (VS) in the biosolids are reduced by less than 17% in an additional 40 day bench-scale anaerobic digestion test at a temperature between 30° and 37°C.

In 2008 a total of 15 bench-scale additional digestion tests were performed in the WTPR Laboratory for the digester draw from the Calumet WRP. Of the 15 tests conducted in 2008, the additional VS reductions in 14 tests were less than 17% as shown in Table II-6. The additional VS reduction of greater than 17% occurred in the April 2008 test. However, VS reduction of 38% through plant-scale anaerobic digesters at the Calumet WRP was achieved in April, 2008, as shown in Table II-7. Table II-7 shows that 38% VS reduction through plant-scale anaerobic digesters was not achieved in August and September of 2008. However, as shown in Table II-6, additional VS reduction of less than 17% was achieved in the additional 40 day bench-scale tests in both August and September 2008. Therefore, the combined monitoring results indicated that the requirements for vector attraction reduction were met at the Calumet WRP throughout 2008.

Upon the request of M&O, the laboratory-scale additional anaerobic digestion tests in accordance with Option 2 were routinely conducted for the Egan WRP during a chemical P removal project in 2008. A total of 25 tests were performed in 2008. Table II-8 presents the test results from these 25 tests along with monthly averages, which are used to evaluate whether the requirements for vector attractor reduction are met. The monthly average test results indicated that additional VS reductions of less than 17% had been achieved in every month of 2008 except for January.

Tunnel and Reservoir Plan Groundwater Monitoring Reports and Thornton Transitional Flood Control Reservoir Fill Events for 2008. Groundwater monitoring reports for the year 2008 were prepared for the six Tunnel and Reservoir Plan systems, which include the Mainstream (Report No. 09-47), Calumet (Report No. 09-37), Des Plaines (Report No. 09-43), and UDP Tunnel Systems (Report No. 09-35), the O'Hare Chicago Underflow Plan Reservoir (Report No. 09-41), and the Thornton Transitional Flood Control Reservoir (Thornton Reservoir) (Report No. 09-48). One report for each system has been published as an M&R report in 2009. All six reports have been submitted to the Illinois Environmental Protection Agency (IEPA) as well as the USEPA. The detailed monitoring requirement and results can be found in these reports.

One of the reporting requirements for the Thornton Reservoir as specified by the IEPA is to prepare a narrative report of fill events that have occurred during the year. There were five fill events at the Thornton Reservoir during the year 2008: January 8, 2008; February 17–18, 2008; May 11–12, 2008; September 13–16, 2008; and December 29, 2008.

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Chemical Phosphorus Removal at the John E. Egan Water Reclamation Plant. For the Salt Creek Phosphorus Reduction Demonstration Project, the P concentrations in the final

effluent of the Egan WRP were reduced to a target level of 0.5 mg/L of TP. Chemical precipitation of P with ferric chloride ($FeCl_3$) was used. Full-scale chemical P removal was conducted from February 2007 through December 24, 2008. Additional data were collected post $FeCl_3$ application until March 12, 2009, to evaluate the impact on solids thickening, digestion and dewatering operations, During 2008, $FeCl_3$ injection was moved from the end of the aeration tanks (January 1 through May 20, 2008) to immediately upstream of the primary clarifiers at the exit end of the aerated grit chambers (May 21, 2008, through December 24, 2008). The average TP concentration in the final effluent of the Egan WRP from January 1 to December 24, 2008, was 0.43 mg/L with a range from 0.09 to 1.38 mg/L. The WTPR Section monitored impacts of chemical P removal on treatment plant operations, solids production, and solids management. Two interim reports summarizing the monitoring results for this project were prepared in 2008. An M&R report describing this project in detail and presenting the results from the entire study will be prepared in 2009.

Calumet Continuous Ambient Hydrogen Sulfide Monitors. Two H_2S monitoring stations were set up in October 2002 for the continuous monitoring and recording of ambient air H_2S concentration. One station (North Monitor) is located at the northern boundary of the Calumet WRP, and the second station (South Monitor) is located outside of the plant fence line near 130th Street. Each station consists of a H_2S analyzer in a temperature-controlled shelter. The monitors are Single Point Monitors made by Honeywell Analytics. Lead acetate impregnated tape is used for the measurement of H_2S with a concentration range of 0 to 90 parts per billion by volume (ppbv). Measurements are recorded every eight minutes.

In 2008, both monitors were in operation all year except for December, when both stationary monitors were out of service. All minimum values were zero. The majority of the concentration values were less than 10 ppbv.

The South and North Monitor percentage of values greater than 10 ppbv for the months of June through August varied from 0.2–5% and 0.1–2.0%. The monthly maximum H_2S concentrations ranged from 0 ppbv to 100.2 ppbv for the North Monitor and from 0 ppbv to 18.2 ppbv for the South Monitor.

The highest H_2S concentration of 100.2 ppbv was recorded on August 28, 2008, and September 1, 2008, with the North Monitor. The H_2S concentration peaked late at night or in the early morning hours.

Ultraviolet Disinfection. The Master Plan recommended UV disinfection for all the major WRPs in anticipation of future NPDES permit requirements. The M&R Department conducted a number of laboratory-scale studies in 2007 to determine the UV dose-response relationship for the all seven WRPs' effluent. Results indicated that collectively, a 2-log reduction in FC for each WRP effluent was achieved with a UV dose of 10 mJ/cm^2. However, a 2-log reduction in FC was not observed with Egan WRP secondary effluent within the study dose range (0–40 mJ/cm^2).

A P removal study using $FeCl_3$ at the Egan WRP coincided with this preliminary UV study. $FeCl_3$ or a residual product was thought to inhibit UV disinfection of the unfiltered secondary effluent. In Spring 2008, a laboratory collimated beam evaluation was performed to examine the effects of $FeCl_3$ on UV disinfection with Egan WRP secondary effluent prior to filtration (unfiltered secondary effluent) and final effluent after filtration (filtered secondary effluent).

Grab samples from each stream were collected on nine separate days and analyzed for TS, TSS, total iron (TFe), TP, FC, and UV transmittance (UVT). Overall, lower TS, TSS, TFe, TP, and FC concentrations were observed in the filtered secondary effluent. The raw unfiltered and filtered secondary effluent had geometric mean FC concentrations of 3,206 and 1,040 colony-forming units (CFU)/mL, respectively. As expected, higher UVTs were observed at lower TSS concentrations and lower iron concentrations.

In the collimated beam tests, the raw samples were exposed to a UV dose range of 0–40 mJ/cm^2. It was observed that the average doses to achieve a reduction to 400 CFU/mL FC were 9.1 mJ/cm^2 and 0.5 mJ/cm^2 for unfiltered and filtered secondary effluent, respectively. Additionally, the doses needed to achieve a 2-log reduction in FC were >40 mJ/cm^2 and 20 mJ/cm^2 for unfiltered and filtered secondary effluent, respectively. Based on these results, lower TS, lower iron, and higher UVTs in a water sample require a lower UV dose for disinfection.

A second evaluation repeating the 2008 study is planned for 2009 to verify the above results. Additionally, a specific evaluation to examine the effects of iron concentration on UV disinfection is planned.

Methane and Nitrous Oxide Emissions from Wastewater Treatment. According to a recent EPA report (Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990–2004, USEPA 2006), domestic and industrial wastewater treatment is the sixth highest contributor to atmospheric methane (CH_4), and treatment of domestic wastewater is the fourth highest contributor to atmospheric nitrous oxide (N_2O). A literature review concluded that anaerobic digestion of organic material was the main source of CH_4 emissions, and incomplete nitrification and denitrification was the main source of N_2O emissions.

A short-term monitoring plan to evaluate the rate of emissions of CH_4, N_2O, and carbon dioxide (CO_2) was initiated at the Stickney WRP in the Fall of 2008. As an initial exploratory approach, a number of samples were collected from within the plant as follows: 1) gas emissions from the water surfaces of the aeration batteries, primary and secondary clarifiers, aerated grit chambers, and Imhoff tanks; 2) fugitive gas emissions from the floating cover anaerobic digesters and sludge concentration tanks; 3) gas emissions from the exhaust points of the coarse Screen Building, Fine Screen and Concentration Tank Building, Pre-Centrifuge Building, Post-Centrifuge Building, and Digester Building; 4) gas emissions from the HASMA biosolids drying bed; and 5) gas samples at the perimeter of the WRP.

The highest CH_4 flux values were found in the Imhoff tanks, anaerobic digester exterior, and aeration batteries. The highest N_2O flux values were found in the aerated grit chamber and aeration batteries. The highest CO_2 fluxes were found in the aerated grit chambers, aeration

batteries, and the anaerobic digester exterior. No greenhouse gases were detected at the plant perimeter.

Due to the high variability of the sampled gas concentrations, both spatially and temporally, and the limited number of samples collected, no firm value can be provided for the annual fluxes of the three greenhouse gases. In 2009, a comprehensive monitoring study will be performed in order to truly assess the greenhouse gas flux from the Stickney WRP. This study will concentrate on the spatial variability with respect to the aeration batteries, settling tanks, grit chambers, and Imhoff batteries. Additionally, an evaluation of the seasonal and diurnal effects for Stickney and possibly other District WRPs will be made.

Evaluation of Quaternary Ammonia Chloride Coated-Sand Disinfection of Water Reclamation Plant Effluent. The WTPR Section conducted a screening-level assessment of wastewater disinfection using quaternary ammonia chloride (QAC) technology. QAC is reported to be an effective disinfectant used for surfaces in the medical industry. A sand filter treated with QAC could potentially eliminate the need for chlorination or UV disinfection. The objective of this study was to evaluate the disinfection effectiveness of QAC-treated sand filtration in a bench-scale study.

The primary goal of the bench-scale study was to determine if the QAC-treated sand has superior disinfection properties compared to the same sand without the QAC coating. The disinfection effectiveness was determined by *Escherichia coli* (*E. coli*) and total coliform (TC) reduction. A secondary goal was to determine if the QAC coated sand causes foaming of the wastewater.

Two bench-scale units of sand filters were constructed with 1-liter plastic graduated cylinders. Ports were installed on the graduated cylinders at 50 mL to collect the samples after filtration. The flow rate was designed to be 80 L/m^2-min. The flow rate was controlled with a peristaltic pump. Samples of Stickney WRP final effluent were used in the bench tests. Filtrates were collected and the pH and temperature of the sample were measured and documented. An unfiltered sample of Stickney WRP effluent was collected and analyzed along with filtered samples. Samples of autoclaved de-ionized water were used as blanks for both sand filters. Duplicate tests for each sample were run. The samples to be tested were collected in sterile 50-mL vials, which were sent to the Microbiology Laboratory to be analyzed for *E. coli* and TC. IDEXX Laboratories Quanti-Tray Most Probable Number method was used to determine the density of *E. coli* and TC.

Additional samples were collected in 50-mL vials with 25 mL of aliquot. The vial was capped, and vigorously shaken for two minutes to evaluate foaming tendencies. Foaming and turbidity were evaluated by visual inspection.

The disinfection results of the sand filter's efficacy are shown in Table II-9. The water blank samples had no detectable levels of *E. coli* or TC when passed through the sand filters. The effluent temperature was 4°C and pH was 6.8.

The unfiltered water blank and effluent control samples, upon shaking, did not foam or appear turbid. However, the samples that passed through the sand filters all showed some turbidity and foaming. The samples that passed through untreated sand had slight foaming with a marked increase in turbidity. The samples that passed through the QAC-treated sand had the twice foam volume as the untreated sand samples. The turbidity of the samples that passed through the QAC-treated sand was less than that of the samples through the untreated sand.

The predicted improved disinfection of WRP effluent filtered through QAC-treated sand compared to untreated sand was not found. The QAC-treated sand was less effective at removing *E. coli* and TC than the untreated sand. The log reductions were less than one. Generally, a 4-log or 5-log reduction is expected for disinfection of WRP effluent. The prediction for increased foaming due to the QAC-treated sand filtration was verified. The reduced turbidity of samples filtered with QAC-treated sand was not predicted.

The disinfection of the effluent appears to be due more to the sand filtering effects than the disinfection properties of the QAC. The QAC-treated sand had problems wetting the sand. The wetting problem was caused by the hydrophobic properties of QAC, according to the supplier.

The flow through the QAC-treated sand could not be maintained as designed due to the hydrophobic nature of the QAC-treated sand. The actual flow rate was 1 L/m^2-min. Both filters were operated with the same flow rate during the tests.

The QAC-treated sand does not appear to be an effective disinfectant for WRP effluent according to the bench-scale test results. The *E. coli* and TC log reduction was not high enough to consider the QAC-treated sand filtration process for further testing. The additional problems with filtrate foaming and wetting the media indicate that considerable developmental work will be needed before the QAC-treated sand can be used for WRP effluent disinfection.

Chicago Department of Transportation Blue Island Sustainable Streetscape Project. The Chicago Department of Transportation plans to begin construction of the Sustainable Streetscape Project (SSP) located on West Cermak Road between South Halsted Street and South Ashland Avenue, and South Blue Island Avenue between South Ashland Avenue and South Western Avenue. This SSP will include a number of control strategies referred to as Best Management Practices (BMPs) to mitigate runoff volumes and associated diffuse pollution due to wet-weather flow. More specifically, it is hoped that the SSP will provide the following: 1) combined sewer overflow abatement; 2) overall flow and pollutant loading reduction to treatment plants; and 3) increased aesthetics of the urban environment. The SSP BMPs include permeable pavers, infiltration basins, planters, and bioswales. These BMPs were designed to account for the complete diversion of a two-year storm event from entering the District sewer system.

M&R has developed a long-term monitoring plan to assess the performance, effectiveness, and efficiency of a collection of BMPs and, if possible, individual BMPs relative to stormwater flow and pollutant load reduction in the Streetscape corridor. Prior to BMP implementation, background monitoring was conducted in 2008, and the following will be

examined: 1) rainfall; 2) stormwater flow and water quality; 2) combined sewer wastewater flow and water quality; 3) groundwater levels and water quality; 4) and soil and biomass quality of current tree pits. Upon BMP implementation, the following will be examined: 1) rainfall; 2) stormwater flow and water quality; 2) combined sewer wastewater flow and water quality; 3) groundwater levels and water quality; 4) soil moisture, soil quality, and soil water quality in planters; 5) biomass quality in planters; overflow and water quality from select BMPs; and 6) sediment quality in catch basins.

Currently, the District in collaboration with the United States Geological Survey is monitoring rainfall, stormwater runoff, combined sewer flow, and groundwater at select locations in the project area for a background evaluation. In 2009, modeling efforts to characterize the pre- and post-BMP conditions will be initiated and water quality monitoring of runoff and combined sewer flow will begin.

TABLE II-1: CENTRIFUGE COMPLEX WINTER POLYMER TEST RESULTS AT THE STICKNEY WATER RECLAMATION PLANT—JANUARY 2008

Number of Vendors Involved in Tests	3
Number of Polymers Submitted for Testing	5
Number of Polymers Qualified for Bidding	5
Polymer Selected	Polydyne CE 1142
Polymer Dosage, lbs/dry ton	430.2

TABLE II-2: SUMMARY OF NUMBER OF SAMPLES ANALYZED FOR FILAMENT ANALYSIS FOR EACH WATER RECLAMATION PLANT IN 2008

WRP	Samples Analyzed
Egan	123
Kirie	41
Lemont	131
North Side	178
Calumet	124
Stickney	36
Total	633

TABLE II-3: SUMMARY OF NUMBER OF FILAMENT IDENTIFICATION ANALYSIS FOR EACH WATER RECLAMATION PLANT IN 2008

WRP	Samples Analyzed
Egan	91
Kirie	0
Hanover Park	16
Lemont	6
North Side	0
Calumet	0
Stickney	0
Total	113

TABLE II-4: INFLUENT HAZARDOUS AIR POLLUTANT CONCENTRATIONS AT THE METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO'S MAJOR WATER RECLAMATION PLANTS IN 2008[1]

HAP Organic Compound	Concentrations in µg/L		
	Stickney	Calumet	North Side
Dichloromethane	1.5	0.5	3.2
Chloroform	2.9	2.6	2.7
Benzene	0.0	3.6	0.0
Tetrachloroethene	0.8	0.0	1.0
Toluene	12.8	25.2	2.6
Carbon disulfide	0.0	2.2	1.2
Methyl ethyl ketone	18.2	0.6	0.0
Styrene	0.2	0.4	0.0
Xylene (total)	3.2	1.6	0.0
Cresol (total)	0.5	1.4	5.2
Acetophenone	0.0	30.4	0.0
Cumene	0.0	18.3	0.0
2,4-D, salts and esters	0.0	5.8	0.0
Acetaldehyde	78.9	0.0	0.0
Propionaldehyde	99.5	0.0	0.0
Bis(2-ethylhexylphthalate)	0.9	0.0	0.0
Ethylbenzene	0.7	0.0	0.0
Naphthalene	1.4	0.0	0.0
Phenanthrene	1.4	0.0	0.0
2,2,4-Trimethylpentane	0.8	0.0	0.0

[1]Average results of the two influent samples collected in January and July 2008.

TABLE II-5: HAZARDOUS AIR POLLUTANT EMISSIONS FROM THE METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO'S MAJOR WATER RECLAMATION PLANTS IN 2008[1]

HAP Organic Compound	Emissions in tons/yr		
	Stickney	Calumet	North Side
Dichloromethane	0.2	0.0	0.2
Chloroform	0.3	0.1	0.1
Benzene	0.0	0.1	0.0
Tetrachloroethene	0.2	0.0	0.1
Toluene	0.1	0.8	0.1
Carbon disulfide	0.0	0.1	0.1
Methyl ethyl ketone	0.2	0.0	0.0
Styrene	0.3	0.0	0.0
Xylene (total)	0.3	0.1	0.0
Cresol (total)	0.0	0.0	0.0
Acetophenone	0.0	0.0	0.0
Cumene	0.0	0.6	0.0
2,4-D salts and esters	0.0	0.0	0.0
Acetaldehyde	2.1	0.0	0.0
Propionaldehyde	4.4	0.0	0.0
Bis(2-ethylhexylphthalate)	0.0	0.0	0.0
Ethylbenzene	0.1	0.0	0.0
Naphthalene	0.1	0.0	0.0
Phenanthrene	0.0	0.0	0.0
2,2,4-Trimethylpentane	0.8	0.0	0.0

[1]Emissions estimated using the BASTE model.

TABLE II-6: RESULTS OF ADDITIONAL ANAEROBIC DIGESTION TESTS FOR THE CALUMET WATER RECLAMATION PLANT PER OPTION 2 OF SECTION 503.33(b) OF THE 40 CFR PART 503 REGULATIONS FOR 2008

Test Start Date	Before Test		After Test*		Volatile Solids (VS) Reduction (%)	
	TS (%)	VS (%)	TS (%)	VS (%)	By Equation**	By Mass
1/10/08	1.46	55.42	1.39	53.61	7.0	7.9
2/7/08	2.18	51.86	2.04	49.32	9.7	11.4
3/13/08	2.15	51.89	2.03	48.54	12.5	11.5
4/4/08	2.31	55.76	2.10	50.31	19.7	18.0
5/8/08	2.47	51.58	2.35	48.95	10.0	9.8
5/22/08	2.42	52.00	2.35	47.98	14.9	10.3
6/19/08	2.48	50.76	2.33	47.17	13.4	12.8
7/16/08	2.45	53.02	2.24	48.65	16.0	15.8
8/7/08	2.35	51.14	2.24	48.84	8.8	8.9
8/21/08	2.52	50.45	2.33	46.15	15.8	15.6
9/18/08	1.98	51.44	1.82	48.51	11.1	13.3
9/24/08	2.71	48.76	2.55	46.47	8.8	10.5
10/2/08	2.86	48.08	2.70	45.95	8.2	10.0
11/13/08	2.33	50.48	2.37	47.63	10.8	4.2
12/11/08	2.11	57.26	1.96	53.31	14.8	13.4
May Average	2.44	51.79	2.35	48.47	12.4	10.0
August Average	2.44	50.80	2.29	47.49	12.3	12.3
September Average	2.35	50.10	2.18	47.49	9.9	11.9
Yearly						
Mean	2.32	51.99	2.19	48.76	12.1	11.6
Min	1.46	48.08	1.39	45.95	7.0	4.2
Max	2.86	57.26	2.70	53.61	19.7	18.0

*After 40 day of incubation at 35.5°C in bench-scale reactors.
**The Van Kleeck Equation was used in calculations.

TABLE II-7: VOLATILE SOLIDS REDUCTION OF BIOSOLIDS AFTER 2-STEP ANAEROBIC DIGESTION AT THE CALUMET WATER RECLAMATION PLANT IN 2008

Month	Digester Feed		Digester Draw		Volatile Solids (VS) Reduction By Equation*
	TS (%)	VS (%)	TS (%)	VS (%)	
January	3.71	65.5	1.93	53.7	37.8
February	4.06	64.4	2.30	48.8	46.8
March	4.09	69.7	2.36	50.2	56.1
April	4.51	64.0	2.38	51.7	38.8
May	4.43	64.8	2.57	49.0	47.3
June	4.48	61.5	2.50	49.2	38.5
July	3.54	64.3	2.52	48.7	47.2
August	3.78	59.9	2.57	49.0	35.3
September	4.08	56.4	2.65	48.3	26.2
October	4.08	60.9	2.94	45.8	45.5
November	3.39	71.0	2.57	49.7	59.3
December	3.56	71.9	2.18	55.5	50.4
Mean	3.98	64.5	2.46	50.0	44.1
Minimum	3.39	56.4	1.93	45.8	26.2
Maximum	4.51	71.9	2.94	55.5	59.3

*The values are monthly means of daily VS reduction values.
The daily VS reduction was calculated using Van Kleeck Equation.

TABLE II-8: RESULTS OF ADDITIONAL ANAEROBIC DIGESTION TESTS FOR THE JOHN E. EGAN WATER RECLAMATION PLANT PER OPTION 2 OF SECTION 503.33(b) OF THE 40 CFR PART 503 REGULATIONS FOR 2008

Date	Before Test		After Test*		Volatile Solids (VS) Reduction (%)	
	TS (%)	VS (%)	TS (%)	VS (%)	By Equation**	By Mass
1/17/2008	2.11	66.82	1.82	62.60	16.9	19.1
1/24/2008	2.08	65.56	1.83	60.81	18.5	18.4
2/8/2008	2.10	66.64	1.91	62.81	15.5	14.3
2/21/2008	2.08	66.13	1.88	62.55	14.4	14.3
3/7/2008	2.18	64.50	1.99	60.56	15.5	14.5
3/21/2008	2.20	62.17	2.06	58.81	13.1	11.2
4/11/2008	1.64	62.09	1.49	57.58	17.2	15.8
4/24/2008	2.37	61.52	2.11	58.59	11.5	15.4
5/2/2008	1.83	62.37	1.66	56.90	20.4	17.2
5/15/2008	2.42	60.96	2.26	57.88	12.0	11.2
5/29/2008	2.72	60.88	2.49	56.63	16.1	15.0
6/12/2008	2.87	59.99	2.64	55.79	15.8	14.3
6/26/2008	3.23	59.71	2.95	55.50	15.8	14.9
7/10/2008	3.28	59.46	3.00	55.85	13.8	14.0
7/24/2008	3.22	58.97	3.03	55.44	13.4	11.5
8/14/2008	2.97	57.58	2.81	55.86	6.7	8.1
8/28/2008	2.93	57.45	2.77	53.75	13.9	11.5
9/12/2008	2.63	57.53	2.45	54.11	13.0	12.1
9/25/2008	2.68	55.35	2.54	51.78	13.4	11.3
10/9/2008	2.71	55.93	2.50	51.42	16.6	15.4
10/23/2008	2.82	55.13	2.62	51.10	15.0	14.2
11/6/2008	2.70	54.94	2.49	50.84	15.2	14.4
11/21/2008	2.53	56.18	2.38	52.38	14.2	12.5
12/4/2008	2.45	56.87	2.26	52.90	14.8	14.4
12/18/2008	2.38	59.11	2.16	55.13	15.0	15.6
January Average					17.7	18.7
February Average					15.0	14.3
March Average					14.3	12.8
April Average					14.3	15.6
May Average					16.2	14.4
June Average					15.8	14.6
July Average					13.6	12.8
August Average					10.1	9.8
September Average					13.2	11.7

TABLE II-8 (Continued): RESULTS OF ADDITIONAL ANAEROBIC DIGESTION TESTS FOR THE JOHN E. EGAN WATER RECLAMATION PLANT PER OPTION 2 OF SECTION 503.33(b) OF THE 40 CFR PART 503 REGULATIONS FOR 2008

Date	Before Test TS (%)	Before Test VS (%)	After Test* TS (%)	After Test* VS (%)	Volatile Solids (VS) Reduction (%) By Equation**	Volatile Solids (VS) Reduction (%) By Mass
October Average					15.8	14.8
November Average					14.7	13.4
December Average					14.9	15.0

*After 40 days of incubation at 35.5°C in bench-scale reactors.
**The Van Kleeck Equation was used in calculations.

TABLE II-9: *ESCHERICHIA COLI* AND TOTAL COLIFORM CONCENTRATIONS* FROM QUATERNARY AMMONIA CHLORIDE-TREATED SAND DISINFECTION

Sample	*E. coli*, MPN/100 mL	Total Coliform, MPN/100 mL
Water filtered with untreated sand	<1	<1
Water filtered with QAC treated sand	<1	<1
Effluent filtered with untreated sand	1,523	9,865
Effluent filtered with QAC treated sand	3,360	22,767
Effluent control sample	6,840	46,400

*Average value of all samples tested.

FIGURE II-1: SPECIFIC OXYGEN UPTAKE RATE VERSUS TANK LENGTH FOR JOHN E. EGAN WATER RECLAMATION PLANT SOUTH BATTERY TANK 1

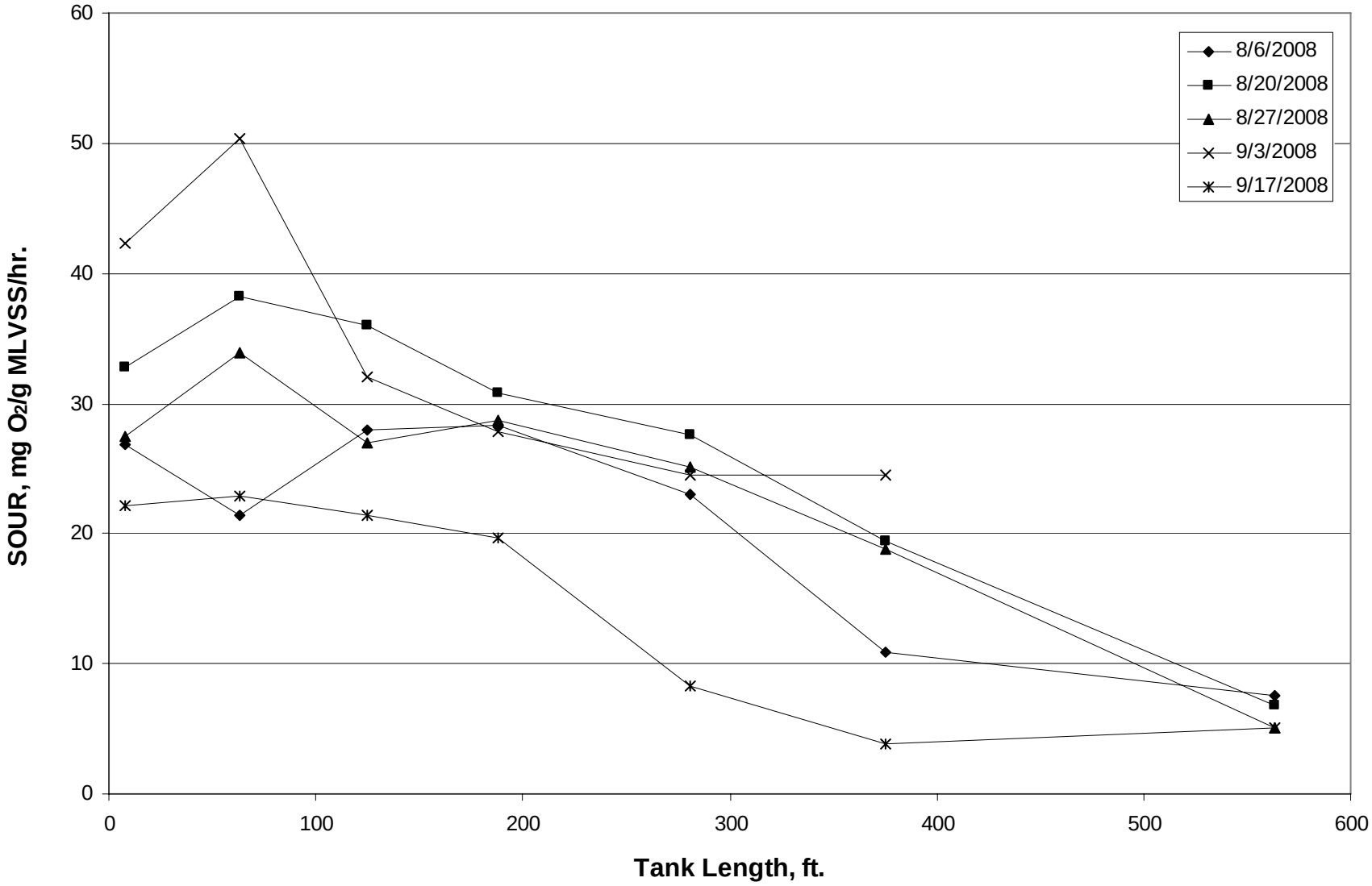


FIGURE II-2: SPECIFIC OXYGEN UPTAKE RATE VERSUS TANK LENGTH FOR JOHN E. EGAN WATER RECLAMATION PLANT SOUTH BATTERY TANK 2

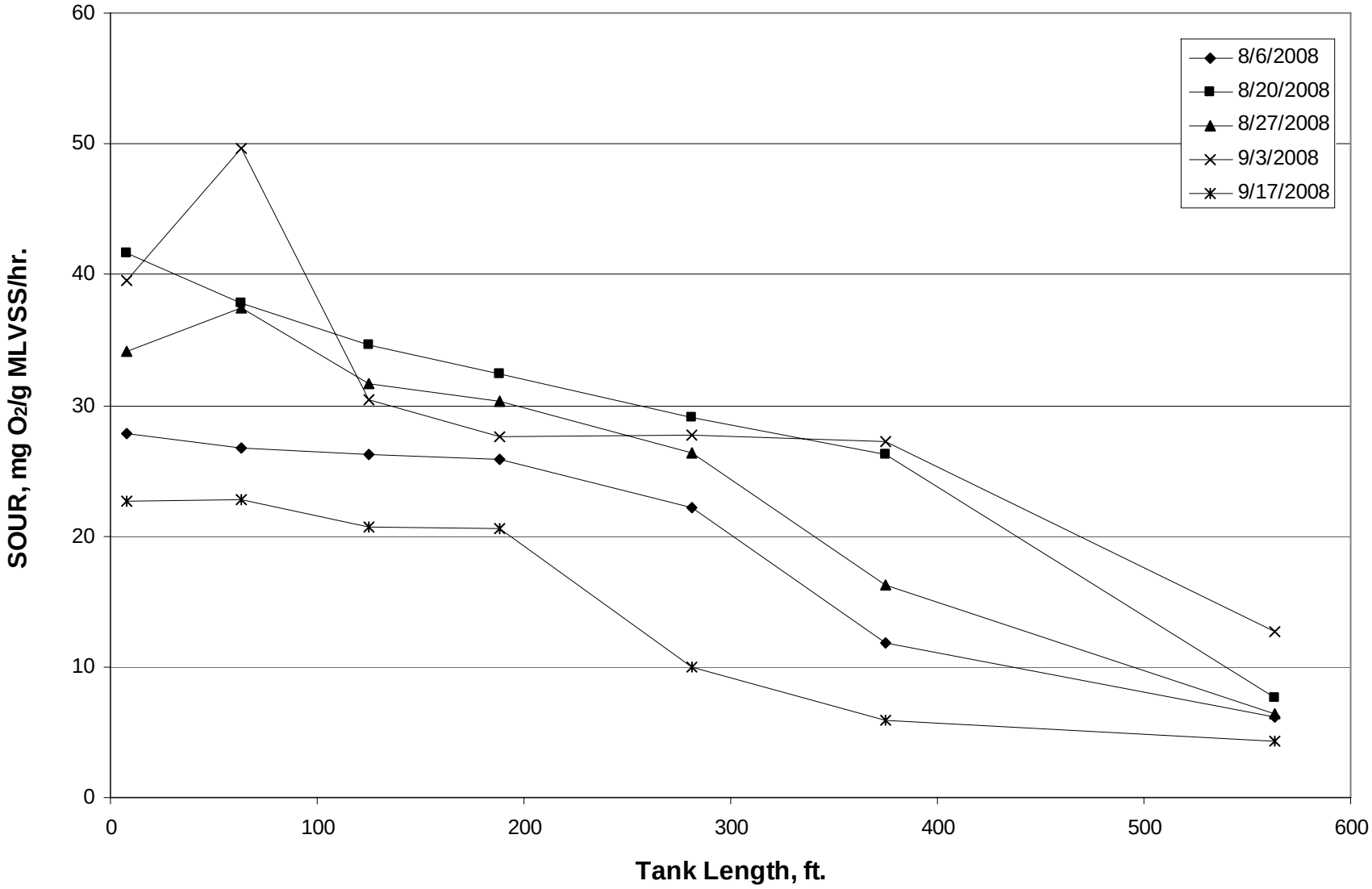
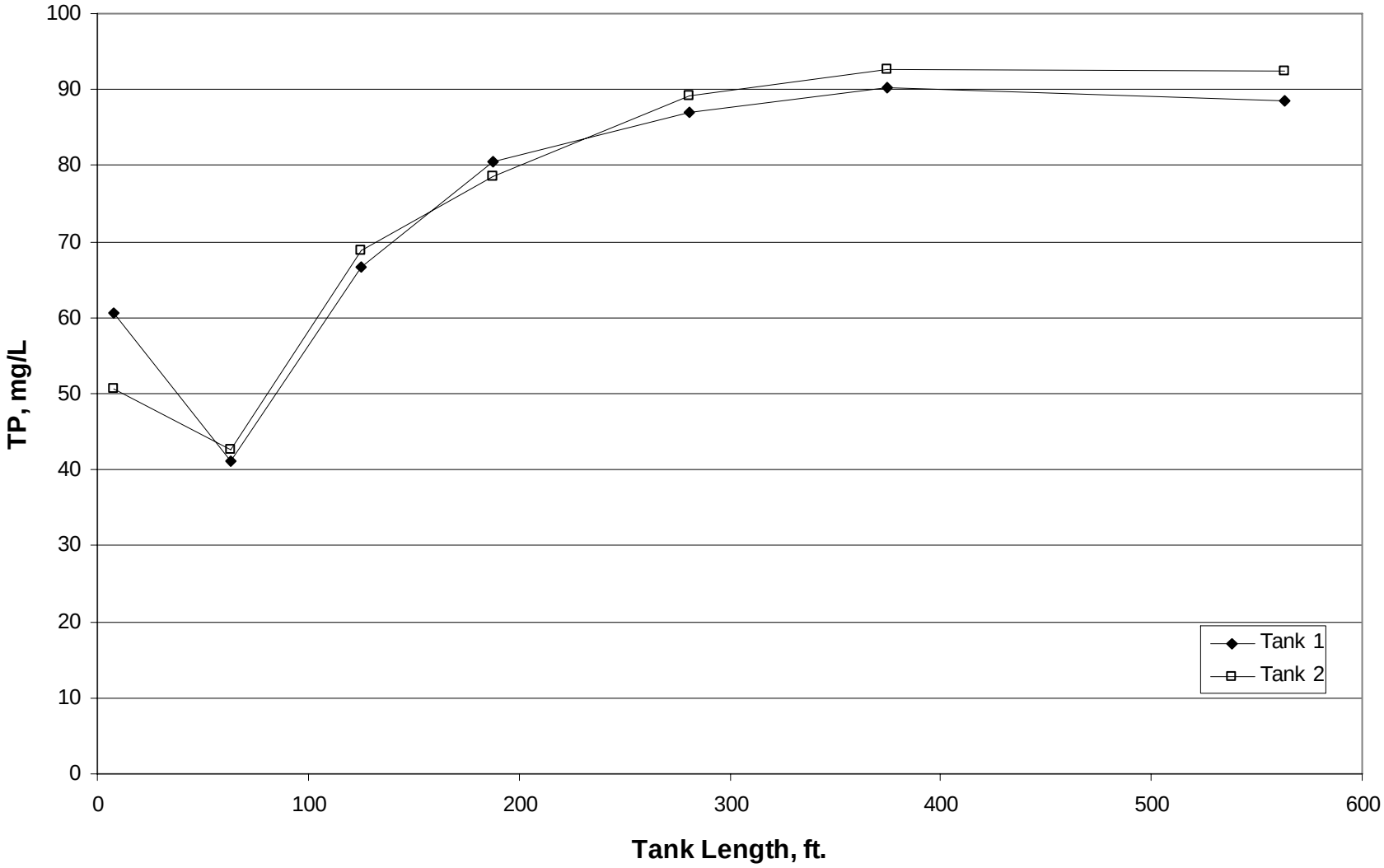
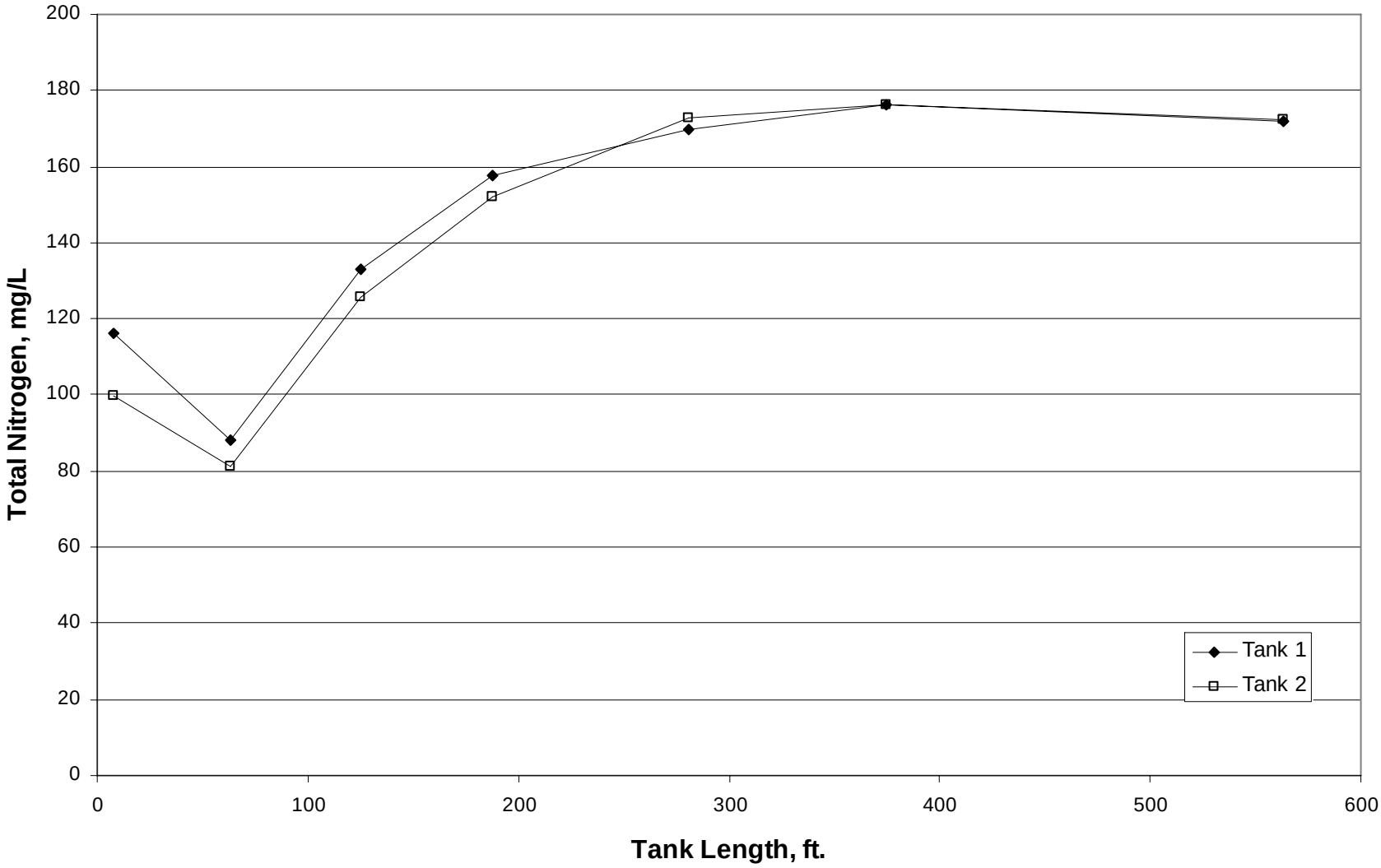


FIGURE II-3: TOTAL PHOSPHORUS PROFILE OF JOHN E. EGAN WATER RECLAMATION PLANT SOUTH BATTERY*



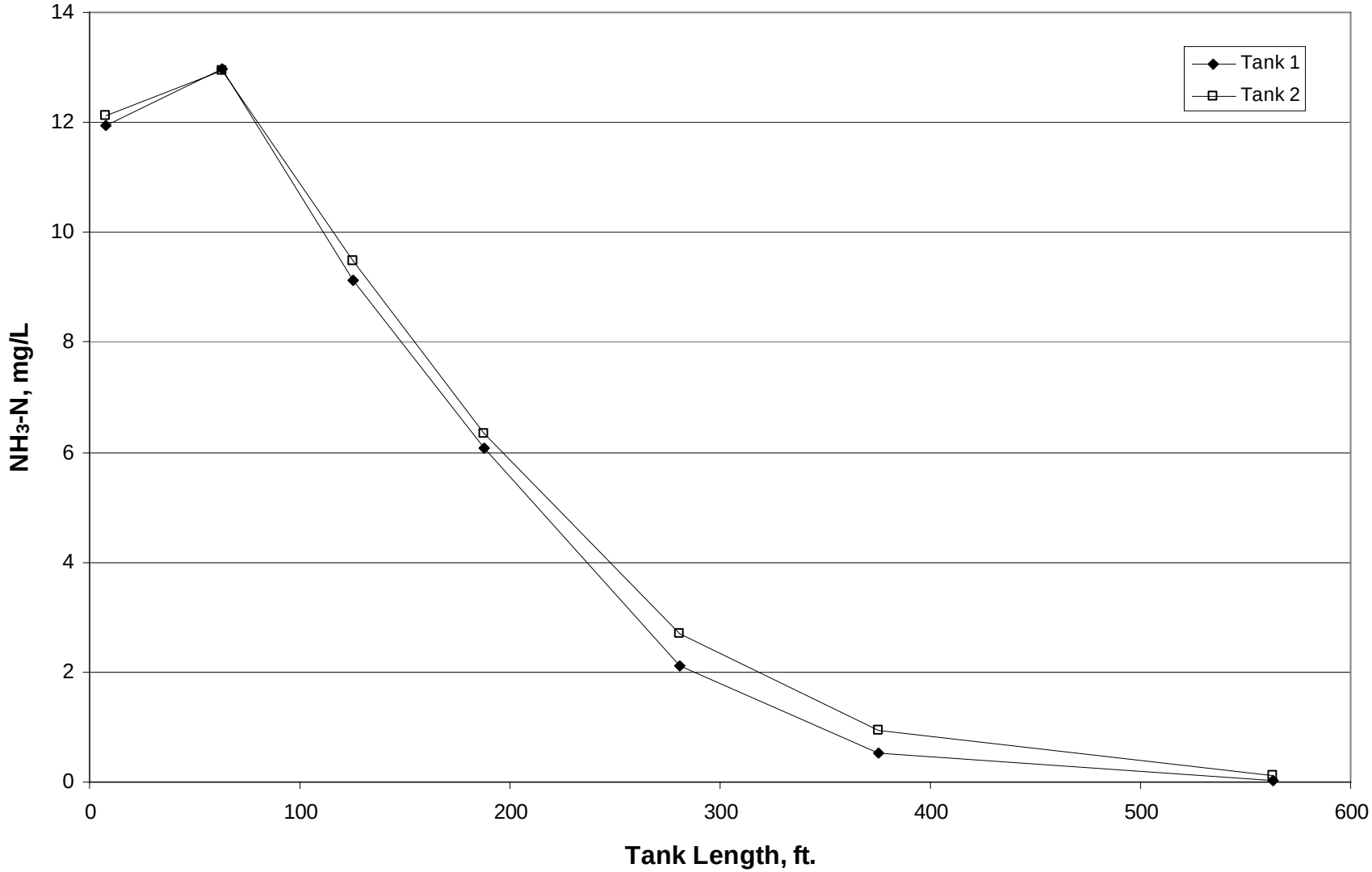
*The mean TP concentrations from five measurements on five different sampling days.

FIGURE II-4: TOTAL NITROGEN PROFILE OF JOHN E. EGAN WATER RECLAMATION PLANT SOUTH BATTERY*



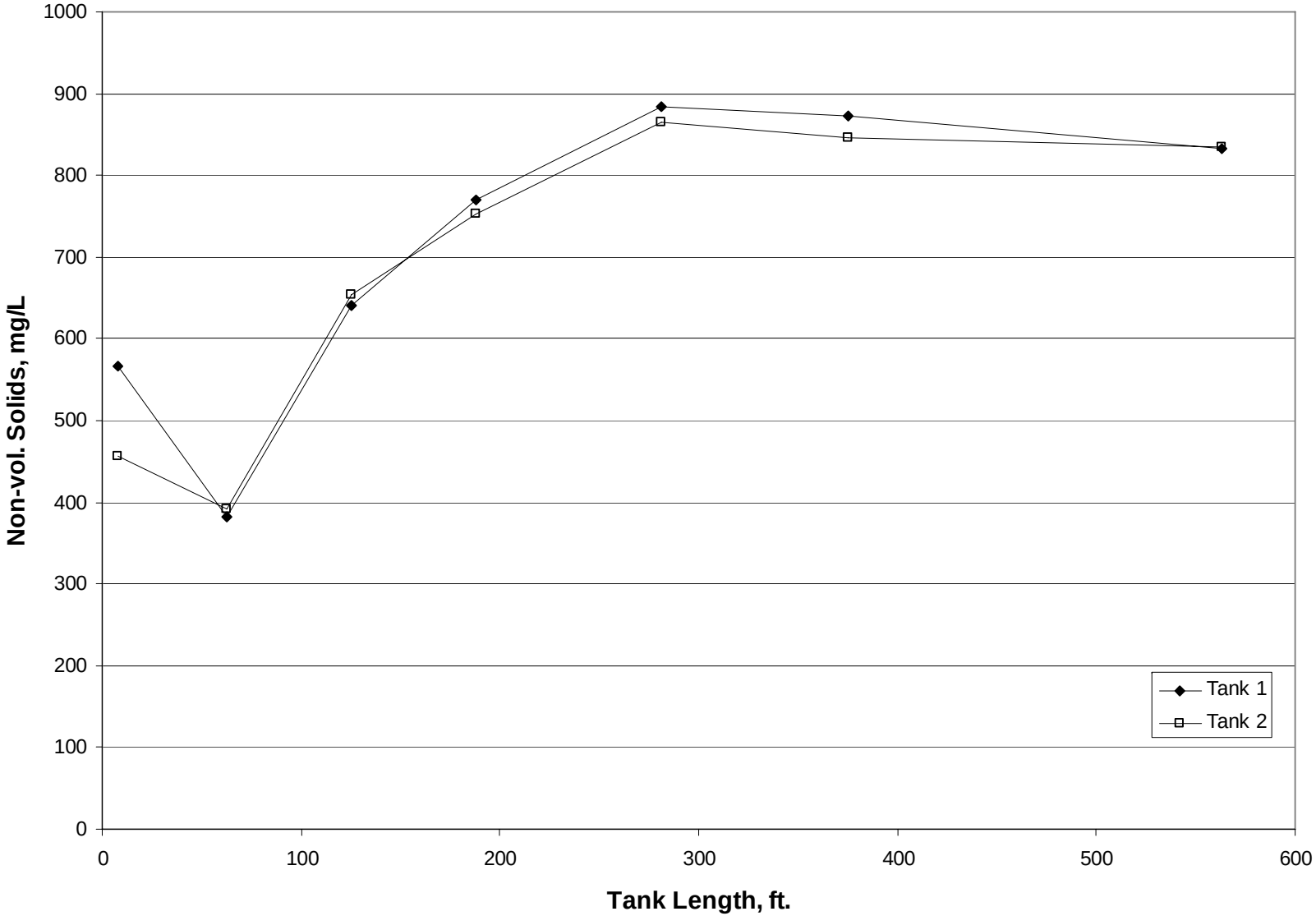
*The mean total nitrogen concentration from five sampling days, 8-6-08 through 9-17-08.

FIGURE II-5: AMMONIA NITROGEN PROFILE OF JOHN E. EGAN WATER RECLAMATION PLANT SOUTH BATTERY*



*The mean ammonia nitrogen concentration from five sampling days, 8-6-08 through 9-17-08.

FIGURE II-6: NONVOLATILE SOLIDS PROFILE FOR JOHN E. EGAN WATER RECLAMATION PLANT SOUTH BATTERY*



*The mean nonvolatile solids concentration from five sampling days, 8-6-08 through 9-17-08.

BIOSOLIDS UTILIZATION AND SOIL SCIENCE SECTION

BIOSOLIDS UTILIZATION AND SOIL SCIENCE SECTION

The role of the Biosolids Utilization and Soil Science Section is to apply science to continuously improve the cost effectiveness of the Metropolitan Water Reclamation District of Greater Chicago's biosolids management program and environmental stewardship through:

1. Research, technical assistance and public outreach;

2. Contribution to formulation of relevant regulations;

3. Compliance with applicable regulatory requirements;

4. National leadership in biosolids management;

5. Assistance on the District's green initiatives.

The long-range goals of the Biosolids and Soil Utilization Section are:

1. To conduct environmental monitoring and reporting to comply with permits and regulations governing the Metropolitan Water Reclamation District of Greater Chicago's (District's) biosolids management program.

2. To conduct applied research aimed at evaluating the benefits and environmental impacts of land application of biosolids.

3. To promote beneficial use of biosolids through dissemination of information, demonstrations, public relations, and technical support to biosolids users.

4. Monitor and review regulations and relevant issues to evaluate the impacts on District's operations, and assist with the development of technically sound regulations.

5. To provide technical support on green initiatives relevant to the District's operations.

Environmental Monitoring and Reporting

The activities conducted under the environmental monitoring and reporting goal includes sampling and analysis of biosolids, waters, soils, and plant tissue as required at biosolids land application sites, landfills, and biosolids drying facilities. The results of this monitoring are reported to the Illinois Environmental Protection Agency (IEPA) and the United States Environmental Protection Agency (USEPA).

Fulton County Environmental Monitoring. The Fulton County Land Reclamation Site is a large tract of land, 6,122.5 hectares (15,264.5 acres), owned by the District in Fulton County, Illinois. Approximately 600 hectares (1,483 acres) were sold through auction in the fall of 2004. The site is used to recycle biosolids for the purpose of reclaiming mine soil and fertilizing agricultural crops. To satisfy the IEPA permit requirements for operation of the site, the District established an environmental monitoring program to ensure that the land application of biosolids would not adversely affect surface water, groundwater, soils, and crops. When necessary, the Maintenance and Operations (M&O) Department staff located at the Fulton County site is responsible for collecting environmental monitoring samples from the site, when needed, and submit them to the Soil Science laboratory or Analytical Laboratory Division for analysis.

No supernatant or biosolids were applied to Fulton County fields during 2008. Supernatant was last applied in 1995 and biosolids were last applied in 2004. Termination of monitoring soil, crop, and surface and groundwater sites was approved by the IEPA in September 2006; and the coal refuse areas in July 2007. Therefore, no environmental monitoring or reporting is required until such time that biosolids application is resumed.

Hanover Park Fischer Farm. The Hanover Park Fischer Farm is a 48-hectare (120 acres) tract of land, which utilizes all biosolids generated at the Hanover Park Water Reclamation Plant (WRP). The farm, located on the south side of the WRP grounds, has seven gently sloping fields, each surrounded by a berm to control surface runoff. Anaerobically digested biosolids are applied by injection from tank trucks. The IEPA operating permit (No. 2007-SC-2951) for the site limits the annual biosolids application rate to 56 dry Mg/ha (25 dry tons/acre). An underground tile drain system collects surface and subsurface drainage, which is returned to the Hanover Park WRP for treatment. Groundwater monitoring is required by the IEPA operating permit. Monitoring wells on the farm have been sampled twice monthly since biosolids applications began in 1979. The analytical data for groundwater sampled from these wells were submitted to the IEPA in the quarterly monitoring reports for 2008 (Report Nos. 08-33, 08-45, 09-03, and 09-20).

Groundwater Quality Monitoring at Solids Management Areas. Groundwater quality is monitored at Solids Management Areas (SMAs) where paved cells are used for air-drying of lagoon-aged or centrifuge cake biosolids to a solids content of 60% or greater.

Groundwater Quality Monitoring at the John E. Egan Water Reclamation Plant Solids Management Area. In 1986, paved solids drying areas were constructed at the John E. Egan (Egan) WRP facility. However, since all biosolids generated at the Egan WRP are currently utilized wet as centrifuge cake through the Farmland Application Program, the Egan drying site is no longer being used. The IEPA operating permit (No. 2005-AO-4282) for this drying facility does not require groundwater monitoring unless drying resumes at the site. In October 1986, lysimeters were installed at the Egan WRP for sampling groundwater immediately below the drying site. From June 12, 2003, sampling was discontinued following the IEPA's approval of a

request from the District to discontinue monitoring. Hence, the submission of groundwater analytical data in quarterly monitoring reports to the IEPA was not required in 2008.

Groundwater Quality Monitoring at the Calumet Water Reclamation Plant Solids Management Area. The Calumet West and Calumet East SMAs were constructed at the Calumet WRP in 1986 and 1990, respectively. The IEPA operating permit (No. 2005-AO-4281) for these facilities requires groundwater monitoring. Lysimeters installed at both Calumet drying sites are sampled once per month. Analytical data were submitted to the IEPA in the quarterly reports for water samples taken in 2008 from the three lysimeters at the Calumet West SMA (Report Nos. 08-32, 08-44, 09-02, and 09-15) and from the six lysimeters at the Calumet East SMA (Report Nos. 08-31, 08-43, 09-01, and 09-14).

In 2008, some lysimeters that were not functioning properly were replaced. At the Calumet West SMA, lysimeters L-1, L-2, and L-3 were replaced by L-1N, L-2N, and L-3N, respectively. At the Calumet East SMA, lysimeters L-2, L-3, L-4, and L-6 were replaced by L-2N, L-3N, L-4N, and L-6N, respectively. The old and new lysimeters will be monitored simultaneously for one year, then a request will be submitted to the IEPA to terminate the monitoring of the old lysimeters.

Groundwater Quality Monitoring at Lawndale Avenue Solids Management Area. In 1983, the District began biosolids drying operations on clay surface cells at Lawndale Avenue Solids Management Area (LASMA). These drying surfaces were paved with asphalt in 1984. The IEPA operating permit for this site (No. 2005-AO-4283) requires groundwater monitoring.

Lysimeters and wells installed at LASMA are sampled monthly and quarterly, respectively, as required by the operating permit. The analytical results for lysimeter and well samples collected in 2008 were submitted to the IEPA in quarterly monitoring reports (Report Nos. 08-30, 08-47, 09-05, and 09-17).

In 2008, lysimeters L-1, and L-2 at LASMA were replaced by L-1N, and L-2N, respectively, because they were not functioning properly. The old and new lysimeters will be monitored simultaneously for one year, then a request will be submitted to the IEPA to terminate the monitoring of the old lysimeters.

Groundwater Quality Monitoring at Ridgeland Avenue Solids Management Area. The solids drying area at Ridgeland Avenue Solids Management Area (RASMA) was originally constructed with a clay surface and drying began in 1987, until the area was paved with asphalt in 1992 and 1993.

The IEPA operating permit for this site (No. 2005-AO-4283) requires groundwater monitoring. Lysimeters installed at RASMA are sampled biweekly, as required by the operating permit. Analytical results for the lysimeter samples collected during 2008 at this site were

submitted to the IEPA in quarterly monitoring reports (Report Nos. 08-28, 08-48, 09-06, and 09-18).

In 2005, lysimeter L-4 at RASMA was replaced by L-4N, because it was not functioning properly. The old and new lysimeters were monitored simultaneously. In 2007, the monitoring of the old lysimeter was terminated following approval by the IEPA.

Groundwater Quality Monitoring at Harlem Avenue Solids Management Area. In 1990, the District began biosolids drying operations at Harlem Avenue Solids Management Area (HASMA). The IEPA operating permit for this site (No. 2004-AO-2591) requires biweekly groundwater monitoring. Analytical data for water sampled from the four lysimeters in 2008 were submitted in quarterly reports to the IEPA (Report Nos. 08-29, 08-46, 09-04, and 09-16).

In 2008, lysimeters L-2, and L-3 at HASMA were replaced by L-2N, and L-3N, respectively because they were not functioning properly. The old and new lysimeters will be monitored simultaneously for one year, then a request will be submitted to the IEPA to terminate the monitoring of the old lysimeters.

Groundwater Quality Monitoring at the 122nd and Stony Island Solids Management Area. In 1980, drying of biosolids at the SMA located at 122nd Street and Stony Island Avenue was started on clay surface drying cells. The drying cells were paved in 1992. The IEPA operating permit for this drying facility (No. 2005-AO-4283) requires groundwater monitoring. Analytical results for water sampled monthly during 2008 from the four lysimeters at this drying facility were submitted to the IEPA in quarterly monitoring reports (Report Nos. 08-27, 08-49, 09-07, and 09-19).

Biosolids Management Regulatory Reporting. In 2008, the section prepared the 2007 biosolids management report (Report No. 08-4) to the USEPA. This report was prepared to satisfy the reporting requirements of the USEPA's 40 CFR Part 503 regulation.

In addition, 12 monthly reports for the District's Controlled Solids Distribution permit were submitted to the IEPA (Report Nos. 08-34, 08-35, 08-36, 08-37, 08-62, 08-64, 09-09, 09-11, 09-12, 09-22, 09-23, and 09-24). The Controlled Solids Distribution Program is the District's urban land application program and the reports prepared by the Section document the biosolids users, project descriptions and locations, and biosolids analyses.

Applied Research

Applied research is conducted in the Monitoring and Research laboratories and greenhouse, the District's Fulton County land reclamation site, and at other field sites in the Chicago area. Some of the research projects are conducted in collaboration with other institutions.

Corn Fertility Experiment on Calcareous Mine Spoil. Since 1973, the District has been conducting a corn fertility experiment on calcareous mine spoil at the Fulton County site. The purpose of this experiment is to evaluate the effect of long-term applications of anaerobically digested biosolids on crop yields, crop chemical composition, and mine spoil chemical composition. The experiment was designed to simulate biosolids application to fields at the site at agronomic and reclamation rates, and to provide information that can be used for management of biosolids and crops.

This is the longest running continuous biosolids research experiment in the country. Data on metal uptake in corn tissues from these plots were used in the risk assessments conducted by the USEPA to develop the 40 CFR Part 503 biosolids regulation, which was promulgated in 1993. All 35 years of soil and plant tissue samples are available in the sample repository at the Fulton County Land Reclamation Laboratory.

The study consists of four treatments of biosolids or commercial fertilizer applied to the plots each year. The amount of biosolids or commercial fertilizer added annually for each treatment is listed in Table III-1, along with the cumulative totals of biosolids applied per plot through 2008. Table III-2 shows a four-year comparison (2005 to 2008) of soil data from the experimental plots. Table III-3 shows the nutrient and metal concentrations in corn grain for the four treatments. Table III-4 shows the comparison of the corn grain and stover yields for 2006 through 2008.

Biosolids Phosphorus Studies. Land application of biosolids and other soil amendments can cause phosphorus (P) in soils to increase to excessive levels that can potentially contaminate water bodies through surface runoff. Currently, a large portion (over 60 percent) of the District's biosolids is managed through the Farmland Application Program in which Class B centrifuge cake biosolids are used as fertilizer on area farms. In an effort to minimize P contamination of surface waters, many states are beginning to implement phosphorus-based (P-based) agronomic biosolids application rates in place of the nitrogen-based (N-based) application rates that are currently used. Phosphorus-based application rates are developed based on P content of both the amendments and the soil, and on site characteristics that affect the potential for surface runoff to water bodies. The P-based agronomic biosolids application rates are much lower than the N-based rates. The P-based rates may substantially reduce the viability of land application programs in Illinois, because the low application rates of biosolids could be operationally impractical and unattractive to farmers.

In 2003, the Biosolids Utilization and Soil Science Section began to collaborate with the IEPA to initiate studies to address the potential for environmental impacts associated with application of District biosolids to cropland. Studies were developed to address the following objectives:

1. To determine the bioavailability of P in District biosolids.

2. To estimate the critical biosolids P application rate (environmental impact threshold) to farmland above which the potential for P losses in surface run-off water increases significantly.

3. To evaluate the potential for P losses in runoff following recent application of centrifuge cake biosolids and aged air-dried biosolids, which is either surface applied or incorporated in soil.

4. To evaluate the effectiveness of two lengths of vegetated buffer strips established in the setback zones of land application fields in controlling P runoff. The information obtained from this objective will be used to determine if buffer strips can be used within the required setback zone to allow the land application of biosolids to be continued at N-based rates without the potential for significant P runoff losses from farmland, where soil test P exceeds environmental impact thresholds.

This work includes the following studies:

- Bioavailability of P in District biosolids - Greenhouse Study
- Bioavailability of P in District biosolids - Field Study
- Potential of phosphorus runoff in biosolids amended soils
- Biosolids P runoff field study

Bioavailability of P in District Biosolids – Field Study. A study was initiated in 2005 at the District's Fulton County site at Field 83, which consists of non-mined soil, to test the bioavailability of biosolids P under field conditions (Objective 1). Before starting the study, the field was cropped for three years without fertilizer P application to deplete the soil to a P deficient level (less than 20 mg P/kg Bray P1 soil test level). This study evaluates crop P uptake in soil amended with two P sources: Class A air-dried biosolids from the Calumet WRP and triple superphosphate (TSP) fertilizer. The experimental layout is a randomized complete block design with four blocks of 10 treatments. The treatments include a control of zero application, sets of four each of TSP and biosolids application established based on the total P loadings associated with biosolids application rates, ranging up to 22.4 Mg/ha (10 dry tons/ac), and a high biosolids rate of 33.6 Mg/ha (15 dry tons/ac). The 10 dry tons/ac rate is equivalent to the average agronomic rate of Class B biosolids utilized in the District's Farmland Application Program. The high biosolids rate of 15 dry tons/ac was used based on the preliminary results from the greenhouse component of the bioavailability study, which indicated that the bioavailability of the biosolids P is much lower than TSP fertilizer P. In November 2005, the treatments (biosolids and TSP fertilizer) were applied to plots 90 feet wide by 120 feet long (0.25 acres) and incorporated into the plow layer (approximately 6 inches). Corn was planted as the test crop in the spring of 2006, 2007, and 2008 (with only the application of supplemental K and N fertilizer), and no additional application of biosolids or TSP treatments. Soil samples are

collected at the 0- to15-cm and 15- to 30-cm soil depths the beginning of each growing season and analyzed for soil test P and total P. Crop samples are collected to measure grain and dry matter yields and tissue P concentration.

The crop P uptake and the changes in soil P in the 0- to 30-cm soil depth during 2005 through 2008 are presented in Table III-5.

Biosolids P Runoff Field Study. This study was designed to address Objective 3, to evaluate the effectiveness of different lengths of vegetated buffer strips. In 2004, five noncontiguous locations in Field 63 at the Fulton County site were selected as main plots. Each of the main plots was 0.72-ha (1 ac), 122 m (400 ft.) long along the slope by 61 m (200 ft.) wide, and was split into two subplots 30.5 m (100 ft.) wide by 61 m (200 ft.) long. The plots were graded lightly to improve surface uniformity such that the slope throughout most of the plots ranged from 3 to 5 percent. A vegetated buffer area was established by planting a mixture of alfalfa (*Medicago sativa* L.) and bromegrass (*Bromus inermis*) on the entire 61-m length of the down-slope portion of the main plots.

In 2005 - 2007, biosolids were applied each spring to the up-slope half of eight of the subplots at two loading rates of 11.25 and 22.5 Mg/ha (5 and 10 dry tons/ac), such that there were four replicates of each amended plot and two unamended control plots. The 22.5 Mg/ha biosolids rate represents the typical N-based application rate of District biosolids. In fall 2008, the plots and the runoff collection system were reconfigured to obtain more reliable data compared to the original design. The new configuration consists of one treatment unit in each of four main plots, and two treatment units in one main plot. This gives a total of six treatment units. Each of the treatment units, as shown in Figure III-1, consist of three subplots 21.5 m (70 ft.) long by 3.1 m (10 ft.) wide separated by aluminum edging. One runoff collection system was installed in the sub-plots at either 0, 25 or 50 ft. from the edge in the vegetated buffer area down-slope. Based on data available in the literature, the reconfigured plots will allow for the use of a plot to buffer ratio for comparing the effectiveness of a range of buffer lengths, including the 100 ft. and 200 ft. buffers established in the original plot design.

Beginning in spring 2009, centrifuge cake biosolids will be applied in three of the treatment units at a rate of 22.5 Mg/ha (10 dry tons/ac). Triple superphosphate will be applied to the other three plots at a total P rate equivalent to the rate associated with the 40 wet tons/acre biosolids.

Runoff was collected from all reconfigured runoff collection systems in fall 2008. The weighted-mean P concentrations in the runoff collected in 2008 are presented in Table III-6.

Bioavailability of P in District Biosolids – Greenhouse Study. The greenhouse study was started in 2004. The study was designed to evaluate the bioavailability of P in the District's air-dried Class A biosolids and centrifuge cake Class B biosolids, relative to TSP fertilizer P (Objective 1). This study was completed in 2006 and a report is being prepared.

Potential for P Runoff in Biosolids Amended Soil. This study was conducted to address Objective 3, to evaluate potential for P losses in runoff following recent applications of centrifuge cake biosolids and aged, air-dried biosolids that are either surface applied or incorporated in soil. This study was completed in 2006 and a report of this work is being prepared.

Nitrogen Mineralization in Biosolids. One of the challenges in land application of biosolids as a nutrient source is predicting the nitrogen (N) mineralization rates so that crop nutrient requirement are met with minimal potential for contamination of receiving waters from biosolids-derived N. Portions of 1 kg of a silty clay loam from Will County and a sandy soil from Kankakee County were moistened to approximately 80 percent of field capacity. The moistened soils were amended with five treatments consisting of centrifuge cake biosolids and lagoon-aged, air-dried biosolids, each from Calumet and Stickney WRPs, and Milorganite biosolids applied to supply total N at 200 lbs. N/acre. This N rate is the approximate amount of N applied in centrifuge cake biosolids at 40 wet tons/acre, which is the typical application used in the District's Farmland Application Program. A treatment of non-amended soil was also included as a control. The biosolids-amended and non-amended control soil was incubated for 100 days at $20\pm2^{o}C$. Periodically, soil samples were removed and analyzed for inorganic N (2 M KCl-extractable ammonium and nitrate-N). The mineralization of organic N in the biosolids calculated as the percent of organic N mineralized to inorganic N is presented in Table III-7.

Farmland Application of Class B Biosolids Project. A major portion of the District's biosolids is managed through farmland application of Class B centrifuge cake. Farmland application of Class B biosolids is cost-effective to the District and the nutrients in biosolids provide savings in fertilizer costs to the farmers. However, the practice of Class B biosolids application to farmland has met with public concern and opposition in some regions of the United States. Most of the concerns stem from misinformation about the potential human health and environmental risks from pathogens and trace metals in the Class B biosolids applied to farmland. These concerns need to be addressed to protect the viability and sustainability of the District's Class B centrifuge cake biosolids application to farmland program.

In the fall of 2004, the District began a three-year research and demonstration project on farmers' fields in Will and Kankakee Counties to demonstrate the safety of farmland application of Class B centrifuge cake biosolids and to improve the overall public perception and understanding of communities residing in the vicinities of biosolids-amended farmlands. The data collection component of this project was concluded in 2007 and the report is being prepared. Since a large proportion of the District's Class B biosolids is being currently applied to farmland in these two counties, a scaled-down project to maintain presence in the area and showcase the benefits of biosolids application was extended for another three-year term.

Plots and Treatments. The scaled-down project was designed to showcase farmland application of biosolids. Biosolids application rates ranged from 10 to 60 wet tons per acre. Plots were established on a three-acre parcel of clayey soil in the township of Florence in Will

County and on a ten-acre parcel of sandy soil in the township of Saint Anne in Kankakee County.

Following the conventional practices in each county, the biosolids are applied in the fall at the Will County site and in the spring just before planting at the Kankakee County site each year. The fall application in Will County is done to reduce the amount of fieldwork required in the spring because the heavy-textured soils drain slowly, and tend to stay wet for longer periods of time, which may leave only a narrow window for completing the required fieldwork before planting.

Sampling and Analyses. Soil sampling was done at both sites after harvesting corn in the fall of 2008. The soil samples were air-dried, ground, and sieved through a 2-mm sieve and stored in plastic bottles for chemical analysis. The soil samples were analyzed for KCl-extractable and water-extractable NO_3-N and NH_3-N, electrical conductivity, and organic carbon. Corn grain and stover tissues were collected and analyzed for total Kjeldahl nitrogen, total P, and total metals. In addition, lysimeters that were installed at the beginning of the study were sampled for analysis.

Results. The results of soil analysis for the 0- to 6-inch depth for both the Will and Kankakee County plots are presented in Table III-8. The mean concentrations of nutrients and trace metals in the subsurface water samples collected from lysimeters in the Will County plots collected during January through October 2008 and in the Kankakee County plots during January through November 2008 are presented in Tables III-9 and III-10, respectively.

Promotion and Technical Support to Biosolids Beneficial Reuse Program

The activities conducted under the biosolids beneficial reuse program are aimed to increase the distribution of exceptional quality biosolids in the Chicago Metropolitan Area and help biosolids users maximize the benefits they receive from the program.

The activities the section conducted in 2008 to support the biosolids beneficial reuse program include:

1. Technical support on projects where biosolids were used as a soil conditioner or fertilizer topdressing by 11 schools, 15 park districts and suburban villages, eight golf courses, one landscaping company, and one District property.

2. Maintenance of plots to demonstrate the beneficial use of Class B biosolids on farmland.

3. Collaborate with University of Illinois to operate research and demonstration plots at various golf courses and recreational fields.

4. Collaborate with the City of Chicago to evaluate and promote the use of biosolids for development of parks and recreational areas in Chicago.

5. Preparation of biosolids information pamphlets.

6. Conduct two field days at the Blue Island Park District to promote biosolids use under the Controlled Solids Distribution Program.

7. Host biosolids exhibition booths at the Illinois Association of Park Districts/Illinois Parks and Recreation Association annual exhibition and at the Illinois Professional Turf Conference.

8. Review 190 field information packets for potential application fields under the Class B biosolids Farmland Application Program. This includes reviewing the field location, buffers established for surface water, roads and dwellings, contacts made with neighbors and public officials, and soil pH and liming. Approval or disqualification of the proposed fields is recommended to the M&O Department.

9. Contribute to and do presentation at field day hosted by Farmland Application Program contractor.

Regulatory Review

Regulatory reviews are conducted in response to imminent regulations that can potentially impact District operations, and requests from professional affiliations or organizations. In 2008, the following reviews were conducted:

- USEPA – "Problem Formulation for Human Health Risk Assessments of Pathogens in Land-Applied Biosolids" (EPA/600/R-08/035A)

- USEPA – "Proposal of New Pesticide Requirements to Protect Clean Water Agencies' Water Quality"

Support to Green Initiatives

Chicago Department of Transportation Streetscape Project. The District is collaborating with Chicago Department of Transportation on a project to demonstrate the use of green techniques in stormwater management. In 2008, the section provided the following assistance on the project:

- Planning and design, including selection of vegetation type for planter boxes, trees, and bioswales.

- Planning for stormwater quality monitoring for various best management practices.

Stickney Permeable Pavement Project. In this project, the District is evaluating porous pavement technology for stormwater management in the Chicago Metropolitan Area. In 2008, the section assisted in evaluation of the design of permeable pavements. The section also assisted in designing the monitoring plan to assess the performance of the pavement.

Wetlands at Lockport Powerhouse Marsh and Centennial Trail Prairie-Marsh. In 2008, the section contributed to review of the 60 percent and 90 percent design documents of this project.

Native Landscaping. During 2008, the section provided technical support for installation and maintenance of native prairie landscaping at the District's facilities. The activities included review of contracts prepared by the M&O Department, project-planning meetings with M&O and contractors and onsite visits to assist in conducting performance evaluation of the native prairie landscaping (NPL). The 2008 quality ratings of NPL at the District facilities are presented in Table III-11.

Native Prairie Research and Demonstration Plots. The native prairie research and demonstration plots established in 2007 were abandoned because the site was within the area identified for future expansion of the Stickney WRP. The section established new long-term native prairie research and demonstration plots at the Stickney WRP in November 2008 in collaboration with the M&O Department. These plots will be maintained for the long-term and no data will be collected until the NPL vegetation develops sufficiently to begin evaluation of the performance of the treatments.

TABLE III-1: BIOSOLIDS APPLICATION RATES AT THE CORN FERTILITY EXPERIMENTAL PLOTS AT THE FULTON COUNTY RECLAMATION SITE FOR 2008

Treatment[1]	Biosolids Application Rate (Dry Weight Basis)			
	Annual		Cumulative	
	Mg/ha	tons/acre	Mg/ha	tons/acre
Control	0.0	0.0	0.0	0.0
¼-Max	16.8	7.5	573	258
½-Max	33.6	15.0	1,146	511
Max	67.2	30.0	2,286	1,021

[1]Control plots receive 336-224-112 kg/ha of N-P-K annually and biosolids amended plots receive 112 kg K/ha annually.

TABLE III-2: MEAN pH, ELECTRICAL CONDUCTIVITY, AND CONCENTRATIONS OF ORGANIC CARBON, NUTRIENTS AND METALS IN THE SURFACE SOIL[1] FROM THE CORN FERTILITY EXPERIMENTAL PLOTS AT THE FULTON COUNTY RECLAMATION SITE FOR 2005 – 2008

Plot[2]	Year	pH	EC	Organic Carbon	0.1N HCl Extracted[3]						Concentrated HNO_3 Extracted						TKN	Tot-P
					Zn	Cd	Cu	Cr	Ni	Pb	Zn	Cd	Cu	Cr	Ni	Pb		
			dS/m	%	mg/kg													
Check	2005	7.4	0.36	1.51	200	13.6	79.1	22.4	11.3	28.1	254	12.1	123	174	44.4	54.7	1,728	2,828
	2006	7.3	0.48	1.46	187	13.0	78	22.7	13.7	29.3	253	13.6	126	173	45.6	54.8	1,440	2,468
	2007	6.9	0.31	1.27	74.1	6.8	7.0	0.60	4.2	0.05	270	14.3	123	181	47.5	58.1	1,739	3,026
	2008	7.1	0.51	0.86	66.7	6.2	16.0	1.7	5.1	0.42	178	10.7	90.3	149	42.3	44.5	1,329	2,531
1/4	2005	7.4	0.40	2.39	366	25.1	143	41.7	18.6	46.5	435	24.1	212	306	58.5	96.1	2,465	4,536
	2006	7.2	0.41	2.20	326	22.6	134	40.1	20.1	46.3	422	23.7	212	295	59.0	92.6	2,152	3,936
	2007	6.8	0.31	2.12	115	9.9	7.0	0.50	5.4	0.01	500	26.4	231	336	61.8	106	2,846	4,904
	2008	7.5	0.47	1.35	89.6	8.0	6.4	0.67	4.4	0.014	320	16.8	153	226	50.8	70.0	1,864	3,205
1/2	2005	7.1	0.59	2.64	446	28.5	163	44.1	21.7	37.3	486	27.1	248	344	62.9	110	2,945	6,169
	2006	7.0	0.78	2.51	377	23.8	141	39.9	21.8	34.4	465	25.7	243	316	60.9	102	2,825	5,705
	2007	6.7	0.39	2.29	109	8.9	12.6	1.2	6.4	0.30	484	25.9	230	320	62.8	104	2,781	5,583
	2008	7.2	0.70	2.07	135	10.9	8.5	0.68	6.0	0.012	510	26.5	248	350	65.3	109	2,724	5,090
Max	2005	7.2	0.53	3.48	562	35.9	206	58.8	27.6	49.2	629	35.5	320	446	72.8	140	3,531	7,362
	2006	6.9	0.60	2.77	462	29.4	174	48.9	26.0	44.9	533	29.8	271	366	66.5	116	2,769	5,371
	2007	6.7	0.46	2.96	151	11.9	13.6	0.98	8.0	0.15	663	35.6	315	448	74.1	141	3,668	6,905
	2008	6.8	1.15	3.97	144	10.5	7.3	0.45	7.0	0.016	789	39.9	398	517	80.6	165	4,456	8,808

[1]Sampling depth = 0-15 cm.
[2]Check = No biosolids application - inorganic fertilizer. 1/4, 1/2, and Max = 16.8, 33.6, and 67.2 Mg/ha/yr biosolids loading rates, respectively.
[3]Beginning in 2007, 0.1N HCl extractable metals were done by using a single extraction instead of three sequential extractions in previous years.

TABLE III-3: MEAN CONCENTRATIONS OF TKN, PHOSPHORUS, AND METALS IN 33P69 HYBRID CORN GRAIN COLLECTED FROM THE CORN FERTILITY EXPERIMENTAL PLOTS AT THE FULTON COUNTY RECLAMATION SITE IN 2008

Analyte[2]	Treatment[1]			
	Control	1/4-Max	1/2-Max	Max
	----------mg/kg----------			
TKN	13,683	11,835	12,794	12,561
P	2,483	2,540	2,471	2,590
Zn	21.4	21.2	21.9	25.2
Cd	<0.03	<0.03	<0.03	<0.03
Cu	1.4	1.4	1.5	1.6
Cr	0.14	0.15	0.13	0.15
Ni	0.44	0.50	0.42	0.43
Pb	<0.2	0.26	0.22	<0.2
K	3,491	3,564	3,655	3,812
Ca	60.4	65.4	50.0	46.3
Mg	1,139	1,110	1,071	1,113

[1]Control = No biosolids application - inorganic fertilizer. 1/4-Max, 1/2-Max, and Max represent biosolids application rates of 16.8, 33.6, and 67.2 Mg/ha/yr, respectively.
[2]Tissue digested with HNO_3 for metals. TKN = Total Kjeldahl-N.

TABLE III-4: AVERAGE GRAIN AND STOVER YIELDS FOR HYBRID CORN 33P69 GROWN AT THE CORN FERTILITY EXPERIMENTAL PLOTS FROM 2006 TO 2008

Harvested Tissue	Unit	Treatment[1]											
		Control			1/4-Max			1/2-Max			Max		
		2006	2007[2]	2008	2006	2007[2]	2008	2006	2007[2]	2008	2006	2007[2]	2008
Grain	bu/acre	43	45	77	70	36	92	84	36	188	90	24	207
	Mg/ha	2.7	2.8	4.8	4.4	2.2	5.8	5.3	2.3	11.8	5.6	1.5	13.0
Stover	tons/acre	2.2	1.5	2.3	2.6	0.88	2.8	2.9	1.1	5.1	3.3	1.2	5.3
	Mg/ha	5.0	3.4	5.2	5.9	2.0	6.3	6.4	2.4	11.5	7.5	2.7	11.8

[1]Control = No biosolids application - inorganic fertilizer. 1/4-Max, 1/2-Max, and Max represent biosolids application rates of approximately 16.8, 33.6, and 67.2 Mg/ha/yr, respectively.

[2]Planting repeated twice in 2007 due to severe damage (seed predation) by birds.

TABLE III-5: CUMULATIVE GRAIN AND STOVER YIELDS, AND PHOSPHORUS UPTAKE IN FIELD PLOTS AMENDED WITH FOUR RATES OF BIOSOLIDS AND TRIPLE SUPERPHOSPHATE IN FALL 2005 AND CROPPED WITH CORN ANNUALLY THROUGH 2008

Treatment	Target P Rate	Grain Yield	Stover Yield	Crop P Uptake
	kg P/ha	---------- Mg/ha ----------		kg P/ha
Control	0	29.9	27.9	88
Biosolids-1	163	31.2	27.4	98
Biosolids-2	325	32.3	28.6	107
Biosolids-3	488	32.4	30.5	113
Biosolids-4	650	32.4	31.1	117
TSP-1[1]	163	29.8	28.7	106
TSP-2	325	30.1	29.8	113
TSP-3	488	30.5	29.4	118
TSP-4	650	28.3	29.8	119

[1]TSP = Triple Superphosphate.

TABLE III-6: WEIGHTED-MEAN[1] CONCENTRATIONS OF DISSOLVED MOLYBDATE REACTIVE AND TOTAL PHOSPHORUS IN RUNOFF COLLECTED DURING 2008 IN VEGETATED BUFFER STRIPS OF CONTROL AND BIOSOLIDS AMENDED PLOTS

Vegetated Buffer Length (ft)	Control		Biosolids	
	mg P/L			
	MRP[2]	Total P	MRP	Total P
0	0.015	1.14	0.77	2.35
25	0.017	0.59	0.69	0.78
50	0.019	0.42	0.57	0.85

[1]Concentrations weighted based on runoff volume.
[2]MRP = Dissolved molybdate reactive P.

TABLE III-7: POTENTIAL NITROGEN MINERALIZATION IN TWO SOILS AMENDED WITH DISTRICT CENTRIFUGE CAKE AND AGED, AIR-DRIED BIOSOLIDS, AND MILORGANITE

		Centrifuge Cake		Aged,Air-Dried	
Soil	Milorganite	Stickney	Calumet	Stickney	Calumet
	---------- %[1] ----------				
Silty clay loam	40	28	32	9	12
Sandy	46	33	37	11	14

[1]Percent of organic N mineralized.

TABLE III-8: MEAN LEVELS OF SOIL FERTILITY PARAMETERS IN SURFACE (0- TO 6-INCH) SOIL LAYER OF THE WILL AND KANKAKEE COUNTY DEMONSTRATION PLOTS AFTER HARVESTING CORN IN 2008

Treatment[1]	Will County Plots				Kankakee County Plots			
	pH[2]	EC[2]	Avail. P[3]	Inorg. N[4]	pH[2]	EC[2]	Avail. P[3]	Inorg. N[4]
		dS/m	mg/kg	mg/kg		dS/m	mg/kg	mg/kg
Control	7.2	0.10	12.1	8.3	6.9	0.03	72.1	1.5
BS-1	7.0	0.13	28.0	11.3	6.4	0.05	87.2	2.5
BS-2	7.0	0.17	20.8	17.1	6.4	0.05	100.8	4.6
BS-3	6.7	0.12	28.6	12.7	6.4	0.06	108.6	5.2
BS-4	7.3	0.10	23.1	19.0	6.2	0.07	109.4	9.0

[1]Control = no N and recommended rate of P. for Will County plots, BS-1 to BS-4 = 10, 30, 40, and 60 wet tons biosolids per acre. For Kankakee County plots, BS-1 to BS-4 = 10, 20, 30, and 60 wet tons biosolids per acre. All plots received K at the recommended agronomic rate.
[2]1:2 (soil:water) ratio.
[3]Bray P1 method.
[4]Sum of KCl-extractable NH_4-N, NO_2-N, and NO_3-N.

TABLE III-9: MEAN CONCENTRATIONS OF NUTRIENTS AND TRACE METALS[1] IN WATER SAMPLES FROM THE LYSIMETERS[2] IN WILL COUNTY DEMONSTRATION PLOTS COLLECTED FROM JANUARY THROUGH OCTOBER 2008

Parameter	Unit	Treatment		
		40 wet tons biosolids/ac[3]	Residual, 40 wet tons biosolids/ac[4]	Residual, 80 wet tons biosolids/ac[4]
TKN	mg/L	1.00	0.37	0.60
NH_3-N	"	0.28	0.05	0.05
NO_3-N+NO_2-N	"	9.4	38.0	59.4
Total P	"	0.08	0.06	0.07
Hg	µg/L	0.23	0.24	0.25
As	mg/L	0.016	0.015	0.015
Ba	"	0.138	0.087	0.125
Cd	"	0.0009	0.0009	0.0008
Cr	"	0.002	0.002	0.002
Cu	"	0.005	0.005	0.004
Mn	"	0.736	0.030	0.005
Mo	"	0.014	0.009	0.009
Ni	"	0.003	0.002	0.001
Pb	"	0.010	0.010	0.010
Sb	"	0.074	0.056	0.065
Se	"	0.055	0.054	0.040
Tl	"	0.022	0.021	0.019
V	"	0.018	0.015	0.008
Zn	"	0.006	0.020	0.012

[1]In calculating mean concentrations of trace metals, method detection limits were used in place of non-detectable levels.
[2]Lysimeters were installed at 3.5-ft. depth.
[3]Received first application of biosolids in November 2007.
[4]Received no biosolids or fertilizer application in 2008. Biosolids were applied in November 2004, 2005, and 2006.

TABLE III-10: MEAN CONCENTRATIONS OF NUTRIENTS AND TRACE METALS[1] IN WATER SAMPLES FROM THE LYSIMETERS IN KANKAKEE COUNTY DEMONSTRATION PLOTS COLLECTED FROM JANUARY THROUGH NOVEMBER 2008

		Treatment/Sampling Depth					
		Control[2]		160 lbs N/ac[3]		30 wet tons biosolids/ac[4]	
Parameter	Unit	5 ft	10 ft	5 ft	10 ft	5 ft	10 ft
TKN	mg/L	0.19	0.85	0.14	0.24	0.27	0.35
NH_3-N	"	0.02	0.07	0.02	0.02	0.03	0.03
NO_3-N[5]	"	3.3	9.8	6.6	5.1	11.0	3.9
Total P	"	0.05	0.15	0.07	0.06	0.33	0.08
Hg	µg/L	0.20	0.38	0.20	0.20	0.27	0.25
As	mg/L	0.015	0.017	0.015	0.013	0.022	0.022
Ba	"	0.046	0.045	0.054	0.051	0.027	0.082
Cd	"	0.0009	0.0007	0.0009	0.0008	0.0014	0.0014
Cr	"	0.001	0.001	0.0015	0.0012	0.0025	0.0020
Cu	"	0.004	0.006	0.0044	0.0038	0.0068	0.0069
Mn	"	0.017	0.007	0.004	0.006	0.003	0.014
Mo	"	0.002	0.009	0.003	0.003	0.005	0.003
Ni	"	0.002	0.003	0.001	0.002	0.001	0.003
Pb	"	0.009	0.007	0.009	0.008	0.014	0.014
Sb	"	0.025	0.039	0.026	0.023	0.048	0.037
Se	"	0.052	0.033	0.052	0.048	0.084	0.099
Tl	"	0.016	0.030	0.016	0.014	0.023	0.022
V	"	0.011	0.032	0.012	0.010	0.015	0.015
Zn	"	0.010	0.005	0.009	0.007	0.008	0.013

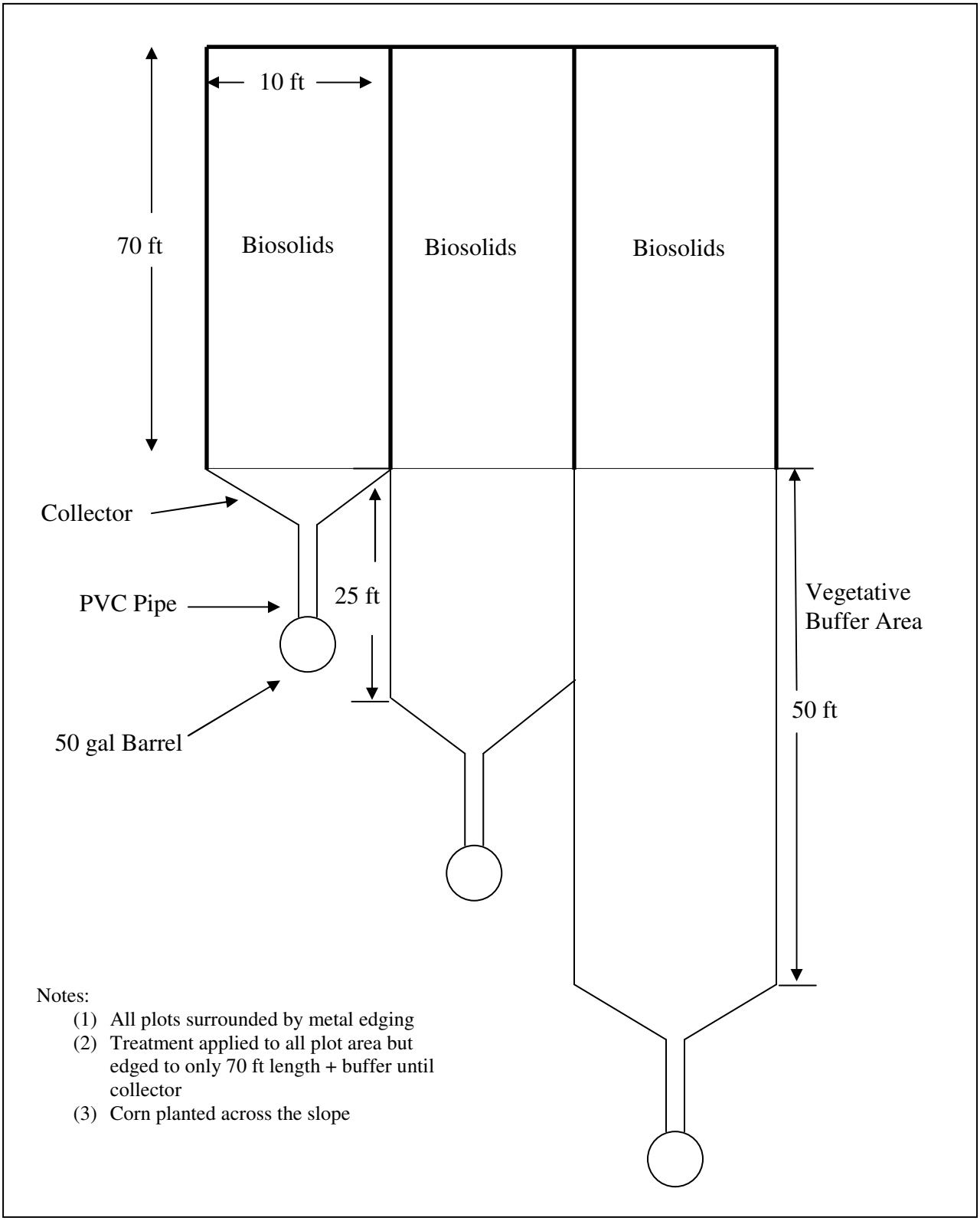
[1]In calculating mean concentrations of trace metals, method detection limits were used in place of non-detectable levels.
[2]Received no N and recommended agronomic rate of P and K.
[3]Received recommended agronomic rate of P and K. Nitrogen was applied as urea.
[4]Received recommended aronomic rate of K.
[5]Sum of NO_2-N and NO_3-N.

TABLE III-11: 2008 QUALITY RATING OF NATIVE PRAIRIE LANDSCAPING INSTALLED AT THE METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO FACILITIES

Location	Installation Date	Area (acres)	2008 Quality Rating[1]
Stickney WRP	2006 – 2007	9.5	4.5
Main Stream Pumping Station	2006 – 2007	3.5	4.5
Willow Spring Berm	2003 – 2004	16	2
Lemont WRP	2003 – 2004	3.5	6
North Side WRP	2003 – 2004	4.2	6
Calumet WRP	2006 – 2007	19.3	3
Egan WRP	2007	3.3	5
Hanover Park WRP	2007	6.9	5

[1]Scale = 1 – 10; 1 = Poor; 10 = Excellent.

FIGURE III-1: SKETCH OF TYPICAL DESIGN OF THE TREATMENT UNITS AND RUNOFF COLLECTION SYSTEM IN THE BIOSOLIDS P RUNOFF FIELD STUDY PLOTS



ANALYTICAL MICROBIOLOGY AND BIOMONITORING SECTION

ANALYTICAL MICROBIOLOGY AND BIOMONITORING SECTION

The Analytical Microbiology and Biomonitoring Section is comprised of four professional and 12 technical personnel who are organized into four groups to perform specific monitoring or research activities. These four groups are:

I. Analytical Microbiology

II. Virology

III. Parasitology

IV. Biomonitoring

Section personnel are often involved in studies of wastewater treatment, biosolids assessment, and environmental monitoring, which require the application of specific microbiological disciplines and expertise. The areas of study in which the Section personnel can be involved during the course of a given year include, but are not limited to:

- Public health risk assessment.
- Ecological risk assessment.
- Water quality monitoring.
- Ecotoxicology and biomonitoring.
- Bioassay (whole effluent toxicity) methodology.
- Microbial processes.
- Enumeration of viral, microbial, and parasitic indicators.
- Enumeration of specific pathogens.
- The microbiology of specific wastewater or biosolids treatment options.
- Epidemiological study of recreational use of the Chicago Area Waterways.
- Emerging microconstituents including endocrine disrupters, pharmaceuticals, antibiotic, and personal care products.

Overview of Section Activities

In 2007, personnel in the Section participated in a variety of monitoring and research activities. Listed below are the most important of these activities separated according to the group with the most direct participation.

Analytical Microbiology Group.

a. Water Reclamation Plant (WRP) Quality Control. Monitoring WRP effluents for the presence and density of fecal coliforms (FC) for disinfection control.

b. Chicago Waterways System (CWS). Monitoring District waterways in Cook County upstream and downstream of the Calumet, North Side, Stickney, and Lemont WRPs.

c. Groundwater Monitoring Wells - TARP. Monitoring FC presence and density in groundwater monitoring wells near TARP tunnels, as required by Illinois Environmental Protection Agency (IEPA) operational permits.

d. Groundwater Monitoring Wells - Land Reclamation. Monitoring the presence and density of FC in groundwater monitoring wells around biosolids processing and application handling sites in Cook County.

e. Part 503 Compliance Monitoring. Analysis of Class A and B biosolids for FC.

f. Biosolids Beneficial Use Support. Monitoring bacterial (FC and *Salmonella* spp.) densities in farm soil after application of biosolids.

g. Potable Water Analysis. Monitoring drinking water at District WRPs, and other locations.

h. Study of Antibiotic Resistant Bacteria (ARB). Monitoring of ARB in Wastewater and the CWS.

i. Disinfection Study. Bacterial density monitoring at three major WRPs. Monitoring for Fecal Coliform to Evaluate the Disinfection Technologies - Ultraviolet Light and Titanium Oxide,

j. Technical support to the Wastewater Treatment Process Research Section. Microbiological evaluation to solve operation problems.

k. Research Study. Dry and wet weather risk assessment of human health impacts of disinfection vs. no disinfection of the CWS.

l. Reviews. Review of the United States Environmental Protection Agency (USEPA) Water Quality Criteria for Bacteria. Review research reports and proposed regulations to determine the impact on District operations.

m. Microconstituents of emerging concern including endocrine disrupters, pharmaceuticals, antibiotics, and personal care products.

Virology Group.

a. Part 503 Compliance Monitoring. Analysis of biosolids for enteric viruses.

b. Process Certification for Class A Biosolids. Analysis of biosolids for enteric viruses to demonstrate that the District's codified Process to Further Reduce Pathogens (PFRP) treatment processes consistently produce Class A biosolids as defined in the Part 503 Regulations.

c. Monitoring of Biosolids for Coliphages (Somatic and Male-specific RNA). Research on the use of coliphages as indicators for enteric viruses in biosolids.

d. Biosolids Beneficial Use Support. Monitoring virus densities in farm soil after application of biosolids.

e. Establishment of Molecular Microbiology Laboratory. Polymerase Chain Reaction (PCR) technology capability to meet the future demands for microbial source tracking, pathogen monitoring, and genetic analysis of ARB.

f. Reviews. Review research reports and proposed regulations for any impact on District operations.

Parasitology Group.

a. Part 503 Compliance Monitoring. Analysis of biosolids for viable *Ascaris* ova.

b. Process Certification for Class A Biosolids. Analysis of biosolids for viable *Ascaris* ova to demonstrate that the District's codified PFRP treatment processes consistently produce Class A biosolids as defined in the Part 503 Regulations.

c. Biosolids Beneficial Use Support. Monitoring viable *Ascaris* ova densities in farm soil after application of biosolids.

d. Reviews. Review research reports and proposed regulations for any impact on District operations.

Biomonitoring Group.

a. Whole Effluent Toxicity (WET) Testing for National Pollutant Discharge Elimination System (NPDES) Permits. Use of fathead minnow *(Pimephales promelas)* and daphnids *(Ceriodaphnia dubia)* to assess acute and chronic toxicity of effluents from District WRPs.

b. The Algal Growth Test (AGT). To assess the Salt Creek nutrient reduction demonstration project at Egan WRP. To assess stream response to nutrient reduction at the Lemont WRP expansion project.

c. Reviews. Review research reports and proposed regulations for any impact on District operations.

Analytical Microbiology Group Responsibilities

The Analytical Microbiology Laboratory has been certified by the Illinois Department of Public Health (IDPH) for the bacterial analysis of water since 1979. Monitoring the densities of FC bacteria in WRP effluents was first mandated by NPDES permits in 1972; at present, the Analytical Microbiology Group is responsible for all bacterial population density analyses used in WRP effluent monitoring. Monitoring of the Chicago beaches is conducted when river reversals to Lake Michigan occur following large amounts of rainfall. In 2006, there were no reversals to Lake Michigan. The Analytical Microbiology Group also conducts microbiological analyses in support of other Sections.

Table IV-1 summarizes the number and types of analyses performed by the Analytical Microbiology Group in 2006. Bacterial analyses for total coliforms (TC), FC, and *Escherichia coli (*EC) are used by the District as indicators of the sanitary quality of water. The heterotrophic plate count (HPC) is a procedure for estimating the number of viable heterotrophic bacteria in water. Bacteria are identified to species (ID-CONF) using specific biochemical metabolic characteristics.

Certification by the IDPH. The Analytical Microbiology Group is certified by the IDPH, Registry #17508, for the following laboratory examinations:

- HPC for water.

- TC with EC broth verification examination of water from public water supplies and their sources (membrane filtration [MF] and multiple tube fermentation [MTF]).

- FC examination of water from public water sources (MF and MTF).

- TC and EC examination of samples of water from public water supplies and their sources (minimal medium orthonitro-phenyl-β-D-galactopyranoside-4-methylumbelliferyl-β-D-glucuronide [MMO-MUG]).

The Analytical Microbiology Group's facilities, equipment, and procedures were the subject of the biennial on-site evaluation for certification by the IDPH on October 18, 2006, and were found to be in general compliance with the provisions of 18th Edition of *Standard Methods for the Examination of Water and Wastewater* (SM 18th ed.) and the Illinois Rules for Certification and Operation of Environmental Laboratories, Title 77, Part 465. The Group collects and analyzes potable water samples from District facilities as required.

NPDES Compliance Monitoring. Fecal coliform data from disinfected effluents are made available to the Hanover Park, James C. Kirie, and Egan WRPs within 24 hours of sample collections. These data are used as a guide in maintaining proper chlorination at these District WRPs and for reporting compliance with NPDES permit regulations. All District WRPs with NPDES disinfection requirements have a seasonal exemption from November 1 through April 30 of each year and are not subject to any effluent disinfection requirements during this period.

NPDES permits also require additional monitoring when increased flow due to storms exceeds the design maximum treatment capacities of the WRPs. These storms can cause the WRPs to divert a portion of their influent, which is then given minimal treatment before being delivered to the receiving stream. These storm-related excess flow discharges must be monitored for the FC bacteria levels. In 2007, the Analytical Microbiology Group performed three analyses of FC bacteria on three storm-related excess flow discharge events at the Egan WRP service area on March 13, October 3, and December 22.

Part 503 Compliance Monitoring. In 2006, the Analytical Microbiology Group performed MPN analyses for FC bacteria on 30 samples of biosolids to determine if they met the Class A pathogen requirement of less than 1,000 FC MPN/g (dry weight) specified in the Part 503 Regulations. The results were reported to the Maintenance and Operations (M&O) personnel responsible for the District's Controlled Solids Distribution Program at the solids management areas. The District has more distribution options for biosolids demonstrated to be Class A than for non-Class A biosolids.

Monitoring Bacterial Densities in Farm Soil. In 2006, the Analytical Microbiology Laboratory continued monitoring FC and *Salmonella* spp. densities in farm soil after application of bio-

solids. These analyses were conducted as part of full-scale studies being conducted in Will and Kankakee Counties to demonstrate the benefits and safety of applying Class B centrifuge cake biosolids to farmland. See the Biosolids Utilization and Soil Science Section chapter of this report for more details on this project.

Study of Antibiotic Resistant Bacteria (ARB) in Chicago Waterways System (CWS). The District expanded the ARB study to survey the CWS. The purpose of expanding is to determine whether ARB present in the final effluents (FE) of the Stickney, Calumet, and North Side WRPs are affecting the number and spatial distribution of ARB in the CWS. In addition, the study is intended to further investigate whether secondary sewage treatment at the Stickney, Calumet, and North Side WRPs is adequately reducing the concentration of ARB present in wastewater. The study consists of three objectives to survey the total numbers and percentages of ARB at the following WRP waterway locations:

1) Chicago Sanitary and Ship Canal (CSSC) upstream and downstream of the Stickney WRP (SWRP).

2) The North Shore Channel (NSC) upstream and downstream of the North Side WRP and in the North Branch of the Chicago River (NBCR) downstream of the North Side WRP.

3) The Little Calumet River upstream and downstream of the Calumet WRP and in the Calumet-Sag Channel downstream of the CWRP.

An experimental plan, titled “Monitoring the Total Numbers, Percentages, and Antibiotic Resistance Patterns of Antibiotic Resistant Fecal Coliforms in the Chicago Waterways System" was written, and the study commenced in the winter of 2005-2006. The first objective of this study investigated the impact of Stickney WRP FE, which was pursued by the collection and analyses of four sets of water samples from one upstream and four downstream locations in the CSSC in the winter of 2005-2006, and in spring, summer, and fall of 2006. The second objective of this study is still in progress. The data collection will be completed in 2008.

Disinfection Study. In 2006, the District was involved in monitoring bacterial densities to assess its future disinfection needs at the Stickney, Calumet, and North Side WRPs. The District performed 723 analyses of the TC, FC, and EC content of 244 WRP final effluent samples.

Review of the USEPA Water Quality Criteria for Bacteria. As part of the Use Attainability Analysis (UAA) study of the CWS, the District commissioned an Expert Review Panel (Panel) comprised of Drs. Herbert E. Allen, Abdel El-Shaarawi, Charles N. Haas, and Joan B. Rose, to conduct a review of the USEPA November 2003 Implementation Guidance for Ambient Water Quality Criteria. The Panel was charged with determining whether the 2003 Guidance provides the proper scientific/technical basis for establishing bacterial water quality standards for the CWS. Dr. Haas served as the chairperson of the Panel, assigned specific tasks to

the other members of the Panel, compiled and edited contributions from other members of the Panel, and prepared the final report. A report titled, "Expert Review Report Regarding the United States Environmental Protection Agency's Water Quality Criteria for Bacteria – 1986: Application to Secondary Contact Recreation," R&D Report No. 2006-38 was published.

Dry and Wet Weather Risk Assessment of Human Health Impacts of Disinfection vs. No Disinfection of the Chicago Waterways System (CWS). As part of the Use Attainability Analysis (UAA) study of the CWS, the District, working with consultants, is evaluating the human health impact of disinfecting versus not disinfecting effluents from the District's Calumet, North Side, and Stickney WRPs, which discharge into the CWS. The consultant is the GeoSyntec Team (GST), which includes GeoSyntec Consulting and its subcontractors; Patterson Environmental Consultants; Cecil Lue-Hing & Associates; Dr. Charles Gerba of the University of Arizona; Dr. John Colford, M.D., of the University of California at Berkeley; Hoosier Microbiological Laboratory, Inc.; and Clancy Environmental Consultants.

The main objectives of the study were to: 1) prepare a sampling and analysis plan (SAP) and Quality Assurance Project Plan (QAPP) for generating microbial analytical results that would form the basis of the microbial risk assessment; 2) provide field training to District's sampling personnel; 3) perform a literature review of pathogen disinfection effectiveness; 4) perform a microbial exposure assessment by literature review; 5) perform a microbial infection dose-response analysis by literature review; 6) perform a microbial risk characterization of three waterway segments in the vicinity of the North Side, Stickney, and Calumet WRPs. Sampling and monitoring activities associated with the dry weather assessment of the study were completed between July and September of 2005. An interim report on the dry weather risk assessment study was completed in 2006 and is on the District website.

The wet weather sampling was completed in 2006 because of the extended dry weather in 2005.

Epidemiological Research Study of Recreational Use of the Chicago Area Waterways. In 2006, the District initiated a scope of work for an Epidemiological Study of Chicago Area Waterways to verify the results of the District's Dry and Wet Weather Microbial Risk Assessment Study and to gain knowledge on the science-based protective bacterial water quality standards for the CWS.

Support to Other Sections. The Analytical Microbiology Group supported a variety of Environmental Monitoring and Research and Industrial Waste Division programs in 2006: effluent analysis, land reclamation and sludge indicator organism densities, District waterway surveys, Lake Michigan monitoring, WRP monitoring, TARP monitoring, research support, industrial waste surveys, the Illinois waterway survey, and other miscellaneous samples. Table IV-2 is a summary of the major programs receiving support from 2005 through 2006 and the number of analyses performed for each program.

Virology Group Activities

In 2007, the Virology Group analyzed 11 biosolids samples for site-specific Processes to Further Reduce Pathogens (PFRP) equivalency monitoring and for compliance with the Part 503 biosolids regulations. Enteric virus densities in all samples of biosolids produced by the District's codified PFRP processing trains were determined to be below the detectable limit, which is less than one plaque forming unit (PFU) per four grams total solids (dry weight basis). Positive recovery studies were performed on these samples for quality assurance purposes. The mean recovery of spiked viruses was ____ percent. Recoveries ranged from 25.7 to 63.4 percent and were dependent upon the sample spiked. Results of these analyses are shown in Table IV-3.

The analytical method used by the District for determining the density of enteric viruses in biosolids was published and approved by the USEPA (Appendix H, EPA/625/R-92/013). The analytical method for enteric viruses involves the elution of viruses from solids, concentration of the eluates, and an assay for plaque-forming viruses using BGM-K cells.

Monitoring of Biosolids for Coliphages (F Specific and Somatic). The USEPA coliphage method was modified and adapted in the District to determine coliphage concentrations in Class A and B biosolids. Research is currently being conducted to evaluate the usefulness of coliphages as an alternative indicator for the presence of enteric viruses in biosolids. In 11 samples of biosolids produced by the District's codified process, the concentrations of F Specific Coliphages (FP) were determined to be below the detectable limit (less than one plaque forming unit [PFU] per gram total solids [dry weight basis]). In 8 samples of biosolids produced by the District's codified process, the concentrations of somatic coliphages (SP) were determined to be below the detectable unit (less than one plaque forming unit [PFU] per gram total solids [dry weight basis]). Results of these analyses are shown in Tables IV-4.

Data collected to date suggest that FP coliphages are a good alternate indicator for predicting the presence or absence of enteric viruses in biosolids.

Monitoring Virus Densities in Farm Soil. In 2007, the Virology Laboratory continued monitoring virus densities in farm soil after application of biosolids. . Results of these analyses are shown in Tables IV-5. These analyses were conducted as part of full scale studies set up in Will and Kankakee Counties to demonstrate the benefits and safety of applying Class B centrifuge cake biosolids to farmland. See the Biosolids Utilization and Soil Science Section chapter of this report for more details on this project

Establishment of Molecular Microbiology Laboratory. The District completed its plans in 2007 to construct a molecular microbiology research laboratory at the Cecil Lue-Hing R&D Complex to meet the future demands for microbial source tracking, pathogen monitoring, and genetic analysis of ARB. It is anticipated that the laboratory will open in 2008.

Parasitology Group Activities

In 2006, the Parasitology Group analyzed 12 biosolids samples for site-specific PFRP equivalency monitoring and for compliance with the Part 503 biosolids regulations. Viable *Ascaris* ova densities in all samples of biosolids produced by the District's codified PFRP sludge processing trains were determined to be below the detectable limit, which is less than one viable *Ascaris* ovum per four grams of total solids (dry weight basis). Results of these analyses are shown in Table IV-6. Since 1996, when the District began monitoring the levels of FC bacteria (see Analytical Microbiology Group Activities above), enteric viruses (see Virology Group Activities above), and viable *Ascaris* in its dried biosolids product for compliance with the Class A biosolids criteria in the Part 503 biosolids regulations, all biosolids produced by the District's codified PFRP sludge processing trains have been in compliance with the Class A criteria for shipment and use under the District's Controlled Solids Distribution Program.

The analytical method used by the District for enumerating Viable *Ascaris* ova in sludge was published and approved by the USEPA (Appendix I, EPA/625/R-92/013). The *Ascaris* method employs a combination of sieving, flotation, centrifugation, incubation, and microscopic analysis to extract and enumerate viable *Ascaris* ova.

Monitoring Viable *Ascaris* Densities in Farm Soil. In 2006, the Parasitology Laboratory continued monitoring viable *Ascaris* ova in farm soil after application of biosolids. These analyses were conducted as part of full scale studies set up in Will and Kankakee Counties to demonstrate the benefits and safety of applying Class B centrifuge cake biosolids to farmland. See the Biosolids Utilization and Soil Science Section chapter of this report for more details on this project.

Microscopic Image Analysis. The District uses microscopic image analysis (MIA) as an aid to monitor viable *Ascaris* ova in biosolids. The MIA system, mounted on a Nikon Eclipse E600 phase contrast microscope, includes a digital camera with a video image acquisition mode to transmit microscopic images from slides to a computer workstation (Figure IV-1). Digital images are stored and analyzed using the MetaMorph™ imaging system (Figure IV-2). The MIA system has proven to be a useful tool for the verification and monitoring of biosolids for Part 503 compliance. For each digital image the following information is automatically stored in a computer file by the imaging software: 1) length of the ovum; 2) width of the ovum; 3) date and time the image was recorded; and 4) sample identification number. A series of digital video images is recorded for each ovum examined when larval movement is observed in order to document viable *Ascaris* ova.

Biomonitoring Group Activities

NPDES Compliance Biomonitoring. In 2006, acute whole effluent toxicity (WET) tests with fathead minnow (*Pimephales promelas)* and daphnids (*Ceriodaphnia dubia)* were conducted on effluent samples from the Egan and Lemont WRPs for NPDES Permit compliance.

No acute toxicity was observed. Chronic WET tests were also conducted on effluent samples from the Hanover Park WRP for NPDES Permit compliance. No chronic toxicity was observed. These data are shown in Table IV-7. Biomonitoring reports for these WRPs were submitted to the IEPA in compliance with the respective NPDES permits.

The Algal Growth Test (AGT). The *Selenastrum capricornutum* Printz Algal Assay Bottle Test (AGT) was developed by the USEPA to determine algal growth potential and nutrient limitation in natural waters (EPA-600/9-78-018). By measuring the algal growth potential of water, a differentiation can be made between the total nutrient in the sample (as determined by chemical analysis) and the nutrient forms that are actually available for algal growth. The District initiated AGT research primarily to study the biological available phosphorus (BP) in the Egan and Lemont WRPs final effluent and in upstream and downstream locations, in conjunction with a planned demonstration project to study river response to phosphorus reduction at WRPs. The AGT was developed using a standard test organism *Pseudokirchneriella subcapitata*, formerly known as *Selenastrum capricornutum*.

Eight valid AGTs were conducted to measure BP in effluent samples from the Egan WRP and samples from three monitoring stations on Salt Creek (Busse Reservoir Dam, Kennedy Blvd., and Thorndale Ave). Four valid AGTs were conducted in effluent samples from the Lemont WRP and samples from three monitoring stations on the Chicago Sanitary and Ship Canal (CSSC). The samples were collected and analyzed once each quarter. The AGT results (Tables IV-8 and IV-9) showed that the mean BP (mg/L) values measured in the Egan and Lemont WRP effluent samples and the two downstream monitoring stations on Salt Creek and CSSC were lower than the total phosphorus (mg/L) measured chemically. The results of the AGTs are important in the District's effort to maintain the biotic integrity of waterways (Salt Creek and CSSC) and the IEPA's effort to develop nutrient standards for the State of Illinois.

TABLE IV-1: ANALYTICAL MICROBIOLOGY GROUP SAMPLES AND ANALYSES 2005 AND 2006

		Analysis or Test Performed[1]										
Year	Samples	TC	FC	FS	PA	SAL	HPC	EC	ENT	IQC	ID-CONF	Total
2005	2,787	135	2,748	0	0	14	33	485	0	7,796	113	11,324
2006	3,140	305	3,195	0	0	9	39	491	0	8,210	191	12,440

[1]TC = Total Coliform; FC = Fecal Coliform; FS = Fecal Streptococcus; PA = *Pseudomonas aeruginosa*; SAL = *Salmonella* spp.; HPC – Heterotrophic Plate Count; EC = *Escherichia coli*; ENT = Enterococcus spp.; IQC = Internal Quality Control testing (reported as the number of procedures performed); ID-CONF = Organism Identification using specific multiple biochemical metabolic characteristics.

TABLE IV-2: INDICATOR BACTERIA ANALYSES PERFORMED BY THE ANALYTICAL MICROBIOLOGY GROUP FOR VARIOUS DISTRICT PROGRAMS 2005 THROUGH 2006

Program	Total Coliform		Fecal Coliform		Escherichia *coli*	
	2005	2006	2005	2006	2005	2006
Effluent Analysis	12	12	703	711	-	-
Land Reclamation	-[a]	-	181	171	-	-
Biosolids Indicator Organism Density	-	-	59	55	-	-
District Waterway Surveys	-	-	847	1065	217	231
Industrial Waste Surveys	-	-	5	6	5	-
Research –Support[1]	41	246	68	364	41	245
Lake Michigan Monitoring[2]	-	-	-	-	-	-
Major Treatment Facility Monitoring	1	-	300	271	192	-
Illinois Waterway	-	-	-	-	-	-
TARP	-	-	566	567	-	-
Other[3]	43	59	-	-	-	15
Total	97	317	2,729	3,210	455	491

[a]No samples analyzed.

[1]Includes disinfection study and support to plant operations.

[2]Includes festivals and District bypasses to Lake Michigan.

[3]Includes drinking water.

TABLE IV-3: VIROLOGICAL ANALYSIS OF CLASS A BIOSOLIDS IN 2007[1]

WRP Sample Location	Number Samples Positive/Number Samples Collected	Total Number of Samples that Meet Class A Pathogen Requirement[2]	PFU/4g Dry Wt Range[3,4]	Percent Recovery of Seeded Viruses[5] Range
Calumet				
East and West	0/9	9	<0.8000 - <0.8000	25.7 - 63.4
Stickney				
LASMA[6]	0/1	1	<0.8000	25.1
Vulcan	0/1	1	<0.8004	37.3

[1]Results of analyses performed in the District's Virology Laboratory for site-specific PFRP equivalency monitoring.
[2]Total Culturable Enteric viruses are less than 1 plaque forming unit (PFU) per 4g total dry solids.
[3]Confirmed plaque forming units/4g.
[4]Failure to detect viruses in solids eluates are recorded as less than (<) the limit of test sensitivity.
[5]Positive recovery controls: percent recovery of 400 plaque forming units of poliovirus 1 Sabin seeded into a 4g aliquot of sample. A positive recovery control was performed for each sample analyzed.
[6]Lawndale Avenue Solids Management Area.

TABLE IV-4: COLIPHAGE (SOMATIC [SP] AND F SPECIFIC RNA [FP]) ANALYSIS OF CLASS A BIOSOLIDS IN 2006[1]

WRP/Sample Location	Total Solids (TS)[2]	Coliphage MPN/Gram Dry Wt[3,4] SP	FP
Calumet			
East, Cell 1	67.80	<0.1475	<0.1475
East, Cell 4	65.43	45.0000	<0.1528
East, Cell 1	79.65	<0.1225	<0.1255
East, Cell 3	69.01	<0.1449	<0.1449
West, Cell 5	77.65	30.0000	<0.1288
West, Cell 1	78.04	<0.1281	<0.1281
West. Cell 4	77.37	10.0000	<0.1292
West, Cell 3	80.69	<0.1239	<0.1239
West, Cell 5	63.23	<0.1582	<0.1582
Stickney			
HASMA[5]	69.40	<0.1441	<0.1441
LASMA[6]	86.91	<0.1151	<0.1151
Marathon	77.24	7.0000	7.0000

[1]The coliphages were enumerated according to the USEPA Method 1601: Male -specific (F+) and Somatic Coliphage in Water by Two-step Enrichment Procedure (EPA/821-R-01-030). The method was modified to increase the sensitivity of the method for biosolids monitoring.
[2]TS=Percent Total Solids.
[3]Most Probable Number of FP and SP Based on Dry Weight of 1g of as-received biosolids.
[4]Failure to detect coliphages in biosolids is recorded as less than (<) the limit of test sensitivity.
[5]Harlem Avenue Sludge Management Area.
[6]Lawndale Avenue Sludge Management Area.

TABLE IV-5: VIROLOGICAL ANALYSIS OF BIOSOLIDS FOR FARMLAND APPLICATION IN 2007[1]

Sample Description	Number Samples Positive/Number Samples Collected	Total Number of Samples that Meet Class A Pathogen Requirement[2]	PFU/4g Dry Wt Range[3,4]	Percent Recovery of Seeded Viruses[5] Range
Kankakee County (Farm Soil)	0/1	1	<0.8000	56.2
HASMA[6]	0/1	1	<0.8000	91.2

[1]Results of analyses performed in the District's Virology Laboratory for site-specific PFRP equivalency monitoring.
[2]Total Culturable Enteric viruses are less than 1 plaque forming unit (PFU) per 4g total dry solids.
[3]Confirmed plaque forming units/4g.
[4]Failure to detect viruses in solids eluates are recorded as less than (<) the limit of test sensitivity.
[5]Positive recovery controls: percent recovery of 400 plaque forming units of poliovirus 1 Sabin seeded into a 4g aliquot of sample. A positive recovery control was performed for each sample analyzed.
[6]Harlem Avenue Sludge Management Area.

TABLE IV-6: VIABLE *ASCARIS* OVA ANALYSIS OF CLASS A BIOSOLIDS IN 2007[1,2]

WRP Sample Location	Range of TS[3]	Number of Samples Collected	Total Number of Samples that Meet Class A Pathogen Requirement[4]	Range of Total Viable Ascaris per 4 Gram Dry Weight[5]
Calumet				
East and West	63.23 - 80.69	9	9	<0.0133 – 0.0800
Stickney				
HASMA[6]	69.40	1	1	<0.0800
LASMA[7]	86.91	1	1	<0.0800
Marathon	77.24	1	1	0.1600

[1]Test Method for Detecting, Enumerating, and Determining the Viability of *Ascaris* Ova in Sludge, Appendix I, Environmental Regulations and Technology, EPA/625/R-92/013, Revised 2003.

[2]United States Environmental Protection Agency, Region V, has approved the practice of analyzing 50g Dry Weight Samples of Biosolids for the determination of *Ascaris* Ova densities with every sixth sample being 300g Dry Weight as required in the District's site-specific PFRP compliance monitoring.

[3]TS=Percent Total Solids.

[4]Viable *Ascaris* ova are less than 1 viable *Ascaris* ovum per 4g total dry solids.

[5]Failure to detect viable ova in biosolids is recorded as less than (<) the limit of test sensitivity.

[6]Harlem Avenue Sludge Management Area.

[7]Lawndale Avenue Sludge Management Area.

TABLE IV-7: RESULTS OF WHOLE EFFLUENT TOXICITY TESTS CONDUCTED ON WATER RECLAMATION PLANT EFFLUENTS FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT COMPLIANCE DURING 2006

Effluent Tested	Sample Collection Date(s)	WET Test[1]		Results[2]
Egan WRP	02/06 - 02/07	Acute *P. promelas*	(Survival)	NTE
		Acute *C. dubia*	(Survival)	NTE
Lemont WRP	03/20 - 03/21	Acute *P. promelas*	(Survival)	NTE
		Acute *C. dubia*	(Survival)	NTE
Egan WRP	05/01 - 05/02	Acute *P. promelas*	(Survival)	NTE
		Acute *C. dubia*	(Survival)	NTE
Hanover Park WRP	05/15 - 05/16 05/17 - 05/18 05/19 - 05/20	Chronic *P. promelas*	(Survival) (Growth)	NTE NTE
		Chronic *C. dubia*	(Survival) (Reproduction)	NTE NTE
Lemont WRP	08/21 - 08/22	Acute *P. promelas*	(Survival)	NTE
		Acute C. *dubia*	(Survival)	NTE
Lemont WRP	09/25 - 09/26 10/09 - 10/10	Acute *P. promelas* Acute *C. dubia*	(Survival) (Survival)	NTE NTE

[1]WET Tests: Acute *Pimephales promelas* (Survival) and Acute *Ceriodaphnia dubia* (Survival), EPA 821-R-02-012, (Fifth Edition), 2002; Chronic *Pimephales promelas* (Survival, Growth) and Chronic *Ceriodaphnia dubia* (Survival, Reproduction), EPA 821/R-02/013, (Fourth Edition), 2002.
[2]Results: NTE = no toxic effect.

TABLE IV-8: RESULTS OF ALGAL GROWTH TEST CONDUCTED ON EGAN WATER RECLAMATION PLANT FINAL EFFLUENT AND SALT CREEK SAMPLES IN 2006

SAMPLE COLLECTION DATE	LIMS NUMBER	SAMPLING POINT	ORTHO-PHOS Ortho-phosphate mg/L	TOT_PHOS Tot Phos mg/L	ALGAL Algal_t mg P/L
01/05/06	4809129	BUSSE_FIL[1]	0.051*	0.01	<0.0100
01/05/06	4809128	EGAN_FIL[2]	2.412	2.42	1.0205
01/05/06	4809130	JFK_FIL[3]	0.616*	0.75	0.0434
01/05/06	4809131	THRNDL_FIL[4]	0.708*	0.79	0.3415
04/05/06	4868738	BUSSE_FIL[1]	0.022*	0.10	<0.0100
04/05/06	4868734	EGAN_FIL[2]	1.555	1.89	0.9628
04/05/06	4868741	JFK_FIL[3]	0.361*	0.49	0.3760
04/05/06	4868742	THRNDL_FIL[4]	0.298*	0.37	0.2516
06/07/06	4922330	BUSSE_FIL[1]	0.017*	0.04	<0.0100
06/07/06	4922325	EGAN_FIL[2]	3.879	4.77	1.0372
06/07/06	4922333	JFK_FIL[3]	3.325*	3.93	0.3062
06/07/06	4922335	THRNDL_FIL[4]	3.133*	3.83	0.3202
08/02/06	4966112	BUSSE_FIL[1]	0.012*	0.07	<0.0100
08/02/06	4966110	EGAN_FIL[2]	3.311	4.51	1.2070
08/02/06	4966122	JFK_FIL[3]	3.310*	3.84	1.0620
08/02/06	4966124	THRNDL_FIL[4]	3.306*	3.85	0.2888
09/20/06	5003730	BUSSE_FIL[1]	0.022*	0.05	0.0438
09/20/06	5003729	EGAN_FIL[2]	5.026	5.15	1.1938
09/20/06	5003731	JFK_FIL[3]	2.578*	2.86	0.9322
09/20/06	5003734	THRNDL_FIL[4]	2.645*	2.87	0.8849

TABLE IV-8 (CONTINUED): RESULTS OF ALGAL GROWTH TEST CONDUCTED ON EGAN WATER RECLAMATION PLANT FINAL EFFLUENT AND SALT CREEK SAMPLES IN 2006

SAMPLE COLLECTION DATE	LIMS NUMBER	SAMPLING POINT	ORTHO/PHOS Ortho/phosphate mg/L	TOT_PHOS Tot Phos mg/L	ALGAL Algal_t mg P/L
10/04/06	5014412	BUSSE_FIL[1]	0.012*	0.04	0.0267
10/04/06	5014410	EGAN_FIL[2]	1.255	1.44	0.8868
10/04/06	5014413	JFK_FIL[3]	0.099*	0.28	0.1663
10/04/06	5014414	THRNDL_FIL[4]	0.145*	0.15	0.0054
11/01/06	5031075	BUSSE_FIL[1]	0.027	0.10	<0.0100
11/01/06	5031073	EGAN_FIL[2]	3.748	4.18	0.8209
11/01/06	5031076	JFK_FIL[3]	1.740	1.92	0.8016
11/01/06	5031077	THRNDL_FIL[4]	1.780	1.96	0.8492
12/06/06	5058693	BUSSE_FIL[1]	0.011*	0.11	<0.0100
12/06/06	5058692	EGAN_FIL[2]	2.672	3.26	1.1740
12/06/06	5058694	JFK_FIL[3]	0.865*	1.14	0.7178
12/06/06	5058695	THRNDL_FIL[4]	0.788*	1.08	0.6659

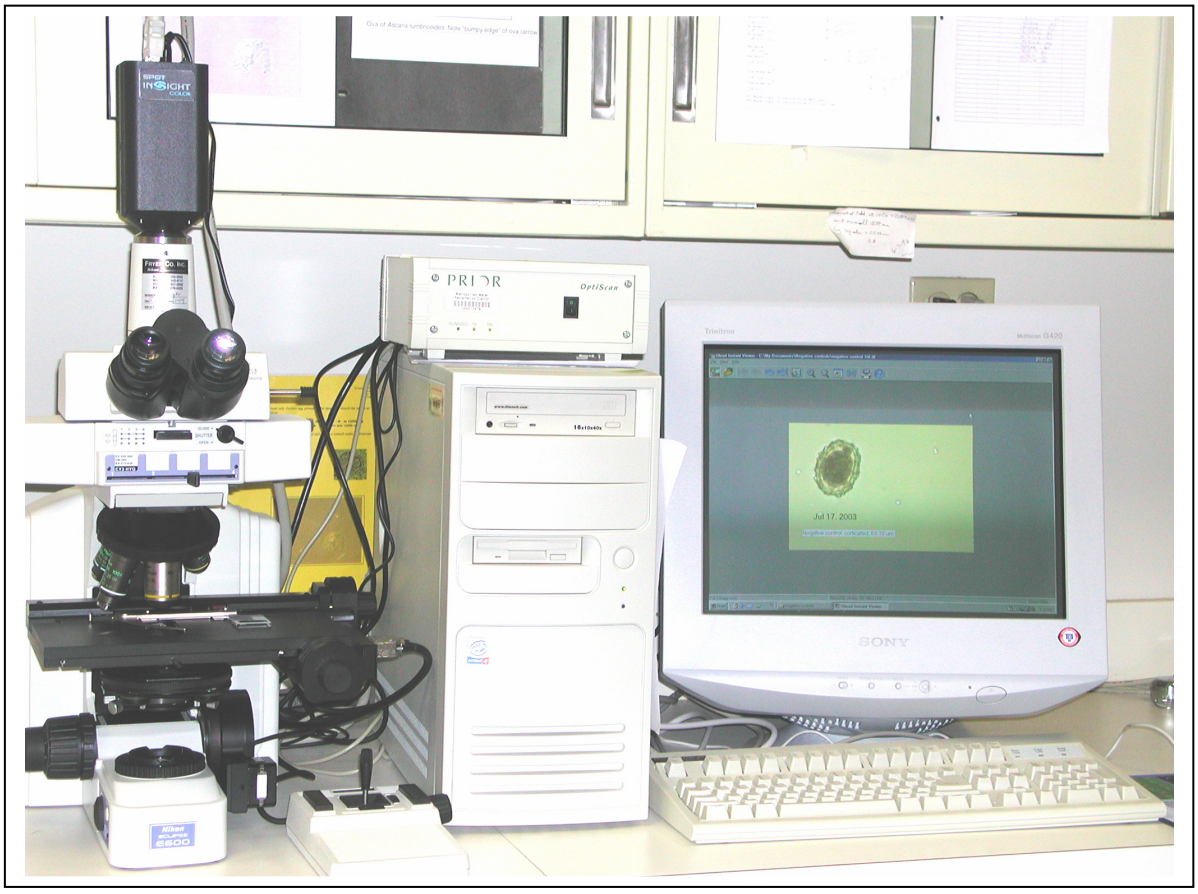
*Results from unfiltered sample.
[1]Busse Dam (0.1 mile upstream).
[2]Egan WRP Final Effluent.
[3]JFK Boulevard (0.7 mile downstream).
[4]Thorndale Avenue (2.4 miles downstream).

TABLE IV-9: RESULTS OF ALGAL GROWTH TEST CONDUCTED ON LEMONT WATER RECLAMATION PLANT FINAL EFFLUENT AND CHICAGO SANITARY AND SHIP CANAL SAMPLES IN 2006

SAMPLE COLLECTION DATE	LIMS NUMBER	SAMPLING POINT	ORTHO/PHOS Ortho/phosphate mg/L	TOT_PHOS Tot Phos mg/L	ALGAL Algal_t mg P/L
02/21/06	4840258	LEPUPSFIL[1]	0.646	0.91	0.7093
02/21/06	4840256	LEPOUTFIL[2]	2.412	2.91	0.5973
02/21/06	4840257	LEPSTEVFIL[3]	0.836	1.03	0.7868
02/21/06	4840239	LEP299.9FIL[4]	0.762	0.93	0.8093
05/16/06	4904813	LEPUPSFIL[1]	0.508	0.58	0.5085
05/16/06	4904805	LEPOUTFIL[2]	2.239	2.44	0.8651
05/16/06	4904812	LEPSTEVFIL[3]	0.624	0.73	0.4632
05/16/06	4904803	LEP299.9FIL[4]	0.770	0.79	0.5651
08/21/06	4978841	LEPUPSFIL[1]	0.515	0.62	0.2969
08/21/06	4978837	LEPOUTFIL[2]	3.653	4.05	<0.0100
08/21/06	4978838	LEPSTEVFIL[3]	0.583	0.68	0.2543
08/21/06	4978835	LEP299.9FIL[4]	0.593	0.71	0.4035
11/20/06	5047955	LEPUPSFIL[1]	0.748	0.85	0.8105
11/20/06	5047942	LEPOUTFIL[2]	2.855	3.13	1.2360
11/20/06	5047953	LEPSTEVFIL[3]	0.803	0.88	0.7535
11/20/06	5047940	LEP299.9FIL[4]	0.855	0.90	0.7969

[1]Upstream 302.6 (1.9 miles upstream).
[2]Lemont Final Effluent.
[3]Downstream Stephens Street (0.1 mile downstream).
[4]Downstream 299.9 (0.6 mile downstream).

FIGURE IV-1: MICROSCOPIC IMAGE ANALYSIS SYSTEM



Nikon E600 Research Phase Contrast Microscope with a Digital Snap Video Camera Transmitting Microscopic Images from Slide to a Computer Workstation with a Metamorph Software Program.

FIGURE IV-2: DIGITAL IMAGES OF *ASCARIS LUMBRICOIDES*

A

B

A. Non viable ovum; 67.34 µm long
B. Viable, fertile ovum; 61.61 µm long.

AQUATIC ECOLOGY AND WATER QUALITY SECTION

AQUATIC ECOLOGY AND WATER QUALITY SECTION

The mission of the section is to provide scientific and technical support to improve the District's environmental stewardship of waterways impacted by District wastewater collection and treatment practices. The goals of the Aquatic Ecology and Water Quality Section are:

1. Assess the water and sediment quality and biological health of waterways in the District's service area and in other waterways impacted by flow from this service area in order to inform policy, support/guide/assess regulatory development and support/improve operations.

2. Generate science to answer new questions or problems as they arise, such as those on emerging chemicals of concern (e.g., endocrine disruptors) or on potential changes in District operations (e.g., effluent disinfection and phosphorus removal).

3. Participate in regulatory review of water quality related standards and documents, including attendance at regulatory hearings and stakeholder meetings, that concern the operations of the District.

4. Promote public awareness and acceptance of District operations through communications of monitoring results based on accepted ethical and scientific methods.

The biological monitoring program, which runs in conjunction with the Ambient Water Quality Monitoring (AWQM) Program, includes chlorophyll monitoring, the study of the benthic invertebrate and fish communities, characterization of the physical habitat, and assessment of sediment toxicity and sediment chemistry. The primary objective of the monitoring program is to provide scientific data to the District and the Illinois Environmental Protection Agency (IEPA) regarding the biological condition of the Chicago Area Waterway System (CAWS). The IEPA uses the data to assess the biological integrity, physical habitat, and sediment quality in waterways in the District's service area. These assessments are summarized in the IEPA's Integrated Water Quality Report and Section 303 (d) Lists. Results are used by IEPA to prepare a list of impaired waters through the 303 (d) listing process.

The biological portion of the AWQM Program, as it currently exists, began in 2001 and is conducted from June through September at 59 stations on the CAWS (Figure V-1). Fifteen of the 59 sampling stations are assessed annually, with the remaining 44 stations assessed once every four years.

Additional water and sediment quality monitoring is conducted outside of the District's service area in the lower Des Plaines River and the Illinois River. Special water quality surveys are also conducted to provide technical assistance for the Maintenance and Operations (M&O) and Engineering Departments.

Fish Monitoring 2008

During June through October of 2008, fish were collected by electrofishing and seining at 29 biological monitoring stations on the CAWS. In 2008, 2,096 fish composed of 41 species and 4 hybrids were identified, weighed, and measured for length. The fish were also examined for parasites and disease.

Data from these collections are shown in Table V-1 for the deep-draft waterways and in Table V-2 for the wadeable waterways. The most abundant species in the deep-draft waterways included gizzard shad, emerald shiner, pumpkinseed sunfish, carp, bluegill, and bluntnose minnow. In the wadeable waterways, green sunfish, bluegill, bluntnose minnow, blackstripe topminnow, orangespotted sunfish, and spotfin shiner were the most abundant.

Chlorophyll Monitoring 2008

As a photosynthetic component of all algae cells, the determination of chlorophyll *a* is an accepted way of quantifying algal biomass in lakes and streams. Chlorophyll *a* values are of interest to regulatory agencies since it is also widely accepted that high algae concentrations may indicate nutrient impairment. The IEPA is cooperating with other state and local agencies to promulgate regional water quality criteria for nutrients and possibly chlorophyll. In light of this consideration, the District began monitoring chlorophyll on a monthly basis in August 2001 as part of the AWQM Program. Results from 2008 are shown in Table V-3. The highest mean values of chlorophyll *a* were 143 µg/L at Burnham Avenue on the Grand Calumet River, 35 µg/L at Oakton Street on the Des Plaines River, and 34 µg/L at Higgins Road on Salt Creek.

Illinois Waterway Monitoring

In 1984, the Monitoring and Research Department (M&R) established a long-term water and sediment monitoring program along the Illinois Waterway from the Lockport Lock to the Peoria Lock, a distance of approximately 133 miles. The purpose of the monitoring program is to assess the chemical and microbiological quality of the water and to characterize the chemical quality of the sediments.

In 2008, water samples were collected during May, August, and October from each of the 49 sampling stations (Figures V-2 and V-3). During October, sediment samples were collected at 14 selected stations. Data for these sampling events were compiled in M&R Report No. 09-46 entitled, "Water and Sediment Quality Along the Illinois Waterway from the Lockport Lock to the Peoria Lock During 2008."

Salt Creek Nutrient Reduction Demonstration Project

Baseline chemical and biological monitoring began in 2005 and continued throughout 2006 in advance of a demonstration project to lower total phosphorus in effluent from the

John E. Egan (Egan) Water Reclamation Plant (WRP). Total phosphorus reduction to approximately 0.5 mg/L was achieved through ferric chloride addition throughout 2007 and 2008, and impacts on water quality in Salt Creek were monitored. Water samples collected from one station upstream of the Egan WRP (Busse Lake Dam) and two stations downstream (J. F. Kennedy Boulevard and Thorndale Avenue) were analyzed for 16 relevant water quality constituents, including chlorophyll *a*. These samples were collected twice per month during April through November, once per month in January through March and December, and for four sequential days following rain events. Biological monitoring, including fish and macroinvertebrate collections and a physical habitat assessment, were performed once at each station during 2008, along with sediment chemistry analysis. An M&R Report comparing conditions pre- and post-phosphorus reduction, including all of the monitoring data collected for the demonstration project, will be forthcoming in late 2009. Results showed that there was no apparent stream response to lower phosphorus concentration during 2007 and 2008.

Continuous Monitoring of Dissolved Oxygen

In order to gain a better understanding of the oxygen dynamics in deep-draft sections of the CAWS, the Environmental Monitoring and Research Division developed a comprehensive Continuous Dissolved Oxygen Monitoring (CDOM) program beginning in August 1998 in the Chicago River System, July 2001 in the Calumet River System, and in the Des Plaines River System in July 2005.

Dissolved oxygen (DO) was measured hourly using remote (in-situ) water quality monitors deployed in protective stainless steel housing enclosures. As shown in Figure V-1, in the Chicago River System the monitors were located at 14 stations on the North Shore Channel, North Branch of the Chicago River, Chicago River, South Branch of the Chicago River, Bubbly Creek, and the Chicago Sanitary and Ship Canal (CSSC). In the Calumet River System, the monitors were located at nine stations on the Calumet River, Grand Calumet River, Little Calumet River, and the Calumet-Sag (Cal-Sag) Channel. Nine stations were located in the Des Plaines River System on the Des Plaines River and Salt Creek.

The DO results for 2008 can be found in the reports entitled, "Continuous Dissolved Oxygen Monitoring in the Deep-Draft Chicago Waterway System During 2008" (M&R Report No. 09-50) and "Continuous Dissolved Oxygen Monitoring in Chicago Area Wadeable Streams During 2008" (M&R Report No. 09-49).

SEPA Study 2008

On October 26, 2007, the IEPA presented proposed water quality standards for the CAWS. The DO standard is significantly more stringent than the current DO standard, specifically for the Cal-Sag Channel. To understand the impact of the proposed standard a study was conducted in 2008 to investigate the potential of the Sidestream Elevated Pool Aeration (SEPA) stations to meet the new DO standard. Continuous DO monitors were used along with the District's CDOM program to determine whether the proposed DO standard could be met with the

existing SEPA stations. A work plan was created, and the results of the study have been published in a District report 09-64.

Isotopic Composition of Nitrate in the Illinois Waterway

The District has conducted surveys of water and sediment quality along the Illinois Waterway between Lockport and Peoria since 1984. Starting in 2004 the University of Illinois at Chicago (UIC) was contracted to analyze stable nitrogen isotope ratios of nitrogen and oxygen in nitrate, and hydrogen and oxygen in water collected during the Illinois Waterway surveys. It was anticipated that these data would provide insight into the occurrence and behavior of nitrate and the rate of denitrification in the Illinois Waterway. Study results from 2004, 2005, and 2006 indicated that the influence of agricultural nitrate was relatively greater in the downstream reaches of the waterway. The study also found that nitrate flux is strongly correlated with waterway discharge rates and also that denitrification is most effective during periods of low flow.

During 2008, in addition to the samples collected from the Illinois Waterway, stable nitrogen isotope analyses were conducted by UIC on samples collected from seven major tributaries to the lower Des Plaines River and the Upper Illinois River in order to better quantify all inputs of nitrogen to the Illinois Waterway. A draft report of the findings of this study was released during the second quarter of 2008.

As part of the 2008 study, samples were also collected for ammonium nitrogen, nitrate and nitrate nitrogen, and total Kjeldahl nitrogen at all sixteen sampling locations. Data from these analyses are shown in Figures V-4 to V-6.

Chicago Area Waterway System Habitat Evaluation and Improvement Study

After thirty years of monitoring the fish populations of the deep-draft waterways in the Chicago area, it became apparent that the aquatic habitat, rather than the water quality, was the major limiting factor for the sustainability of these populations. In order to provide aquatic habitat information for a Use Attainability Analysis (UAA) of the deep-draft waterways of the CAWS, the District conducted a Habitat Evaluation and Improvement Study.

This study would formulate an aquatic habitat index that was applicable to the unique environment of the CAWS. For development of this habitat index, the District's consultant, LimnoTech Inc., used fish, macroinvertebrate, and habitat data sampled by the District during the period 2001 through 2007 from the District's 26 sampling stations on the CAWS. During 2008, 25 District sample stations were sampled using an expanded habitat assessment. Also, five additional stations not previously described were included. Three of these additional stations were on the Cal-Sag Channel and two were on the CSSC. Eight CAWS stations were sampled by the District in 2008 for fish and macroinvertebrates, and LimnoTech collected fish and macroinvertebrates from 14 stations not sampled by the District during 2008.

LimnoTech also included the analysis of collected digital video of bank conditions, habitats, and high resolution aerial imagery and bathymetry to support the assessment of the habitat conditions and index development. LimnoTech also examined the potential of navigational effects to adversely affect habitat.

The LimnoTech report will be completed in December 2009 for submittal to the Illinois Pollution Control Board.

TABLE V-1: FISH COLLECTED FROM DEEP-DRAFT WATERWAYS DURING 2008

Station No.	Location	Number of Fish Collected	Weight (kg) of Total Catch	Number of Fish Species	Number of Game Fish Species	Most Abundant Fish Species
			North Shore Channel			
36	Touhy Avenue	68	78.2	13	7	Carp
			North Branch Chicago River			
46	Grand Avenue	59	23.0	6	3	Gizzard shad
			Chicago Sanitary and Ship Canal			
75	Cicero Avenue	58	44.2	11	6	Carp
41	Harlem Avenue	186	8.8	12	5	Pumpkinseed
92	16th St., Lockport	171	14.9	9	4	Gizzard shad
			Calumet River			
55	130th Street	254	54.7	13	7	Emerald shiner
			Little Calumet River			
76	Halsted Street	45	62.7	12	5	Carp
			Calumet-Sag Channel			
59	Cicero Avenue	66	28.7	4	2	Gizzard shad
			North Branch Chicago River (Shallow Portion)			
96	Albany Avenue	52	42.9	5	1	Fathead minnow
			Buffalo Creek			
12	Lake-Cook Road	95	1,692.7	10	5	Bluegill
			Higgins Creek			
77	Elmhurst Road	107	575.1	4	1	Bluntnose minnow
78	Wille Road	20	114.9	5	2	Fathead minnow

TABLE V-2: FISH COLLECTED FROM WADEABLE WATERWAYS DURING 2008

Station No.	Location	Number of Fish Collected	Weight (g) of Total Catch	Number of Fish Species	Number of Game Fish Species	Most Abundant Fish Species
			Des Plaines River			
13	Lake-Cook Road	214	1,461.5	11	6	Green sunfish
17	Oakton Street	21	8,972.5	8	5	Green sunfish Northern pike
19	Belmont Avenue	13	5,317.9	6	3	Green sunfish
20	Roosevelt Road	5	5,276.4	3	1	Carp
22	Ogden Avenue	117	4,046.1	16	5	Hornyhead chub
23	Willow Springs Rd.	24	10,438.8	11	8	Gizzard shad
29	Stephen Street	176	343.3	14	6	Blackstripe topminnow
91	Material Services Rd.	72	277.2	13	5	Bluntnose minnow
			Salt Creek			
79	Higgins Road	83	10,159.2	9	6	Bluegill
80	Arlington Heights Rd.	52	30,173.3	7	5	Bluegill
18	Devon Avenue	6	151.7	4	3	Green sunfish
24	Wolf Road	23	333.5	10	3	Bluntnose minnow
109	Brookfield Avenue	42	373.7	9	2	Bigmouth shiner
			West Branch DuPage River			
110	Springinsguth Road	3	7.3	1	1	Bluegill
89	Walnut Lane	49	347.0	3	3	Green sunfish
64	Lake Street	90	5,244.2	8	4	Green sunfish
			Poplar Creek			
90	Route 19	20	289.0	9	3	Green sunfish

TABLE V-3: MEAN AND RANGE OF CHLOROPHYLL *a* VALUES FROM CHICAGO AREA WATERWAYS DURING 2008

Station No.	Location	Number of Samples	Mean (µg/L)	Minimum (µg/L)	Maximum (µg/L)	Standard Deviation (µg/L)
		West Fork North Branch Chicago River				
106	Dundee Road	11	14	4	45	11
103	Golf Road	10	9	4	18	5
		Middle Fork North Branch Chicago River				
31	Lake-Cook Road	10	11	2	23	6
		Skokie River				
32	Lake-Cook Road	10	8	2	14	4
105	Frontage Road	12	18	5	38	11
		North Branch Chicago River (Wadeable Portion)				
104	Glenview Road	12	11	3	27	7
34	Dempster Street	11	9	2	20	6
96	Albany Avenue	12	8	1	16	5
		North Shore Channel				
35	Central Street	9	6	1	25	8
102	Oakton Street	11	13	1	51	17
36	Touhy Avenue	12	2	0	7	2
101	Foster Avenue	12	1	0	3	1
		North Branch Chicago River (Deep-Draft Portion)				
37	Wilson Avenue	12	3	1	6	2
73	Diversey Avenue	12	4	1	6	2
46	Grand Avenue	12	4	1	9	3
		Chicago River				
74	Lake Shore Drive	10	2	1	3	1
100	Wells Street	12	2	1	5	1

TABLE V-3 (Continued): MEAN AND RANGE OF CHLOROPHYLL *a* VALUES FROM CHICAGO AREA WATERWAYS DURING 2008

Station No.	Location	Number of Samples	Mean (µg/L)	Minimum (µg/L)	Maximum (µg/L)	Standard Deviation (µg/L)
		South Branch Chicago River				
39	Madison Street	12	4	1	12	3
108	Loomis Street	11	3	1	10	3
		Bubbly Creek (South Fork South Branch Chicago River)				
99	Archer Avenue	12	11	1	38	12
		Chicago Sanitary and Ship Canal				
40	Damen Avenue	12	3	1	9	3
75	Cicero Avenue	12	4	1	12	3
41	Harlem Avenue	12	2	0	8	2
42	Route 83	12	4	1	12	3
48	Stephen Street	12	6	2	16	5
92	Lockport	50	5	1	17	4
		Calumet River				
49	Ewing Avenue	9	2	1	6	2
55	130th Street	8	5	2	8	2
		Wolf Lake				
50	Burnham Avenue	12	7	3	15	5
		Grand Calumet River				
86	Burnham Avenue	10	143	2	1006	310
		Little Calumet River (Deep-Draft Portion)				
56	Indiana Avenue	9	21	4	36	11
76	Halsted Street	12	8	1	16	5
		Thorn Creek				
54	Joe Orr Road	9	4	1	8	2
97	170th Street	11	8	3	13	4

TABLE V-3 (Continued): MEAN AND RANGE OF CHLOROPHYLL *a* VALUES FROM CHICAGO AREA WATERWAYS DURING 2008

Station No.	Location	Number of Samples	Mean (µg/L)	Minimum (µg/L)	Maximum (µg/L)	Standard Deviation (µg/L)
		Little Calumet River (Wadeable Portion)				
52	Wentworth Avenue	10	6	1	14	4
57	Ashland Avenue	10	8	2	14	4
		Calumet-Sag Channel				
58	Ashland Avenue	12	8	3	17	5
59	Cicero Avenue	11	8	2	23	6
43	Route 83	10	10	1	27	8
		Buffalo Creek				
12	Lake-Cook Road	11	20	4	46	12
		Higgins Creek				
77	Elmhurst Road	5	26	7	92	37
78	Wille Road	12	2	1	4	1
		Des Plaines River				
13	Lake-Cook Road	12	19	4	74	20
17	Oakton Street	11	35	9	124	36
19	Belmont Avenue	12	22	2	80	27
20	Roosevelt Road	12	23	2	85	30
22	Ogden Avenue	11	21	1	83	25
23	Willow Springs Road	11	22	1	79	25
29	Stephen Street	12	22	2	72	21
91	Material Service Road	12	26	4	118	30
		Salt Creek				
79	Higgins Road	9	34	5	60	18
80	Arlington Heights Road	12	12	3	40	10
18	Devon Avenue	12	14	4	44	11
24	Wolf Road	12	9	1	19	7
109	Brookfield Avenue	11	6	1	11	4

TABLE V-3 (Continued): MEAN AND RANGE OF CHLOROPHYLL *a* VALUES FROM CHICAGO AREA WATERWAYS DURING 2008

Station No.	Location	Number of Samples	Mean (µg/L)	Minimum (µg/L)	Maximum (µg/L)	Standard Deviation (µg/L)
		West Branch DuPage River				
110	Springinsguth Road	11	14	2	43	13
89	Walnut Lane	12	7	2	18	5
64	Lake Street	12	19	5	36	11
		Poplar Creek				
90	Route 19	11	9	2	18	4

FIGURE V-1: AMBIENT WATER QUALITY MONITORING AND CONTINUOUS DISSOLVED OXYGEN MONITORING SAMPLE STATIONS

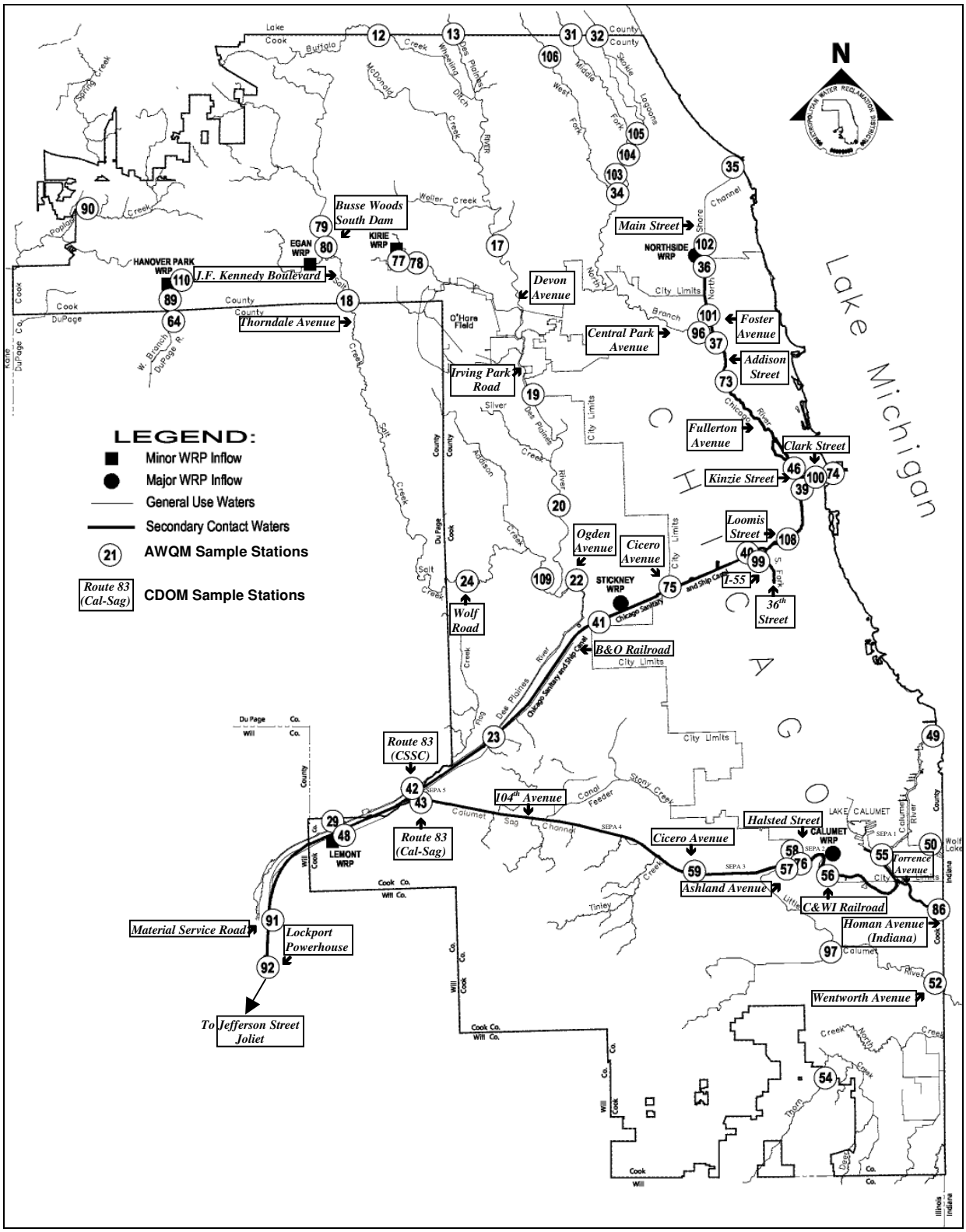


FIGURE V-2: MAP OF THE ILLINOIS WATERWAY FROM LOCKPORT TO MARSEILLES SHOWING SAMPLING STATIONS 1 TO 21

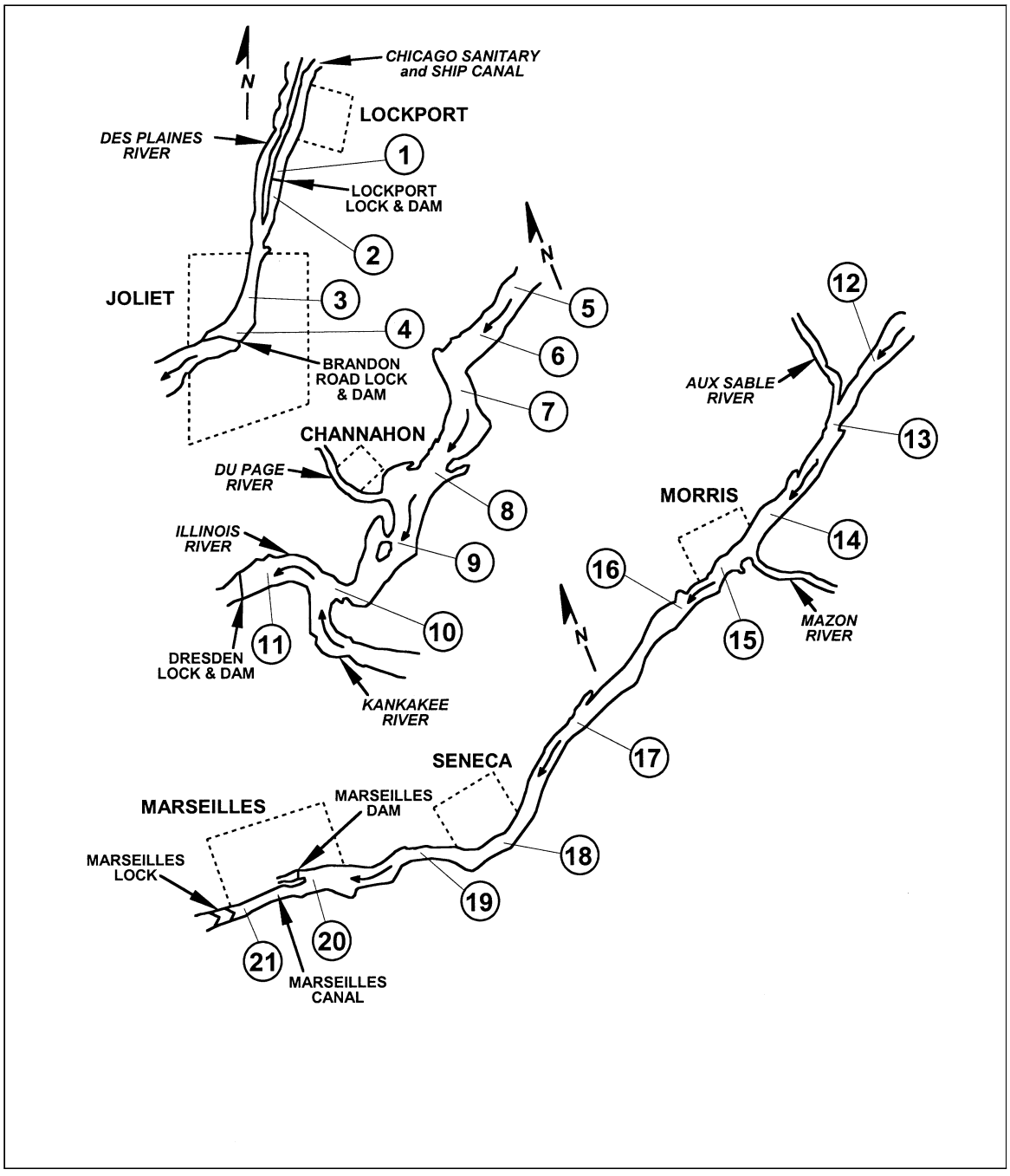


FIGURE V-3: MAP OF THE ILLINOIS WATERWAY FROM OTTAWA TO PEORIA SHOWING SAMPLING STATIONS 22 TO 49

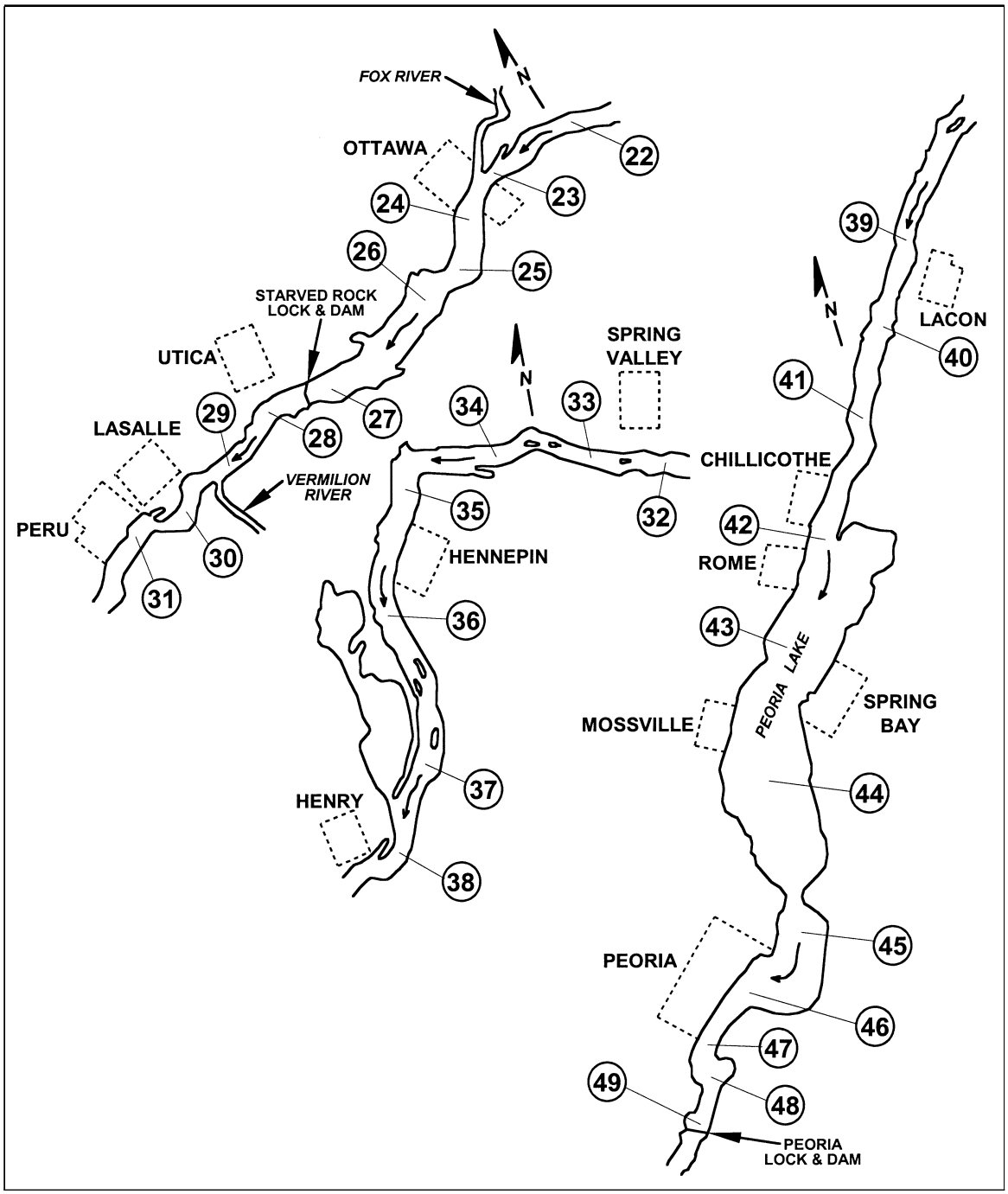


Figure V-4: Monthly Ammonium Nitrogen Concentrations at Selected Locations in the Illinois Waterway and its Major Tributaries

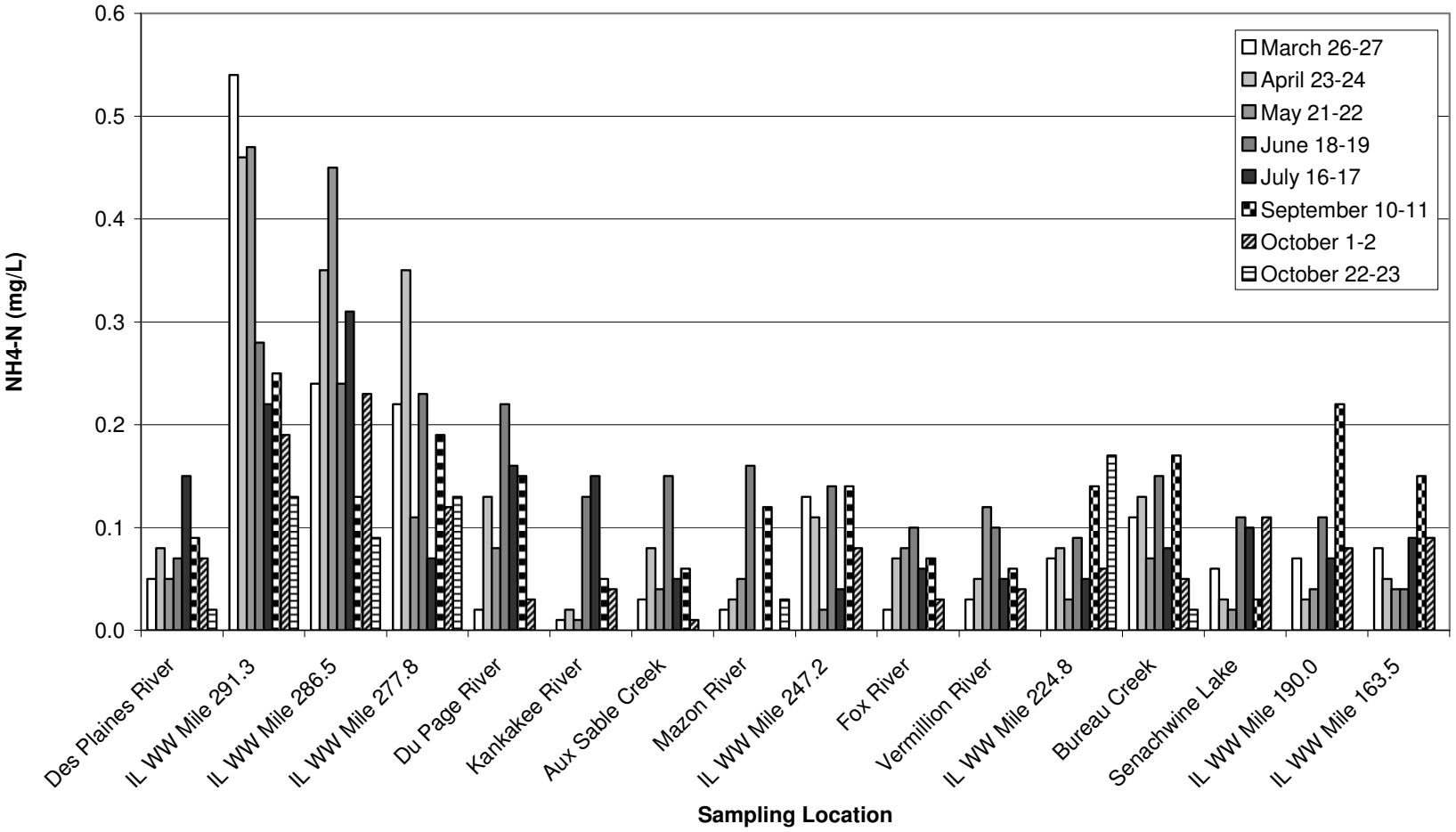


Figure V-5: Monthly Nitrite + Nitrate Nitrogen Concentrations at Selected Locations in the Illinois Waterway and its Major Tributaries

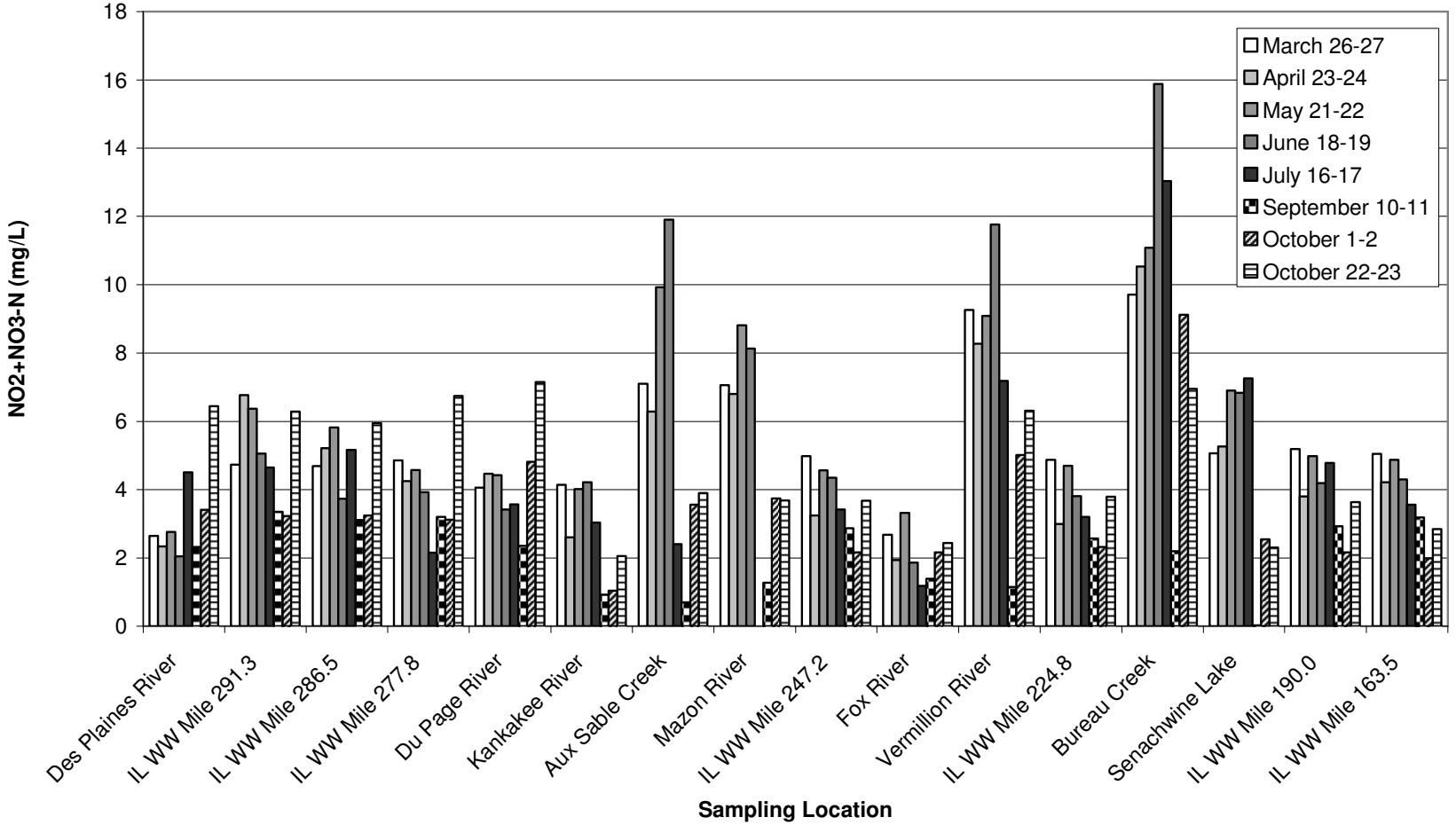
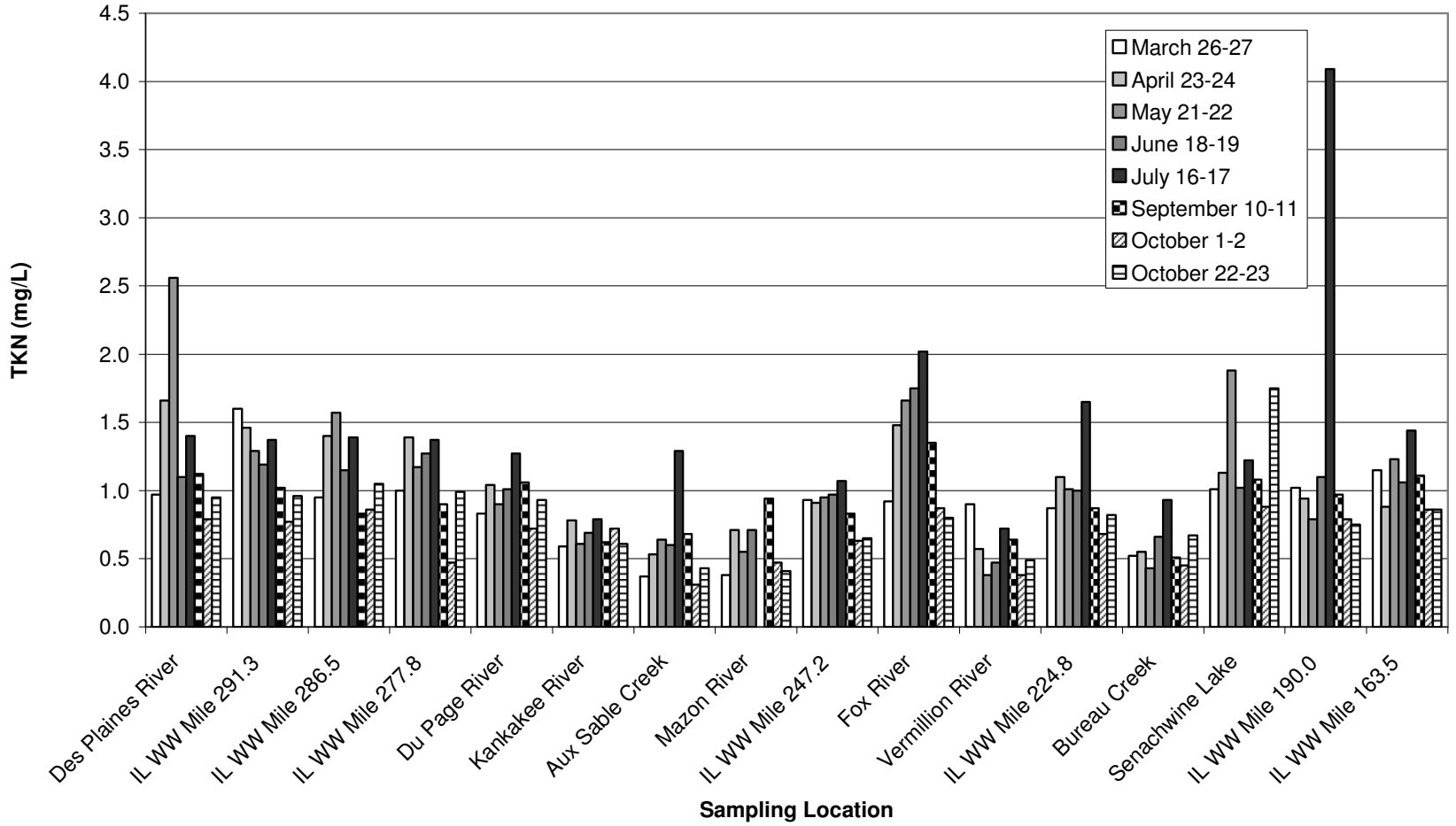


Figure V-6: Monthly Total Kjeldahl Nitrogen Concentrations at Selected Locations in the Illinois Waterway and its Major Tributaries



RADIOCHEMISTRY SECTION

RADIOCHEMISTRY SECTION

Radiological Monitoring of the Chicago Area Waterway System

Radiological monitoring is a part of the overall monitoring program of the water quality within the Metropolitan Water Reclamation District of Greater Chicago's (District) waterways. Radiological monitoring involves the determination of gross alpha and gross beta radioactivity of samples collected from the waterways. The program includes the Calumet, Chicago, and Des Plaines River systems comprising 170 miles (273.6 km) of waterways. There are sixteen sampling locations on the Chicago River system, nine on the Calumet River system, and twenty on the Des Plaines River system. Each location was sampled once per month.

The samples were analyzed for gross alpha and gross beta radioactivity by the Environmental Inc. Midwest Laboratory, Illinois. The data is presented in the 2008 Annual Summary Report - Water Quality Within the Waterways System of the Metropolitan Water Reclamation District of Greater Chicago. The concentrations of radioactivity in all samples analyzed were well within the United States Environmental Protection Agency (USEPA) Drinking Water Standards of 15 pCi/L for gross alpha (excluding radon and uranium), and 50 pCi/L (screening level) for gross beta particle activity minus the naturally occurring potassium-40 beta particle activity.

Levels of Radioactivity in Raw and Treated Wastewaters

Radiological monitoring of raw wastewaters and final effluents from the District's seven water reclamation plants (WRPs) continued in 2008. Data from the monitoring serves as a measure of present-day radioactivity levels in comparison to levels in past years. The Illinois Pollution Control Board (IPCB) has established General Use water quality standards for radioactivity in the waters of Illinois. According to IPCB regulations, (Title 35, Chapter 1, Section 302.207) gross beta concentration shall not exceed 100 pCi/L, and the strontium-90 concentration must not exceed 2 pCi/L. The annual average radium-226 and 228 combined concentration must not exceed 3.75 pCi/L in General Use waters. There are no IPCB or USEPA radioactivity standards for raw sewage or final effluents. However, the District uses the IPCB General Use waters limits for gross beta concentration as the standard for monitoring effluents.

The radioactivity analysis was conducted on 24-hour composite samples of raw sewage and final effluent collected monthly at all WRPs. The samples were analyzed by Environmental Inc. Midwest Laboratory, Illinois. The data are presented in the 2008 Annual Report entitled Radiological Monitoring of the Raw Sewage, Final Effluent, Sludges, and Biosolids of the Metropolitan Water Reclamation District of Greater Chicago (Monitoring and Research Department [M&R] Report No. 09-42).

The results show that the amount of gross alpha and gross beta radioactivity in the final effluent is less than the allowable contaminant levels in drinking water standards set by the USEPA National Primary Drinking Water Regulations 40 CFR Part 141. The gross beta

radioactivity in the final effluent is also less than the General Use Water Quality Standards established by the IPCB. The monitoring data indicate that the discharge of the final effluent from the seven WRPs is not likely to have any adverse effect on the radiological quality of the Chicago Area Waterways.

Levels of Radioactivity in Sludge and Biosolids

In 1993, the Radiochemistry Section revised and expanded its radiological monitoring program of District sludges in response to the increased emphasis on monitoring biosolids quality brought about by adoption of the USEPA's Part 503 Sewage Sludge Regulations. Although there are no standards for radioactivity in these regulations, it was felt that the District should expand its database on the radiological characteristics of its sludge and biosolids.

During 2008, sludge or biosolids samples were collected monthly at all WRPs. Biosolids samples were also collected monthly from the solids drying sites of the District from May through September. The samples were analyzed for gross alpha and gross beta radioactivity by the Environmental Inc. Midwest Laboratory, Illinois.

Sludge and biosolids samples were also analyzed for eleven gamma-emitting radionuclides with a potential for reconcentration in biosolids. Only three of these radionuclides were detected at measurable levels. Two of these three radionuclides, radium-226 and potassium-40, are of natural origin. The third radionuclide, cesium-137, is man-made and may have arisen from fallout of nuclear weapons testing in the middle of the 20th century.

The data are presented in the 2008 Annual Report on the Radiological Monitoring of the Raw Sewage, Final Effluent, Sludges, and Biosolids of the Metropolitan Water Reclamation District of Greater Chicago (M&R Report No. 09-42).

Radiation Safety

The Radiochemistry Section maintains a radiation safety program for the District. The District possesses a radioactive material license from the Illinois Emergency Management Agency, Division of Nuclear Safety (IEMA-DNS). The radiation protection program is conducted in accordance with the license conditions and regulatory requirements of IEMA-DNS. The program includes:

- maintaining the IEMA-DNS radioactive material license;
- managing low-level radioactive waste;
- monitoring personnel for radiation exposure;
- testing the operation of radiation survey meters;

- leak testing the radioactive sealed sources; and

- maintaining a physical inventory of licensed radioactive materials.

The Illinois Low-Level Radioactive Waste Management Act requires all generators and brokers of low-level radioactive waste in Illinois to file an annual survey with the IEMA-DNS. In 2008, the relevant forms were received from the IEMA-DNS, completed, and returned to the IEMA-DNS.

The monitoring of District employees for radiation exposure was carried out using dosimeter badges and finger ring dosimeters. The dosimeters are worn by the users of moisture/density gauges. No District employee was exposed to an overdose of radiation in 2008.

The operational checks of radiation survey meters were carried out on the day radioactive materials were used or at least once a quarter. A record was maintained for the operational checks of radiation survey instruments.

As per IEMA-DNS regulations, radioactive sealed sources are tested for leakage or contamination at intervals not to exceed six months. All of the radioactive sealed sources used by the District personnel were tested for leakage twice in 2008.

Nickel-63 sources constitute a part of the electron capture detectors of gas chromatographs used by M&R. Leak tests were performed on four detectors from two gas chromatographs in 2008. No leaks were discovered in any of these detectors.

The APD2000 Chemical Warfare (CW) detector is equipped with a nickel-63 sealed source. Leak tests were performed in 2008 on the APD2000 CW Detector owned by the Safety Section of General Administration. No leaks were discovered in these detectors.

Leak tests were also performed on four Troxler surface moisture/density gauges used by the Construction Division of the Engineering Department. No leaks were discovered in any of these gauges.

A physical inventory of the radioactive sealed sources possessed by the District was carried out twice in the year 2008. A record of this inventory was maintained as per license requirements.

APPENDIX I

MEETINGS AND SEMINARS 2008
ENVIRONMENTAL MONITORING & RESEARCH DIVISION

1. Illinois Association of Park Districts/Illinois Parks and Recreation Association Conference, Chicago, Illinois, *January 2008.*

2. Illinois Association of Wastewater Agencies, Nutrient Subcommittee Meeting (and follow-up committee meetings throughout the year), Starved Rock, Utica, Illinois, *January 2008*.

3. Illinois Pollution Control Board, Use Attainability Analysis Hearings (and follow-up hearings throughout the year), Chicago, Illinois, *January 2008.*

4. Illinois Water Environment Association/Central States Water Environment Association, Government Affairs in Water Pollution Control Seminar, Willowbrook, Illinois, *January 2008*.

5. Midwest Water Analysts Association, Winter Expo 2008, Kenosha, Wisconsin*, January 2008*.

6. United States Department of Agriculture, Regional Research Committee W-1170 Annual Meeting, Las Vegas, Nevada, *January 2008*.

7. United States Environmental Protection Agency, Aquatic Nuisance Species Barrier Panel Meeting (and follow-up committee meetings throughout the year), Chicago, Illinois, *January 2008*.

8. Illinois Nutrient Standard Workgroup, Springfield, Illinois, *March 2008.*

9. Illinois Water Environment Association, 29th Annual Conference and Exhibition (and follow-up committee meetings throughout the year), Peoria, Illinois, *March 2008*.

10. United States Environmental Protection Agency, Regional Technical Assistance Group, Nutrient Workgroup Meeting, Chicago, Illinois, *March 2008*.

11. United States Environmental Protection Agency, Surface Water Monitoring and Standards (SWiMS), 7th Annual Meeting, Chicago, Illinois, *March 2008*.

12. United States Fish and Wildlife Service, Hines Emerald Dragonfly Critical Habitat Planning Meeting (and follow-up committee meetings throughout the year), Romeoville, Illinois, *March 2008*.

13. Water Environment Federation, Residuals and Biosolids 2008: Traditions, Trends, and Technologies, Philadelphia, Pennsylvania, *March 2008*.

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MEETINGS AND SEMINARS 2008
ENVIRONMENTAL MONITORING & RESEARCH DIVISION

14. American Chemical Society, 235th National Meeting, New Orleans, Louisiana, *April 2008.*

15. Calumet Government Working Group Meeting (and follow-up committee meetings throughout the year), Chicago, Illinois, *April 2008*.

16. Central States Water Environment Association, 13th Annual Education Seminar, Madison, Wisconsin, *April 2008.*

17. City of Chicago, Earth Day Celebration, Chicago, Illinois, *April 2008*.

18. DuPage River, Salt Creek Watershed Workgroup Meeting (and follow-up committee meetings throughout the year), Elmhurst, Illinois, *April 2008*.

19. Water Environment Federation/Air and Waste Management Association, Odors and Air Emissions 2008 Joint Conference, Phoenix Arizona, *April 2008.*

20. City of Chicago/United States Army Corps of Engineers, Laborer's International Union of North America, Local 4, Bubbly Creek Ecosystem Restoration Public Meeting, Chicago, Illinois, *May 2008.*

21. Lake Michigan Watershed Academy Conference, Hammond, Indiana, *May 2008.*

22. Air and Waste Management Association, 101th Annual Conference, Portland, Oregon, *June 2008*.

23. American Society for Microbiology, 108th General Meeting and Workshops, Boston, Massachusetts, *June 2008*.

24. American Society of Mining and Reclamation, 25th Annual Meeting, Richmond, Virginia, *June 2008.*

25. City of Chicago, Department of Environment, Bubbly Creek Active Sediment Capping Committee Meeting (and follow-up committee meetings throughout the year), Chicago, Illinois, *June 2008*.

26. Illinois Water Environment Association, 2008 Joint Laboratory Seminar, Crystal Lake, Illinois, *June 2008*.

27. Midwest Water Analysts Association, 2008 Spring Meeting, Wheaton, Illinois, *June 2008*.

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MEETINGS AND SEMINARS 2008
ENVIRONMENTAL MONITORING & RESEARCH DIVISION

28. Water Environment Federation/United States Environmental Protection Agency, Sustainability 2008 Conference, Green Practice for the Water Environment, National Harbor, Maryland, *June 2008*.

29. National Association of Clean Water Agencies, 38th Annual Meeting, Anchorage, Alaska, *July 2008*.

30. Environmental Laboratories Annual Seminar, Springfield, Illinois, *September 2008.*

31. Great Lakes Beach Association Annual Conference, Indiana Dunes National Lakeshore, Porter County, Indiana, *September 2008.*

32. Smith Root Electrofishing Training and Certification, Grand Rapids, Michigan, *September 2008.*

33. Chicago Metropolitan Agency for Planning, Workshop on Water Reuse and Water Efficiency; Options for Industry, Chicago, Illinois, *October 2008*.

34. Illinois Water Conference 2008, Champaign, Illinois, *October 2008.*

35. International Conference on Soil, Sediments, and Water, 24th Annual, Amherst, Massachusetts, *October 2008.*

36. Midwest Water Analysts Association, 2008 Fall Meeting, Milwaukee, Wisconsin, *October 2008*.

37. Treatment Wetland Interagency Meeting, Woodridge, Illinois, *October 2008.*

38. United States Environmental Protection Agency, Integrated Nitrogen Committee Workshop, Washington, D.C., *October 2008*.

39. Water Environmental Federation, 81st Annual Technical Exhibition and Conference, Chicago, Illinois, *October 2008*.

40. Water Environment Research Foundation, Workshop on Advanced Whole Plant Modeling, Chicago, Illinois, *October 2008.*

41. American Water Works Association, Water Quality Technical Conference, Cincinnati, Ohio, *November 2008.*

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MEETINGS AND SEMINARS 2008
ENVIRONMENTAL MONITORING & RESEARCH DIVISION

42. Lake Michigan Air and Waste Management Association, 2008 Air Quality Management Conference, Downers Grove, Illinois, *November 2008.*

43. Midwest Institute of Park Executives Meeting, Schaumburg, Illinois, *November 2008.*

44. Northern Illinois University, Graduate Geography Department Colloquium, DeKalb, Illinois, *November 2008.*

45. Society of Environmental Toxicology and Chemistry, North America, 29th Annual Conference, Tampa, Florida, *November 2008*.

46. Soil Science Society of America, Annual Meeting, Houston, Texas, *November 2008*.

47. University of Illinois Chicago, Chicago Wilderness Congress, Chicago, Illinois, *November 2008.*

48. Illinois Sports Turf Managers Association, Illinois Professional Turf Conference, Schaumburg, Illinois, *December 2008*.

49. University of Illinois at Chicago, Department of Earth and Environmental Sciences Lunch Seminar, Chicago, Illinois, *December 2008.*

50. Water Environment Research Foundation, Research Forum, Clearwater Beach, Florida, *December 2008*.

APPENDIX II

PRESENTATIONS 2008
ENVIRONMENTAL MONITORING & RESEARCH DIVISION

1. "Simple Retrofitting for Phosphorus Removal and Its Impact on Plant Performance." Presented at the Midwest Water Analysts Association, Winter Expo 2008, Kenosha, Wisconsin, by H. Zhang, J. S. Jain, C. O'Connor, T. C. Granato, J. Wasik, M. Brand, K. Lai, J. Ford, and S. Carmody. *January 2008.* PP

2. "Antibiotics in the Terrestrial Environment: What's the Scoop with Animal and Human Poop?" Presented at the Illinois Water Environment Association, 29th Annual Conference and Exhibition, Peoria, Illinois, by K. Kumar, L. S. Hundal, A. E. Cox, T. C. Granato, L. Kollias, and R. Lanyon. *March 2008.* PP

3. "Concerns about Endocrine Disrupting Chemicals in Land-Applied Biosolids – Media Hype or Reality." Presented at the Illinois Water Environment Association, 29th Annual Conference and Exhibition, Peoria, Illinois, by L. S. Hundal, K. Xia, A. E. Cox, T. C. Granato, L. Kollias, R. Lanyon, K. Armbrust, and K. Kumar. *March 2008.* PP

4. "Dry Weather Microbial Risk Assessment of Human Health Impacts of the Chicago Area Waterway System." Presented at the Illinois Water Environment Association, 29th Annual Conference and Exhibition, Peoria, Illinois, by G. Rijal. *March 2008.* PP

5. "Potential Effects of Ferric Chloride on GBT Performance at Egan Water Reclamation Plant." Presented at the Illinois Water Environment Association, 29th Annual Conference and Exhibition, Peoria, Illinois, by J. A. Kozak and K. Patel. *March 2008.* PP

6. "The Application of Microscopic Image Analysis Technology to the Enumeration of Ascaris Ova in Biosolids." Presented at the Illinois Water Environment Association, 29th Annual Conference and Exhibition, Peoria, Illinois, by R. Gore. *March 2008.* PP

7. "The Carbon and Energy Footprint of Water Reclamation and Waterway Management in Greater Chicago." Presented at the American Chemical Society, 235th National Meeting, New Orleans, Louisiana, by C. O'Connor, J. A. Kozak, K. Kumar, T. C. Granato, L. Kollias, and R. Lanyon. *April 2008.* B

8. "Metropolitan Water Reclamation District of Greater Chicago's Role in Protecting Public Health and Chicago Area Waterways." Presented at the American Society for Microbiology, 108th General Meeting and Workshops, Boston, Massachusetts, by G. Rijal. *June 2008.* PP

9. "Soil Nitrogen Replenishment Resulting from Long-Term Application of Biosolids for Reclamation of Strip-Mined Land." Presented at the American Society of Mining and

Reclamation, 25th Annual Meeting, Richmond, Virginia, by G. Tian, T. C. Granato, A. E. Cox, R. I. Pietz, and C. R. Carlson, Jr. *June 2008.* PP

10. "Enterococci qPCR: Implications for POTWs." Presented at the Great Lakes Beach Association, Annual Conference, Indiana Dunes National Lakeshore, Porter County, Indiana, by A. Glymph. *September 2008.* PP

11. "Activated Sludge and BNR Process Control – Hands-On in the Real World. Station: 'Microscopy (The Bugs)'." Presented at the Water Environment Federation, 81st Annual Technical Exhibition and Conference, Chicago, Illinois, by A. Glymph. *October 2008.* PS

12. "Current Practice of Water Reuse by the Metropolitan Water Reclamation District of Greater Chicago." Presented at the Chicago Metropolitan Agency for Planning, Chicago, Illinois, by C. O'Connor, T. C. Granato, L. Kollias, and R. Lanyon. *October 2008.* PP

13. "Dissolved Oxygen in the Chicago Area Waterway System, Using a Continuous Dissolved Oxygen Monitoring Program to Support Water Quality Improvement Efforts." Presented at the Water Environment Federation, 81st Annual Technical Exhibition and Conference, Chicago, Illinois, by T. Minarik. *October 2008.* PS

14. "Impact of $FeCl_3$ Addition for Phosphorus Removal on Solids Processing at the John E. Egan Water Reclamation Plant." Presented at the Water Environment Federation, 81st Annual Technical Exhibition and Conference, Chicago, Illinois, by K. Patel, J. A. Kozak, D. T. Lordi, C. O'Connor, and T. C. Granato. *October 2008.* B

15. "Innovative Recycling of Biosolids: No Problem with Metals." Presented at the International Conference on Soil, Sediments, and Water, 24th Annual, Amherst, Massachusetts, by P. Lindo, T. C. Granato, and A. E. Cox. *October 2008.* PS

16. "Simple Retrofitting for Phosphorus Removal and Its Impact on Plant Performance at the John E. Egan Water Reclamation Plant." Presented at the Water Environment Federation, 81st Annual Technical Exhibition and Conference, Chicago, Illinois, by H. Zhang, J. S. Jain, C. O'Connor, T. C. Granato, M. Brand, K. Lai, J. Ford, and S. Carmody. *October 2008.* B

17. "Stream Response to Phosphorus Reduction at the Metropolitan Water Reclamation District of Greater Chicago, John E. Egan Water Reclamation Plant." Presented at the Water Environment Federation, 81st Annual Technical Exhibition and Conference,

Chicago, Illinois, and DuPage River, Salt Creek Watershed Workgroup Meeting, Elmhurst, Illinois, by J. Wasik. *October 2008.* PP

18. "The Carbon and Energy Footprint of Water Reclamation and Waterway Management in Greater Chicago." Presented at the Illinois Water Conference 2008, Champaign, Illinois, by J. A. Kozak, C. O'Connor, T. C. Granato. *October 2008.* PP

19. "Water Environment Federation/Water Environment Research Foundation: Getting Prepared for 'New' Pathogen Standards." Presented at the Water Environment Federation, 81st Annual Technical Exhibition and Conference, Chicago, Illinois, by G. Rijal. *October 2008.* PP

20. "Overview of Emerging Issues: Wastewater Treatment and Water Resource Management." Presented at Northern Illinois University, Graduate Geography Department Colloquium, DeKalb, Illinois, by T. C. Granato. *November 2008.* PP

21. "Save with Biosolids as a Fertilizer Substitute and as a Soil Amendment." Presented at the Midwest Institute of Park Executives Meeting, Schaumburg, Illinois, by A. E. Cox and D. Collins. *November 2008.* PP

22. "Wastewater Treatment Opportunities at the Metropolitan Water Reclamation District." Presented at University of Illinois at Chicago, Department of Earth and Environmental Sciences Lunch Seminar, Chicago, Illinois, by J. A. Kozak. *December 2008.* PP

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*P = Available as a paper
B = Available as both a paper and PowerPoint Presentation
PP = Available as PowerPoint Presentation
PS = Poster Presentation

APPENDIX III

PAPERS PUBLISHED 2008
ENVIRONMENTAL MONITORING & RESEARCH DIVISION

1. Hundal, L. S., A. E. Cox, T. C. Granato, and Z. Abedin. "Levels of Dioxin in Soils and Corn Tissues after 30 Years of Biosolids Application." *Journal of Environmental Quality,* 37: 1497-1500. *2008.*

2. Koo, B. J., A. C. Chang, A. L. Page, T. C. Granato, and R. H. Dowdy. "Assessing Long-Term Plant Availability of Biosolids-Borne Heavy Metals Accumulated in Cropland Soils." Proceedings of Water Environment Federation, 21st Annual Residuals and Biosolids Management Conference, Philadelphia, Pennsylvania. *2008.*

3. Koo, B. J., W. Chen, T. C. Granato, R. H. Dowdy, A. L. Page, and A. C. Chang. "New Approach to Assess Plant-Availability of Soil-Borne Heavy Metals." Proceedings of 14th International Conference on Heavy Metals in the Environment, Department of Agricultural Chemistry, National Taiwan University, Taipai, Taiwan, *2008.*

4. Oskouie, A. K., D. T. Lordi, T. C. Granato, and L. Kollias. "Plant-Specific Correlations to Predict the Total VOC Emissions from Wastewater Treatment Plants." *Atmospheric Environment,* 42: 4530-4539. *2008.*

5. Tian, G., T. C. Granato, F. D. Dinelli, and A. E. Cox. "Effectiveness of Biosolids in Enhancing Soil Microbial Populations and N Mineralization in Golf Course Putting Greens." *Applied Soil Ecology,* 40: 381-386. *2008.*

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO
MONITORING AND RESEARCH DEPARTMENT 2008 SEMINAR SERIES

January 25, 2008 ***The Antibiotic Paradox: What's the Scoop with Animal and Human Poop?*** Dr. Kuldip Kumar, Soil Scientist, Monitoring and Research (M&R) Department, Metropolitan Water Reclamation District of Greater Chicago (District), Cicero, IL

February 29, 2008 ***Direct Electricity or Hydrogen Generation from Wastewater and other Waste Biomass using Microbial Fuel Cell Technologies*** Dr. Bruce Logan, Pennsylvania State University, College Station, PA

March 28, 2008 ***Chicago Health, Environmental Exposure, and Recreation Study***
Dr. Samuel Dorevitch, University of Illinois at Chicago, Chicago, IL

April 25, 2008 ***Life Cycle Inventory and Impacts of Reactive Nitrogen in Agroecosystems***
Dr. Thomas Theis, University of Illinois at Chicago, Chicago, IL

May 30, 2008 ***An Exploration of Emerging Contaminants in the Chicago Waterways: Ongoing Collaborative Research between USEPA and the District*** Mr. Todd Nettesheim, United States Environmental Protection Agency, Chicago, IL

June 27 2008 ***Occurrence and Fate of Microconstituent Chemicals in Biosolids***
Dr. Edward Topp, Agriculture and Agri-Food Canada, Ottawa, Ontario, CAN

July 25, 2008 ***The District's Global Warming Initiatives*** Dr. Catherine O'Connor, Research Scientist, M&R Department, District, Cicero, IL

August 22, 2008 ***Total Nitrogen Removal in the Hybrid Membrane-Biofilm Process***
Dr. Robert Nerenberg, University of Notre Dame, South Bend, IN

September 26, 2008 ***Update of the Proposed State of Illinois Nutrient Standards***
Mr. Robert Mosher, Illinois Environmental Protection Agency, Springfield, IL

October 17, 2008 ***Full-Scale Removal of Struvite from Biosolids Centrate for Production of Commercial Fertilizer at the City of Edmonton's Gold Bar Water Reclamation Plant*** Mr. Vince Corkery, City of Edmonton, Edmonton, Alberta, CAN

November 21, 2008 ***Effect of Full-Scale Chemical Phosphorus Removal at the John E. Egan Water Reclamation Plant on Treatment Process Performance, Sludge Dewatering, Biosolids Management, and Water Quality in Salt Creek***
Ms. Jennifer Wasik, Biologist; Dr. Heng Zhang, Research Scientist; Mr. Kamlesh Patel, Research Scientist; and Dr. Guanglong Tian, Soil Scientist; M&R Department, District, Cicero, IL

December 12, 2008 ***Update on the District's Biosolids Management Program***
Dr. Albert Cox, Soil Scientist, M&R Department, District, Cicero, IL; Ms. Manju Sharma, Assistant Chief Engineer and Mr. Daniel Collins, Principal Civil Engineer, Maintenance and Operations Department, District, Chicago, IL

RESERVATIONS REQUIRED (at least 24 hours in advance); PICTURE ID REQUIRED FOR PLANT ENTRY
CONTACT: Dr. Thomas C. Granato, Assistant Director of M&R, EM&R Division, (708) 588-4264 or (708) 588-4059
LOCATION: Stickney Water Reclamation Plant, Lue-Hing R&D Complex, 6001 West Pershing Road, Cicero, IL 60804; TIME: 10:00 A.M.
NOTE: These seminars are eligible for Professional Development Credits/CEUs

Environmental Monitoring and Research Division

Section 121
Administrative Section

Granato, Thomas, Assistant Director of R&D
Messina, Deborah, Secretary

O'Connor, Catherine, Research Scientist 4
Urlacher, Nancy, Administrative Assistant
Abedin, Zainul, Biostatistician

Section 122
Wastewater Treatment Process Research

Lordi, David, Research Scientist 3
Zhang, Heng, Research Scientist 3
Franklin, Laura, Prin. Office Support
Oskouie, Ali, Research Scientist 2
Patel, Kamlesh, Research Scientist 2
Bernstein, Doris, Research Scientist 1
Kozak, Joseph, Research Scientist 1
MacDonald, Dale, Research Scientist 1
Vacant, Research Scientist 1
Haizel, Anthony, Lab Tech 2
Reddy, Thota, Lab Tech 2
Bodnar, Robert, Lab Tech 1
Byrnes, Marc, Lab Tech 1
Vacant, Lab Tech 1
Robinson, Harold, Lab Tech 1
Vacant, Lab Tech 1

Section 123
Biosolids Utilization and Soil Science

Cox, Albert, Soil Scientist 3
Quinlan, Kathleen, Prin. Office Support
Hundal, Lakhwinder, Soil Scientist 2
Tian, Guanglong, Soil Scientist 2
Kumar, Kuldip, Soil Scientist 1
Lindo, Pauline, Soil Scientist 1
Dennison, Odona, Sanitary Chemist 1
Patel, Minaxi, Sanitary Chemist 1
Mackoff, Ilyse, Lab Tech 2
Tate, Tiffany, Lab Tech 2
Adams, Richard, Lab Tech 1
Burke, Michael, Lab Tech 1
Holic, Lawrence, Lab Assistant
Rogers, Robert, Lab Assistant

Section 124
Analytical Microbiology and Biomonitoring

Rijal, Geeta, Microbiologist 4
Schaefer, Susan, Prin. Office Support
Glymph, Auralene, Microbiologist 3
Gore, Richard, Microbiologist 2
Yamanaka, Jon, Biologist 1
Billett, George, Lab Tech 2
Jackowski, Kathleen, Lab Tech 2
Maka, Andrea, Lab Tech 2
Rahman, Shafiq, Lab Tech 2
Shukla, Hemangini, Lab Tech 2
Hussaini, Syed, Lab Tech 1
Kaehn, James, Lab Tech 1
Mangkorn, Damrong, Lab Tech 1
Roberts, David, Lab Tech 1
Schipma, Jane, Lab Assistant
Latimore, Thomas, Lab Assistant

Section 126
Aquatic Ecology and Water Quality

Dennison, Sam, Biologist 4
Griffith, Rhonda, Prin. Office Support
Sopcak, Michael, Biologist 3
Wasik, Jennifer, Biologist 2
Minarik, Thomas, Biologist 1
Gallagher, Dustin, Lab Tech 2
Joyce, Colleen, Lab Tech 2
Schackart, Richard, Lab Tech 2
Vick, Justin, Lab Tech 2
Lansiri, Panu, Lab Tech 1
Whitington, Angel, Lab Tech 1

Section 128
Radiochemistry

Khalique, Abdul, Radiation Chemist

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