Protecting Our Water Environment

Metropolitan Water Reclamation District of Greater Chicago

MONITORING AND RESEARCH DEPARTMENT

REPORT NO. 10-62

ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

2009

ANNUAL REPORT

DECEMBER 2010

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

2009

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Monitoring and Research Department
Louis Kollias, Director

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ACKNOWLEDGMENTS

This 2009 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, Bettina Gregor, Coleen Maurovich, Deborah Messina, Kathleen Quinlan, Pam Slaby, 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 65 employees, and is comprised of five Sections. These are illustrated in Figure 1 and Appendix V with a breakdown of the number of employees. The five 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

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.

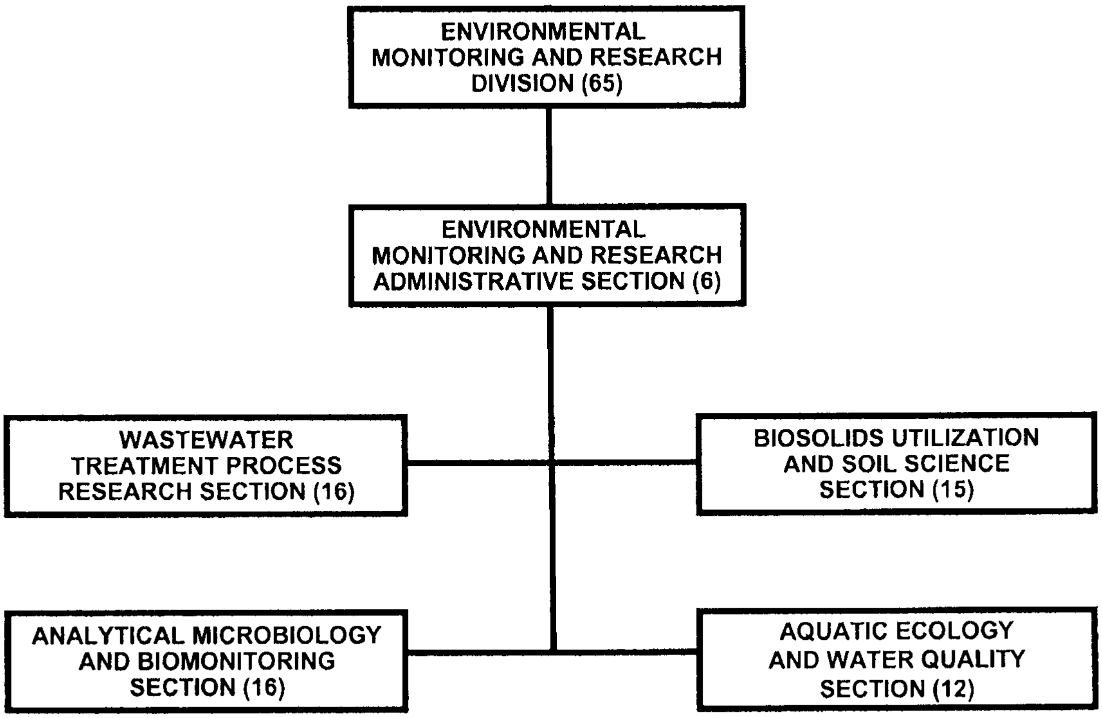
- Assessing the impacts of new or proposed regulations on District activities. Notably in 2009, the Division continued formulating the District's case in the Illinois Pollution Control Board Rulemaking R08-9 Chicago Area Waterways Use Attainability Analysis.

- 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 2009, 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



ADMINISTRATIVE SECTION

ADMINISTRATIVE SECTION

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 2009, 1,672 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. Personnel of this section also develop multistage automation programs to interconnect different software programs such as LaTeX, Visual Basic, SAS, Access, Excel, Outlook, and Power Point. 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 2009, the Biostatistician provided statistical and computing support to various projects. The following is a description of some of the activities.

1. Statistical support was provided to the Analytical Microbiology and Biomonitoring Section to study antibiotic resistant bacteria in wastewater. This work was published in Water Science and Technology in 2009.

2. Extensive statistical analyses support was provided on the reduction of sampling frequencies in the District's drying sites.

3. EDSEG provided data management support to the Biosolids Utilization and Soil Science Section to produce quarterly reports on biosolids management at the District's Biosolids Management Areas in accordance with the Illinois Environmental Protection Agency (IEPA) permit requirements.

4. Drying site reports were produced for Harlem Avenue Solids Management Area, Lawndale Avenue Solids Management Area, Ridgeland Avenue Solids Management Area, 122nd and Stony Island Solid Management Area, Calumet East, Calumet West, and Hanover Park Solids Management Area for the first, second, and third Quarter of 2009.

5. Statistical support was provided for research investigating the availability of phosphorus in biosolids.

6. Statistical support was provided for centrifuge analyses on polymer dose and the total solids of cake produced.

7. Support was provided to the Aquatic Ecology and Water Quality Section on the production of Continuous Dissolved Oxygen (DO) Monitoring Reports (Deep-Draft, and Wadeable) annually.

8. Statistical support was provided to Aquatic Ecology and Water Quality Section on the study of fish abundance in the District's waters.

9. Three Ambient Water Quality Monitoring Exceedance Reports were produced by this Group for last quarter of 2008 and first three quarters of 2009.

10. On numerous occasions, statistical support was provided to answer questions regarding the impact of proposed IEPA regulations.

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

12. Numerous supports were provided to clients who requested data and statistical analyses.

Water Quality Data. Each year, the EDSEG summarizes results of the District's Ambient Water Quality Monitoring program for the Chicago Waterway System. Surface water quality data for 2009 were evaluated regarding compliance with water quality standards set by the Illinois Pollution Control Board (IPCB). In 2009, 67 water quality parameters were analyzed and reported.

Radiochemistry Group

The Radiochemistry Group is responsible for the radiological monitoring of waters, wastewaters, sludge and biosolids, and the maintenance of radiation safety at the District. It also performs any special tasks involving the use of ionizing radiation and radioisotopes.

Radiological Monitoring of the Chicago Area Waterway System. Radiological monitoring is a part of the overall monitoring program of the water quality within the waterways system of the Metropolitan Water Reclamation District of Greater Chicago (District). 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 Eberline Analytical Corporation, Oak Ridge, Tennessee. The data is presented in the 2009 Annual Summary Report Water Quality Within the Waterways System of the Metropolitan Water Reclamation District of Greater Chicago (Monitoring and Research Department [M&R] Report No. 10-36). 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 2009. Data from the monitoring serves as a measure of present-day radioactivity levels in comparison to levels in past years. The 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 Eberline Analytical Corporation, Oak Ridge, Tennessee. The data are presented in the 2009 Annual Report entitled Radiological Monitoring of the Raw Sewage, Final Effluent, Sludges, and Biosolids of the Metropolitan Water Reclamation District of Greater Chicago (M & R Report No. 10-34).

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 Group 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 2009, 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 Eberline Analytical Corporation, Oak Ridge, Tennessee.

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 20^{th} century.

The 2009 data are presented in the M&R Report No. 10-34.

Radiation Safety. The Radiochemistry Group 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 2009, 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 2009.

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.

In accordance with 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 2009.

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 2009. 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 2009 on the APD2000 CW Detector owned by the Safety Section of the Human Resources Department. 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 2009. A record of this inventory was maintained as per license requirements.

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 (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 address 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 2009 included the following.

Technical Support to Maintenance and Operations Department

Polymer Tests at the Stickney and Hanover Park Water Reclamation Plants. Full-scale polymer tests at Hanover Park WRP Gravity Belt Thickening Complex were conducted during April/May 2009 for the selection and purchase of polymer used in the gravity belt thickening process of activated sludge.

Any polymer that does not produce a minimum of six percent of cake solids is disqualified from bidding on the polymer contract. Of the polymers that pass the test performance criteria as described in the bid documents, the one with the lowest cost for conditioning per unit mass of sludge is the polymer of choice for purchase. The full-scale tests are conducted once every three years, a few months before the polymer purchase contracts are up for renewal.

During 2009, a total of eight polymers from four manufacturers were tested and found to be eligible for bidding as shown in Table II-1. Polydyne C-6287 was selected as the winner out of eight products eligible for bidding.

Aeration Tank Performance Evaluation at the James C. Kirie Water Reclamation Plant. The James C. Kirie (Kirie) WRP is a conventional wastewater treatment plant which utilizes the activated sludge process for nitrification and the removal of organic matter. The Kirie WRP has two aeration batteries, each containing six aeration tanks. Battery A is currently used for biological treatment while Battery B is used solely as polishing tanks following treatment in Battery A. Each aeration tank in Battery A is comprised of three 250-foot long passes and is operated in conventional plug flow mode, with the degritted sewage and return activated sludge entering the beginning of the first pass.

Sampling of the Battery A aeration tanks at the Kirie WRP was conducted in the spring and summer of 2009 with two objectives: 1) to evaluate aeration tank performance and 2) based on the performance, determine whether or not a potential for energy savings exists if operations were converted from conventional plug flow to step feed operations. To evaluate the performance of the aeration tanks the following parameters were measured: dissolved oxygen (DO) concentration, oxygen uptake rate (OUR), specific OUR (SOUR), mixed liquor suspended solids (MLSS), mixed liquor volatile suspended solids (MLVSS), ammonia nitrogen (NH_3-N), nitrate nitrogen (NO_3-N), nitrite nitrogen (NO_2-N), and phosphorus (P). Profiles of these parameters were created by measuring the parameters along the length of the aeration tank.

DO concentration profiles were measured in Aeration Tanks 2 and 6, as shown in Figure II-1. DO concentrations were relatively constant through the first two passes of the tanks. Due to the similarity of DO profiles in the two tanks, only Tank 2 was further sampled to obtain profiles of the remaining parameters. The SOUR is the OUR normalized to the MLVSS concentration. The SOUR profile for Tank 2 is shown in Figure II-2. The SOUR profiles for the four different sampling days generally follow the same trend. A higher SOUR is an indication of stronger (more concentrated) raw wastewater.

The MLSS and MLVSS concentration profiles for Tank 2 were relatively consistent and stable on the four sample days. MLSS generally ranged from 3,000 to 4,000 and MLVSS ranged from 2,000 to 3,000 except on May 21, 2009, when solids concentrations were higher due to abnormal wasting conditions on the previous day. The NH_3-N and NO_3-N concentration profiles for Tank 2 are shown in Figures II-3 and II-4. The results indicate that nitrification is complete by the middle or end of Pass 3 and little to no nitrification occurs in Pass 1.

Data from the profile sampling at the Kirie WRP show that the supply of air adequately matches to the demand in the aeration tanks, and as a result we observed relatively low DO concentrations in Pass 1 and Pass 2. In particular, the NH_3-N and NO_3-N data show slow nitrification and even some denitrification occurring in Pass 1, indicating that Pass 1 operates as an anoxic zone. Because of the minimal air use during current operations, it is unclear whether converting to step feed operations will result in energy savings as a result of decreased air use. A summary of the 2009 sampling results was provided to M&O. Additional sampling will be conducted at the Kirie WRP in 2010 involving a side-by-side comparison of tanks following current and step feed operations. A Monitoring and Research Department (M&R) report detailing the results of this study will be prepared in 2010.

Odor Management and Corrosion Control in Select Interceptors in the Kirie Water Reclamation Plant Service Area. A full-scale study was initiated to obtain the pertinent parameters that could be considered as precursors for hydrogen sulfide (H_2S) along Upper Des Plaines (UDP) interceptors 14A, 14B and 20B leading to Drop Shaft 5, and to analyze the data to determine the variation of these parameters along the interceptors. The goal was accomplished by sampling from seven manholes along these interceptors for eight water quality and air quality parameters. These data were analyzed using graphical and statistical methods to evaluate the significance of these parameters on the variation of the oxidation-reduction potential (ORP) and total sulfide along the interceptors, as well as locating the hot spots for H_2S emissions along these interceptors.

The results of analysis showed that the average ORP levels along the interceptors with and without Bioxide injection for the morning and afternoon events were below -50 mV, and this was an indication of reducing conditions and a potential for emission of H_2S from the interceptors. Based on the results of this study, two stations, UDP 14D and 14E, which are located upstream and downstream, respectively, of the present Bioxide injection station, were determined to be hot spots, where the concentration of H_2S ranged from 0 to 34 ppmv and from 2 to 27 ppmv, respectively. All measured parameters pertinent to odor emissions and potential for corrosion have indicated the existence of suitable conditions for corrosion throughout UDP 14A and B and UDP 20B leading to DS5, even with the current Bioxide dosing system.

Excess Flow Disinfection Improvement Study for John E. Egan Water Reclamation Plant. The goal of the disinfection improvement study was to determine the causes of unpredictable fecal coliform (FC) concentration in the excess flow discharge at the John E. Egan (Egan) WRP during a storm and to find a method to consistently meet the National Pollutant Discharge Elimination System (NPDES) permit limit of 400 colony forming units (CFU)/100 mL. The hypothesis was that chloramines, which are produced when ammonia in the wastewater reacts with sodium hypochlorite (NaOCl), would result in variable disinfection efficiency for the same total residual chlorine (TRC). The bench study was intended to develop a breakpoint curve specific to the Egan WRP primary effluent. The breakpoint curve would then be used to determine a more consistent chlorine dosing method. The findings were verified with tests on Stickney WRP primary and secondary effluents. A future M&R report will include the details of this study.

The original hypothesis was that the chlorine doses required to consistently meet the permit limit of 400 CFU/100 mL would be above breakpoint chlorination. However, effective disinfection was consistently achieved with chlorine doses well below the breakpoint, based on the stoichiometric ratio of chlorine to NH_3-N of 7.6:1. Chloramines could be responsible for disinfection. However, the same TRC resulted in various FC concentration reductions. The variable disinfection results were attributed to NH_3-N concentrations in the primary effluents and, possibly, other factors that are unclear at this time. Additional investigation is planned for this study.

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 (ML) samples from the Stickney, Calumet, North Side, Kirie, Egan, and Lemont WRPs, and weekly or monthly personal visits to the Calumet, North Side, Kirie, and Lemont WRPs. <u>Table II-</u>

2 shows that a total of 742 microscopic examinations for filament analysis of ML were performed for six WRPs in 2009. A breakdown of these analyses for each WRP is also presented in Table II-2.

As a way of understanding what may have caused poor settling of ML, filament identification of filaments in ML was performed upon the request from M&O. As shown in Table II-3, a total of 35 filament identification analyses were conducted to better assist M&O plant operations in 2009.

Technical Support to Engineering Department

Ultraviolet Disinfection Study at the Hanover Park Water Reclamation Plant. A Disinfection Blue Ribbon Committee recommended that high-intensity medium pressure ultraviolet (UV) and oxygen-generated ozone be considered as the best available disinfection technologies for use at the three large District plants. Before these technologies are used, however, the committee strongly recommended that pilot-scale studies be performed due to uncertainty of the effects of variable water quality parameters. Considering this recommendation, the District is conducting a side-by-side evaluation of three different UV disinfection technologies at the Hanover Park WRP.

The Engineering Department selected three UV systems manufactured by three leading manufacturers, Trojan Technologies, Inc., ITT Wedeco, Inc., and Severn Trent Water Purification, Inc., under Engineering Department Contract 07-527-AP. The Engineering Department prepared the specifications of these UV systems with the help of three outside consulting firms, Harza Engineering, Malcolm Pirnie, and Black and Veatch. The Wedeco and Severn Trent systems were installed in October 2008 at the Hanover Park WRP. These two systems became operational in November 2008 and Trojan system in March 2009.

Each system is pre-assembled in a fixed dimension channel. Each of the three systems is designed to treat 0.5 MGD of secondary unfiltered effluent, approximately 4.2 percent of the average design plant flow of 12 MGD. Each system may be stressed and tested at a 1 MGD flow rate. The remaining secondary effluent is chlorinated as usual in six additional filters using the filtration beds as contact units.

The baseline tests have been conducted with 0.5 MGD flow since November 2008, and stress tests were conducted at 1 MGD flow for a short period. We have sampled the influent and effluent from all three units as well as filtered and unfiltered secondary effluent for numerous physical, chemical, and microbiological analyses as outlined in the sampling plan. Additionally, the necessary plant data, economics of system operation and maintenance were documented but not limited to the system power requirements, bulb replacement, and life-cycle of bulbs and system etc.

Sampling, analyses, and collection of plant data began in November 2008 and continued until October 15, 2009. Data compiled and analyzed for the period beginning November 18, 2008, through June 11, 2009, shows that the Wedeco and Trojan units are comparable in reduction of FC and *Escherichia coli* (EC). Data collected reveals that the Wedeco unit is the most consistent and reliable with respect to FC and EC kill. All three units, however, demonstrate the ability to meet the existing NPDES FC limit of 200 CFU/100 mL monthly geometric mean from May through October.

The sampling is to be resumed during 2010 under the direction of the Engineering Department. At the conclusion of the additional sampling and data collection, an appropriate system will be recommended and necessary design criteria will be established for full-scale system implementation at District plants.

Stickney Preliminary and North Side Combined Sludge Thickening Evaluation. Eight 80-foot diameter concentration tanks are planned for the Stickney WRP to thicken Stickney Preliminary Sludge (SPS) and North Side Sludge (NSS) as documented in the Stickney Master Plan. NSS is composed of approximately 50 percent primary sludge and 50 percent waste activated sludge. The two sludge streams are to be added together into a combined sludge (CS) at a ratio of 1:7 for NSS and SPS.

A settling and thickening evaluation was performed on the CS to determine whether five to six percent total solids (TS) could be achieved in settling tanks or if flotation problems would inhibit settling. This study included: 1) a screening level investigation of SPS, NSS, and CS settling in 1-liter graduated cylinders and subsequent sludge concentration (Phase I); 2) a preliminary evaluation of the effect of various vessels, including a 3.2-liter column, 2-liter beaker, and 1-liter Imhoff cone, on SPS and CS settling and subsequent sludge concentration (Phase II); 3) an investigation of CS settling in 1-liter graduated cylinders and subsequent sludge concentration at four separate settling times: 0.5, 1.0, 3.0, and 5.6 hours (Phase III); 4) an investigation of the water column height (WCH) effect on CS settling and sludge concentration in four 2-liter columns at four separate volumes and initial WCHs of 500 mL and 9.5 cm, 1,000 mL and 20.9 cm, 1,500 mL and 30.4 cm, and 2,000 mL and 44.1 cm, respectively (Phase IV); 5) an investigation of the diameter-to-height (D:H) ratio effects on CS settling and sludge concentration in different diameter vessels at a constant WCH (Phase V); 6) an investigation of the effects of dilute mannich polymer addition on CS settling and sludge concentration in 1-liter columns (Phase VI).

Based on these settling tests, flotation problems are of minimal concern. However, the five to six percent TS (%TS) benchmark for the designed concentration tanks was achieved in the passive settling tests only 5.3 percent of the time from all six phases of bench tests, i.e. seven of the 133 tests performed with CS. Increased volumes and WCHs did enhance sludge concentration up to certain limits, but diminishing returns were observed beyond these limits. Therefore, it was difficult to predict how significant the effect of the large volumes and WCHs of the design tanks would have on CS settling. As the D:H ratio is a function of both WCH and test volume for the size of vessels used, it is difficult to use it as a standalone variable in predicting the effect on settling. Additionally, dilute mannich polymer addition was not observed to have a significant impact on the concentration of the settled sludge.

Details and additional information for this project are provided in M&R Report 10-01, "Evaluation of the Settling Characteristics of North Side Water Reclamation Plant Combined Solids and Stickney Water Reclamation Plant Preliminary Sludge."

Support to the Engineering Department for the Hanover Park Water Reclamation Plant Master Plan Study. The WTPR Section provided support to the Engineering Department for the Hanover Park WRP Master Plan Study. The study has been conducted to evaluate alternatives for improving and updating the infrastructure and process facilities to meet future needs. The support included participation in workshops and assistance with a stress-testing study of the primary and secondary clarifiers.

The primary clarifier stress tests evaluated the TSS removal for various surface overflow rates. The secondary clarifier stress tests were used to correlate sludge volume index, return flow rate, and solids retention time to the blanket settling rate. The secondary clarifier performance was used to evaluate settling problems due to denitrification, and physical and biological flocculation.

Calumet Water Reclamation Plant Digester Mixing Study. Mixing is one of the most important physical factors that affect the anaerobic digestion process. Adequate mixing has been related to several operational and performance advantages. Existing mixing of digester contents through draw and feed, gas production, and sludge circulation for heating may not be enough to harness all benefits, and external mixing devices augment natural sludge mixing.

Under Engineering Department Contract 02-818-2P, six new mechanical digester sludge mixers had been installed on an experimental basis on the floating cover of Digester No. 5 at Calumet WRP for the evaluation of the performance of the mixing system. In response, M&R prepared an experimental plan during December 2006 to evaluate the effects of mechanical mixing on digester performance. However, the study could not commence until May 12, 2009, due to numerous reasons, the most important being related to the proper installation and calibration of new digester gas meters. According to the experimental plan, digester feed, draw, and gas samples from both the experimental digester (Digester No. 5) and the control digester (Digester No. 6) were collected in addition to the routine plant samples. All samples were analyzed in the M&R laboratories except for the digester gas samples, which were analyzed by the Gas Technology Institute (GTI). Data collected from May 12, 2009, through November 17, 2009, and the historic data (January 1, 2004, through May 11, 2009) selected for comparison against the data collected during this study along with data analysis will be documented in an M&R report.

It should be noted that all 12 digesters were cleaned at some time in the 2004–2006 period. Digesters No. 5 and 6 were out of service due to cleaning from July 23, 2005, through August 31, 2006, and February 26, 2005, through May 17, 2005, respectively. Also, all twelve digesters have been operated as primary digesters since February 2009. Prior to February 2009, Digesters No. 1 through No. 8 were operated as primary digesters while Digesters No. 9 through No. 12 were operated as secondary digesters.

The final report will be completed in 2010.

GPS-X Modeling of the North Side Water Reclamation Plant. A steady-state model of the North Side WRP was developed by the consultants, Architecture, Engineering, Consulting, Operations and Management (AECOM), using the GPS-X software as part of a Master Plan study completed in 2007. This project will further develop a dynamic model based on the steady-state model and use it as a tool to evaluate the existing plant capacity of handling wet weather flow. Special sampling commenced in 2009 and will continue into 2010. Special sampling will include discrete sampling, additional daily composite samples, and flow measurement. Sample results will be used for further model development including calibration and validation as needed. When complete, the dynamic model will allow for the evaluation of plant capacity and plant operations and will assist in evaluating plant expansion options. An M&R report detailing the dynamic modeling of the North Side WRP will be prepared for this project.

Evaluating Two Different Aeration Systems at the John E. Egan Water Reclamation Plant. This project was initiated to compare the operational efficiency of two different aeration systems at the Egan WRP: full floor, fine bubble, ceramic disc diffusers in a tapered configuration in the North Aeration Battery and the original, spiral roll aeration system using square ceramic diffusers placed on one side of the aeration tank in the South Aeration Battery. Major field testing including process oxygen transfer efficiency (OTE) measurement using the off-gas technique and profile sampling along the aeration tanks to evaluate OURs, nitrification, and DO distribution was conducted in 2007. Supplemental field tests on process OTE measurements were conducted in 2008.

In 2009, additional supplemental field tests were conducted to compare process OTE measurements at a particular location versus various configurations of the off-gas collection hoods. These configurations included one three-foot by six-foot hood placed with the three-foot side along the aeration tank wall, one three-foot by ten-foot hood with the three-foot side along the wall, and a combination of the two hoods together with the three-foot side along the wall and the hoods spanning the width of the tank. These three configurations vary the amount of surface area from which the off-gas is collected. Since off-gas flow rate can vary across the width of the aeration tank and the off-gas flow rate is used in calculating the process OTE, these supplemental tests will provide further information regarding the experimental method employed during the intensive sampling done in 2007.

The results from the sampling conducted in 2009 were limited and are not presented here. The supplemental field tests will be completed in 2010 followed by an M&R report presenting the results of the entire study.

Stickney Water Reclamation Plant Permeable Pavement Project. In 2008, the District initiated a plan to evaluate porous surface technology for stormwater flow and pollutant load reduction at the Stickney WRP. The Conservation Design Forum designed three permeable test surfaces and a control area in the parking lot on the northwest side of the Stickney WRP. The three test surfaces consisted of: 1) a porous asphalt (PA); 2) a porous concrete (PC); and 3) a porous paver (PP) system. The control area is a traditional black top asphalt, and is considered impervious.

All three permeable plots overlay a stone bed followed by the natural soil of the area which allows drainage towards the local groundwater. A system of four-inch perforated pipe rests upon the bottom of the gravel fill in each lot. These pipes can accept infiltrated flow migrating through the fill as well as subsurface water if water levels rise above the top of the perforated pipe. The perforated pipes coalesce into a closed catch basin. All four plots have an open-grated catch basin to accept runoff (RO) in the center of the plot. In the permeable plots, the infiltration catch basin is connected to the open-grated catch basin via a 12-inch closed pipe. Thus, water collected by the perforated pipes will flow into the open-grated catch basin. A second 12-inch closed pipe leads from the open-grated catch basin conveys water off site. The typical permeable lot layout is shown in Figure II-5.

Huff & Huff Incorporated developed a monitoring plan for the four test plots in order to track rainfall, flow measurements, water level measurements, and water quality. This plan included two rain gauges (RGs) that were installed to continuously monitor rainfall. Shallow 12-inch diameter wells are located at each permeable lot. The wells are approximately two feet deep and contain a Hach area velocity (AV) sensor to continuously measure water levels within each plot.

Plots of the cumulative rainfall for the eastern and western RGs are shown in Figures II-6 a and b. The eastern and western lots received similar total rainfall over the course of the 2009 monitoring season (23.66 inches and 23.88 inches, respectively). Periodic site visits during periods of rainfall indicated no visible standing water or RO on any of the permeable lots.

The near-surface water level response paralleled rainfall events as indicated by the AV sensor data for each lot (Figures II-7 a–c). During times of rainfall, increases in water levels were observed. As the water either drained into the natural soil or into the infiltration perforated pipes, the water levels decreased.

The infiltrated and total flow response for the three permeable plots showed a similar pattern. Flow increase was observed during rain events. Upon conclusion of the rainfall event, flows decreased to a base line level. Unfortunately, due to many problems with the equipment, the majority of the flow meter data collected over the study period was not considered reliable and cannot be used to make any evaluations of permeable lot performance. These issues are currently being addressed.

In April 2009, only the flow data from the first two rainfall events were considered reliable. Table II-4 summarizes the expected volume of water received by each lot, the RO calculated, and the percent RO based on the volume received. The April 13, 2009, event indicates that the lowest RO was observed in the PP lot followed by the PA lot. The April 19, 2009, event indicates that the lowest RO was observed in the PP lot followed by the PC lot.

Because the flow meter function directly impacts the autosampler operation, only nine water quality sampling events occurred during the season. Of the nine events, samples were collected in all four lots on only four occasions (April 20, April 28, May 8, and August 28, 2009). The average reduction in COD, TSS, and VSS concentrations for these events are shown in Table II-5. The PA lot showed the highest reductions in TSS and VSS concentrations, and the PC lot showed the highest reductions in COD concentrations. However, higher pH values are observed for the three permeable lots. This may be due to the limestone CA-16 fill, which is composed of calcium carbonate. Dissolution of calcium carbonate elevates pH levels.

For the special sample analysis, August 28, 2009, was the only common sampling event for the four lots. Significant differences were not observed for any of the analytes. Slightly higher ammonia concentrations were observed in the control lot relative to the permeable lots, and slightly higher nitrate concentrations were observed in the permeable lots relative to the control lot. Bacterial driven nitrification may have occurred in the permeable lot subsurface, converting ammonia to nitrate. At or near below detectable concentrations were observed for all metals and PAHs.

The results of ringed infiltrometer tests indicated infiltration rates of 1.50, 1.23, and 1.0 inches per second for the PC, PA, and PP lots, respectively. Based on these results, unless the subsurface water level at each site was just below grade thus inhibiting infiltration, rainfall intensities would have to exceed infiltration capacities of over one inch per second in order for RO to occur. From the rainfall data, the maximum intensity observed during 2009 was less than 10^{-3} in/sec. As such, it is questionable that any RO would have occurred during the 2009 study period for the permeable lots. Rainfall may still enter directly into the open-grated catch basin or via the small concrete pad around the catch basin, but this is assumed to be negligible. These results further indicate that the flow data recorded during the study period was unreliable even for the first two April events analyzed herein.

The Stickney WRP Permeable Pavement monitoring efforts have been carried over into 2010 to evaluate the lots' performances after a year of use, snowfall, snow removal, and salting activities. In recent ringed infiltrometer tests, infiltration capacities remained the same except for the PC lot, which decreased to 1.3 inches per second. However, persistent equipment and infrastructure problems as well as power outages for more than two months have limited the collection of reliable data.

Regulatory Monitoring, Reviews, and Technical Development

Odor Monitoring Programs. As part of the District's continuing odor surveillance program, the EM&RD conducts odor monitoring at the Harlem Avenue Solids Management Area (SMA), Vulcan, the Lawndale Avenue SMA, 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 (at the Egan WRP), or daily (at the Kirie WRP), depending on the individual 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.

The details of the odor surveillance program and odors detected at or near District operations will be summarized in an M&R report entitled, "Odor Monitoring Program at Metropolitan Water Reclamation District Facilities during 2009."

Estimation of Emission of Hazardous Air Pollutants. Under Section 112 of Part A, Title I, of the Clean Air Act, a POTW is considered a major source of hazardous air pollutants (HAPs) if it emits or has the potential to emit ten 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 2009, influent samples were collected in January and July. The average influent concentrations found are presented in Table II-6 for the three major District WRPs. The estimated emissions of individual HAPs for the three major District WRPs are summarized in Table II-7.

According to the BASTE model, all of the individual HAP emissions were less than the ten ton/year criterion. Toluene and acetaldehyde were the predominant compounds emitted from the wastewater treatment processes at the Stickney WRP. Carbon disulfide was the predominant compound 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 VS in the biosolids are reduced by less than 17 percent in an additional 40 day bench-scale anaerobic digestion test at a temperature between 30° and 37°C.

In 2009 a total of 21 bench-scale additional digestion tests were performed in the WTPR Laboratory for the digester draw from the Calumet WRP. Of the 21 tests conducted in 2009, the additional volatile reductions in 18 tests were less than 17 percent as shown in Table II-8. The additional VS reduction of greater than 17 percent occurred in one of tests each in October and November 2009. However, VS reduction of 38 percent through plant-scale anaerobic digesters at the Calumet WRP was achieved in October and November 2009, as shown in Table II-9. Table II-9 shows that 38 percent VS reduction through plant-scale anaerobic digesters was not achieved in January, March, and June of 2009. However, as shown in Table II-8, additional VS reduction of less than 17 percent was achieved in the additional 40 day bench-scale tests in January, March, and June 2009. Therefore, the combined monitoring results indicated that the requirements for vector attraction reduction were met at the Calumet WRP throughout 2009.

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 for three months after a chemical P removal project, which ended in December 2008, during January through March 2009. A total of six tests were performed in 2009. Table II-10 presents the test results from these six 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 percent had been achieved in January, February, and March of 2009.

Tunnel and Reservoir Plan Groundwater Monitoring Reports and Thornton Transitional Flood Control Reservoir Fill Events for 2009. Groundwater monitoring for the Tunnel and Reservoir Plan (TARP) systems was performed in 2009 as required by the Illinois Environmental Protection Agency (IEPA). The monitoring results for the year 2009 were summarized in six M&R reports, each of which represents an individual TARP system, in early 2010. These reports are M&R Report No. 10-27, 10-28, 10-29 and 10-30 for the Calumet, Des Plaines, UDP, and Mainstream Tunnel Systems, respectively, Report No. 10-31 for the O'Hare Chicagoland Underflow Plan Reservoir, and Report 10-32 for the Thornton Transitional Flood Control Reservoir (Reservoir). All six reports are to be submitted to the IEPA as well as the USEPA in 2010.

One of the reporting requirements for the Reservoir as specified by the IEPA is to prepare a narrative report of fill events that have occurred during the year. There were seven fill events at the Reservoir during the year 2009: February 27, 2009; March 8-12, 2009; April 28, 2009; May 15-16, 2009; October 23-24, 2009; October 30 – November 1, 2009; and December 25–26, 2009. In six of the seven fill events, samples were collected from the Reservoir and the four water quality monitoring wells surrounding the Reservoir. Sampling for the December 25–26, 2009 diversion event could not be performed because access to the water quality monitoring wells and the Reservoir was blocked by heavy snow. The monitoring results for the water quality monitoring wells were compared event by event with the statistical background determinations from these wells. The description and analyses of the monitoring results for each fill event are included in M&R Report No. 10-32.

Applied Research for Process Optimization, New Technologies

Operating the Sidestream Elevated Pool Aeration Stations to Meet the Proposed Water Quality Standards. This project evaluated whether the Sidestream Elevated Pool Aeration (SEPA) stations located along the Calumet-Sag Channel could be operated to meet the water quality standards, specifically DO concentrations, proposed by the IEPA to the Illinois Pollution Control Board on October 26, 2007. During the spring, summer, and fall of 2008, the SEPA stations were operated according to the study operating schedule in an attempt to meet the proposed DO standards. Data analysis and a report summarizing the results of the study were completed in 2009. The study demonstrated that in some cases SEPA station operation alone will not provide enough supplemental DO so that the proposed standards are met 100 percent of the time. Temperature was found to greatly affect the amount of DO that SEPA stations can transfer to the water. In addition, an environmental cost in the form of carbon dioxide (CO_2) emissions was estimated for the use of additional SEPA station pumps to meet the proposed standards. Details of this study can be found in M&R Report No. 09-64.

Chemical Phosphorus Removal at the John E. Egan Water Reclamation Plant. A full-scale study was undertaken at the Egan WRP in February 2007 through December 2008 to evaluate the performance of P removal by $FeCl_3$ addition to ML before secondary clarifiers and influent to primary settling tanks and the impact on wastewater and solids unit processes due to the addition of $FeCl_3$ at the plant. During the study, both wastewater and solids streams were monitored intensively. The data collected through the study was analyzed in 2009.

The $FeCl_3$ addition for P removal appeared to impose little negative impact on liquid treatment unit processes. Adding $FeCl_3$ to the secondary treatment system for P removal resulted in the accumulation of inorganic solids in the system, which led to the increase of the MLSS for maintaining sufficient quantity of VS for normal operation. The amount of $FeCl_3$ added for removing P to the target level of 0.5 mg/L of total P (TP) did not improve the settling of MLSS in the secondary clarifiers when the chemical was added into the secondary treatment system, but increased BOD_5 and SS removal efficiencies in the primary settling tanks when the chemical was added to the primary influent. During the test, low soluble P concentration in the secondary treatment system at the level of 0.15 mg/L did not cause inhibition to bioactivity, particularly nitrification.

There was no adverse impact of $FeCl_3$ addition for P removal on the effluent quality with respect to meeting the current NPDES permit for the final effluent discharged through the 001 outfall of the Egan WRP during either phase. However, the lowest pH measured at the 001 discharge point was 6.4 during $FeCl_3$ application to the secondary treatment system. The pH value would be out of the NPDES permit range, if the permit range were changed to 6.5 to 9. The impurity of $FeCl_3$ caused the daily manganese concentration to exceed the ambient water quality standard for manganese, which is 1.0 mg/L for general use waters in Illinois, twice in nearly two years of the P removal test.

Thickening of waste activated sludge by GBTs and anaerobic digestion and centrifugal dewatering operations were monitored during the study and compared against background data. The

GBT operations were closely monitored due to a concern regarding possible operation interruption. The analysis of data collected showed no operational problems with the above solids processing operations. Positive impact on the downstream solids processes was observed. The residual $FeCl_3$ sequestered H_2S levels in digesters by ten fold. The conditioning demand was reduced by 20 and 28 percent for polymer and $FeCl_3$, respectively, for the similar sludge throughput in the dewatering operations. Cake became drier by seven percent.

An M&R report for this project was drafted in 2009 and the report will be finalized and published in 2010. The details of the study can found in this report.

Methane and Nitrous Oxide Emissions from Wastewater Treatment. In 2009 the EM&RD in collaboration with the University of Illinois at Chicago performed comprehensive monitoring of greenhouse gas (GHG) emissions from the Stickney WRP and exploratory monitoring from the North Side and Egan WRPs. A total of 494, 159, and 190 off-gas samples were collected and analyzed from liquid and solids treatment processes at the Stickney, North Side, and Egan WRP, respectively. Additionally, 74 water quality samples were collected and analyzed from the Stickney WRP aerated grit chambers and aeration batteries. Below is a brief summary of the 2009 monitoring results. The details of the study will be presented in an M&R report.

At the Stickney WRP, the highest nitrous oxide (N_2O) emissions were observed in the aeration batteries and grit chambers. The highest CH_4 emissions were observed in the Imhoff tanks, aerated grit chambers, aeration batteries, anaerobic digesters, and process exhaust. The highest CO_2 emissions were observed in the aerated grit chamber and aeration basins. No strong relationships were observed between any of the three GHGs and water quality parameters in the Stickney WRP aeration basins and aerated grit chambers.

At the North Side WRP, the highest CH_4 and N_2O emissions were observed in the aeration batteries. At the Egan WRP, the highest N_2O emissions were also observed in the aeration batteries, and the highest CH_4 emissions were observed in the aeration batteries and primary settling tanks. For all three plants, some of the highest GHG emissions were observed at the head of aerated systems as the dissolved gases were stripped from the liquid stream.

Effect of Ferric Chloride Addition and Filtration on Ultraviolet Disinfection of Secondary Effluent at John E. Egan Water Reclamation Plant. In light of the potential need for disinfection of effluent from the District's major WRPs as a response to the proposed effluent FC standards for the Chicago Area Waterway System (CAWS), M&R conducted a laboratory-scale collimated beam study in 2007 to determine the UV radiation dose-response relationship for WRP secondary and final effluents. Results indicated that, in general, all plants responded similarly to the applied UV doses with the exception of Egan WRP secondary effluent; much higher UV doses were needed in order to achieve target FC levels at the Egan WRP than at the other plants. A P removal study using $FeCl_3$ at Egan coincided with this preliminary 2007 UV study. $FeCl_3$ or a residual product may have inhibited UV disinfection of the Egan WRP secondary effluent. As the District is currently considering using $FeCl_3$ for nutrient removal and UV radiation for disinfection at the WRPs, the Egan WRP results may be of concern.

A follow-up laboratory collimated beam evaluation in 2008 and 2009 was performed to confirm the results of the 2007 study and examine the effects of $FeCl_3$ on UV disinfection with respect to Egan WRP secondary effluent prior to filtration and final effluent after filtration. These tests were performed in two stages: 1) during P removal with $FeCl_3$ addition at the Egan WRP, and 2) three months after discontinuation of $FeCl_3$ addition at the Egan WRP.

Single 3.78-liter grab samples of secondary and final (filtered) effluent were collected nine times from April 1, 2008, through April 17, 2008; $FeCl_3$ was added to the Egan WRP aeration batteries during this time (Stage I). Approximately 9.5-liter grab samples of secondary and final effluent were collected five times from March 31, 2009, through April 14, 2009; no $FeCl_3$ was added to the aeration batteries during this time (Stage II). The samples were analyzed for TS, TSS, total Fe (TFe), and TP concentrations, and UV transmittance (UVT); Stage II samples were also analyzed for soluble Fe (SolFe). Fifty milliliters of the secondary and final effluent samples were placed in separate 100-mL Petri dishes and irradiated at 0, 10, 20, 30, and 40 millijoules (mJ)/cm^2 in order to develop dose-response relationships for reduction in FC density. The UV dose-response of FC in the effluent was determined using a Trojan Technologies collimated beam apparatus and the species-specific enumeration method.

Table II-11 summarizes the water quality for both Egan effluents from the Stage I sampling events. It was observed that the final effluent had a slightly higher average UVT than secondary effluent (75.8 percent and 74.2 percent, respectively). Generally, lower TSS, TFe, and TP concentrations were observed in the final effluent; TS concentrations were essentially the same for both effluent types. Table II-12 summarizes the water quality for both Egan effluents from the Stage II sampling events. Much like the Stage I results, the final effluent had a slightly higher UVT relative to the secondary effluent (75.1 percent and 74.5 percent, respectively). The TS concentrations for both effluent types were relatively the same, while the TSS, TFe, SolFe, TP, and FC concentrations of the final effluent were lower than the secondary effluent.

Due to the removal efficiencies of the filter beds alone, the geometric mean FC concentration of the Stage I final effluent samples was 32.1 percent of the geometric mean FC concentration of the secondary effluent samples; therefore, the filter beds themselves had a FC removal efficiency of 67.9 percent. Lower removal rates were observed in Stage II as the filter beds showed a FC removal efficiency of 40.2 percent.

Generally, higher UVTs were observed at lower TSS and TFe concentrations. Therefore, at a constant UV radiation over a set period of time, a higher effective UV dose would be received by an effluent with lower TSS and TFe relative to an effluent with higher TSS and TFe concentrations.

Table II-13 summarizes the average water quality data for both Stage I and Stage II. Because $FeCl_3$ addition occurred during Stage I, higher TS and TFe were observed relative to Stage II for both effluent types. Although Stage II had no $FeCl_3$ addition and less TS than Stage I, there is no observable difference in the UVT data between both stages and effluent types. Because phosphates were being removed during Stage I, lower TP concentrations were observed during Stage I relative to Stage II for both effluent types.

Figure II-8 shows the UV dose versus the average log reductions for the Egan WRP secondary and final effluents. Both the 2007 and Stage I secondary effluents show similar dose-response curves; this is expected as $FeCl_3$ addition was occurring during both periods. It is observed that lower doses achieved higher log reductions for the final effluent relative to secondary effluent and effluent without $FeCl_3$ addition relative to effluent with $FeCl_3$ addition. Generally, it is observed that filtration had a bigger effect on FC log reductions than does the impact of effluents without $FeCl_3$ addition.

Table II-14 summarizes the average and maximum dose needed in order to achieve a reduction to 400 CFU/100 mL and the maximum dose needed to achieve two- and three-log reductions of FC for every effluent sample. The Stage I final effluent achieved the 400 CFU/100 mL benchmark at a lower dose than the secondary effluent (8.1 mJ/cm^2 and 13.5 mJ/cm^2, respectively). Stage II secondary and final effluents achieved the 400 CFU/100 mL benchmark at relatively the same dose (9.8 and 9.4 mJ/cm^2, respectively); however, two- and three-log reductions were observed at much lower doses in the Stage II final effluents relative to the unfiltered, secondary effluent. Filtered effluents needed a lower dose to achieve the reduction targets relative to the unfiltered effluents.

The Stage I secondary effluent achieved the 400 CFU/100 mL at a higher dose than the Stage II secondary effluent (13.5 mJ/cm^2 and 9.8 mJ/cm^2, respectively). Additionally, the Stage II secondary effluent was able to meet the two-log reduction mark at 30 mJ/cm^2, whereas the Stage I secondary effluent was not able to meet the two-log reduction within the dose range (>40 mJ/cm^2). Conversely, the Stage I final effluent achieved the 400 CFU/100 mL benchmark at a lower dose than the Stage II final effluent (8.1 mJ/cm^2 and 9.4 mJ/cm^2, respectively). However, the average initial FC concentrations were significantly lower in the Stage I final effluents compared to the Stage II final effluents (1,029 CFU/100 mL and 3,316 CFU/100 mL, respectively) making it easier to meet the 400 CFU/100 mL benchmark. When considering the two- and three-log reductions, Stage II final effluents achieved this targets at lower UV doses relative to Stage I final effluents.

Based on these results, filtration may be required if $FeCl_3$ addition for nutrient removal is used at plants planned for UV disinfection. Further investigation will be conducted to determine what the individual and combined effects of iron (Fe) and SS, respectively, have on UV disinfection, and a laboratory study is currently being planned.

Chicago Department of Transportation Blue Island Sustainable Streetscape Project. In order to minimize the impacts of urban nonpoint source pollution and associated costs of control associated with wet-weather flows, stormwater RO volumes and pollutant loads must be reduced through stormwater management. In summer 2010 the Chicago Department of Transportation (CDOT) 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 (Figure II-9). The SSP will include a number of control strategies referred to as best management practices (BMPs) to mitigate RO volumes and associated diffuse pollution due to wet-weather flow. 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.

In support of the SSP, M&R has developed a long-term monitoring plan to assess the performance, effectiveness, and efficiency of the combined SSP BMPs and, if possible, individual BMPs relative to stormwater flow and pollutant load reduction. Prior to BMP implementation, background monitoring has been initiated to examine: 1) rainfall; 2) stormwater flow and water quality; 2) combined sewer wastewater flow and water quality; and 3) groundwater levels and water quality. 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; 6) overflow and water quality from select BMPs; and 7) sediment quality in catch basins.

Currently, the District is partnered with the United States Geological Survey (USGS) to perform the SSP background monitoring. In late August 2008 the District installed three tipping bucket RGs as shown in Figure II-9. The cumulative rainfall over the study time period for all three RGs through November 2009 is shown in Figure II-10. Cumulative rainfall totaled up to 60 inches over the study period; RG1 was in need of recalibration. The USGS installed four monitoring wells in the Streetscape corridor (Figure II-9). Continuous monitoring of water table depths was conducted via pressure transducers (PTs) in each well over the study period. Figures II-11 a through c show the water level depths for all four monitoring wells over the study period with concurrent precipitation. The four wells showed fluctuating water levels between 4.8 to 8.4 feet below grade.

The USGS planned to install three AV flow meters (FMs) in the combined sewer system along the SSP corridor in 2009 (Figure II-9). The USGS has already installed FM2 and FM3. Figures II-12 a and b show the stage data for FM2 from July 20, 2009, to September 21, 2009, and November 14, 2009, to January 22, 2010, respectively, as well as the concurrent rainfall. Figures II-13 a and b show the stage data for FM3 from July 21, 2009, to September 18, 2009, and October 13, 2009, to January 22, 2010, respectively, as well as the concurrent rainfall.

Both FMs were expected to show diurnal variations in stage and flow with peaks occurring in the morning. However, this pattern was difficult to discern on a regular basis. Spikes in stage and flows were observed during rainfall events. Often irregular flow patterns were observed which may be due to sewer clogging downstream from the flow meters. This phenomenon will be examined more closely in 2010. Additionally, it was observed that the groundwater levels in the monitoring wells were much higher than the stage elevations in the sewers. Currently, investigations are being undertaken to determine whether significant inflow or outflow could be occurring.

The USGS is planning to install three PTs to continuously measure water levels and indirectly run off flow in the catch basins in three locations (Figure II-9). Additionally, two auto samplers will be installed on the southern sidewalk near FM3 and PT3 at South Blue Island Avenue and South Leavitt Street to collect storm and sewer water samples for water quality analysis.

A comprehensive computer hydraulic and hydrological model was developed to characterize: 1) the current background conditions of the Streetscape corridor; 2) individual BMPs and their respective performance; and 3) the collective BMPs across the Streetscape corridor and their combined performance. This modeling was performed using InfoWorks CS software by CH2M HILL under contract with the District. The SSP model was designed to function within the existing Chicago Department of Water sewershed model developed for the combined sewer system. An expanded model was also developed to determine how BMP implementation over the entire city would affect stormwater reduction to the collection system. Additionally, a spreadsheet-based water quality model was developed to evaluate the effect of BMP implementation on water quality improvement. The *Hydraulic Analysis of Blue Island/Cermak Ave Sustainable Streetscape* by CH2M HILL provides a detailed synopsis of the model development and evaluation.

Based on the Streetscape model with some minor BMP design modifications, a typical year of rainfall was simulated. Simulation results suggest that 80 percent of the rainfall could be captured by the Streetscape BMPs. The Citywide model was developed to include a number of parameters, including extent of BMP implementation, typical storage of BMPs, inclusion of CDOT's permeable green alleys, and infiltration rates of native soils. The Citywide model was examined for the following design storms: two months, one year, two years, five years, and ten years. Simulation results suggest that significant reduction in basement flooding risk and combined sewer overflow (CSO) volumes could be achieved with citywide implementation of BMPs. Additionally, for the design storms, the highest BMP implementation scenario was shown to reduce stormwater discharge to the collections system by 24 to 30 percent.

A water quality spreadsheet model was also designed to facilitate the calculation of water quality impacts for various BMP improvement options. There are two components to the water quality calculation: 1) the reduction in flows discharged to the system; and 2) the reduction in constituent concentration caused by the BMP. The data to support this calculation came from the hydraulic inflow/outflow data from the hydraulic and hydrological modeling performed by CH2M HILL and the BMP influent/effluent typical event mean concentrations from the American Society of Civil Engineers BMP Database. This database will be amended once SSP water quality and flow data becomes available. The model is able to perform simple evaluations on water quality impacts based on the BMP implemented and storm event. This model can also be used to assess the impact on a citywide scale and will be used once data is collected upon BMP implementation.

Technical Support to Other Requests

Support for the Use Attainability Analysis. In support of the Use Attainability Analysis (UAA) for the CAWS, the WTPR Section provided various data analyses as needed to the other sections or departments of the District and various entities involved in the UAA project. Specific tasks completed in 2009 were the analysis on waterway DO concentrations and their relation to the storm events that triggered wet weather urban run-off and CSO.

The District's continuous DO monitoring data for the CAWS and the corresponding CSO and RG data were used for this analysis. Data from 2001 to 2008 were used to determine the effect of storm events on DO concentration in the waterways. Conclusions were drawn based on the analysis that waterway DO is affected by wet weather events and the intensity and duration of a storm event impact the duration that DO concentrations decrease. The impact of wet weather on waterway DO also varies by location. For example, the DO drop in the Chicago River was almost exclusively due to wet weather, while the DO drop in the upper North Shore Channel occurred during both dry and wet weather periods.

Support for Three-Dimensional Water Quality Modeling for the Chicago Area Waterway System. A three-dimensional (3D) water quality modeling for a portion of the CAWS is being developed by the University of Illinois at Urbana-Champaign (UIUC). To support this project, the WTPR Section conducted sampling and collected data for UIUC's use in calibrating the model. Sampling included five waterway locations: Grand Avenue on the North Branch of the Chicago River, Columbus Drive on the Chicago River, Laramie Avenue on the Chicago Sanitary and Ship Canal., Madison Street and Loomis Street on the South Brach of the Chicago River. Samples during three dry weather and three wet weather events were collected at these locations.

Samples were also collected for the CSO discharge from the Racine Avenue Pump Station (RAPS), using an auto-sampler for most of the CSO discharge events in 2009. All sampling results were provided to UIUC. These results are not presented here, but can be provided by the WTPR Section upon request. A report on the 3D model will be provided by UIUC.

The WTPR Section also provided technical and facility support to the sediment resuspension and oxygen demand measurement at Bubbly Creek, which is the South Fork of the South Branch of the Chicago River. This innovative work is an important part of the 3D modeling study by UIUC, since sediment resuspension as a result of CSO discharge at RAPS to Bubbly Creek is a major factor depleting DO concentration in the creek.

TABLE II-1: POLYMER TEST RESULTS AT HANOVER PARK WATER RECLAMATION PLANT GRAVITY BELT THICKENER COMPLEX
APRIL/MAY 2009

Polymer Manufacturer	Polymer Identification	Polymer Dose* (lbs/dry ton)
Ciba	Zetag 8818	3.53
Ciba	Zetag 8819	3.52
Stockhausen	Praestol-K260FL	4.57
Stockhausen	Praestol-K148L	4.40
Polydyne	C-6257	3.91
Polydyne	C-6287	4.77
U. S. Polymers	Sedifloc 1040 C	5.85
U. S. Polymers	Sedifloc 1085 C	5.90

*Polymer dosage to obtain a 6.0 percent cake.

TABLE II-2: SUMMARY OF NUMBER OF SAMPLES ANALYZED FOR FILAMENT ANALYSIS FOR EACH WATER RECLAMATION PLANT IN 2009

Plant	Number of Samples
Egan	149
Kirie	52
Hanover Park	0
Lemont	162
North Side	208
Calumet	131
Stickney	40
Total Samples Analyzed	742

TABLE II-3: 2009 SUMMARY OF NUMBER OF SAMPLES ANALYZED FOR FILAMENTOUS BACTERIA IDENTIFICATION FOR WATER RECLAMATION PLANTS

Plant	Number of Samples
Egan	30
Kirie	0
Hanover Park	0
Lemont	5
North Side	0
Calumet	0
Stickney	0
Total Samples Analyzed	35

TABLE II-4: LOT RUNOFF EVALUATION FOR THE APRIL 13 AND APRIL 19, 2009, RAINFALL EVENTS

Lot	Date	Expected Total, ft^3	Measured RO, ft^3	% RO
Asphalt	4/13/2009	670.8	27.7	4.1
Concrete	4/13/2009	694.4	51.7	7.4
Paver	4/13/2009	625.9	18.9	3.0
Control	4/13/2009	667.1	484.7	100.0
Asphalt	4/19/2009	1168.3	210.4	18.0
Concrete	4/19/2009	1218.3	178.6	14.7
Paver	4/19/2009	1090.1	119.8	11.0
Control	4/19/2009	1161.8	1251.9	100.0

TABLE II-5: AVERAGE PERCENT CONCENTRATION REDUCTIONS FOR PERMEABLE LOTS RELATIVE TO CONTROL LOT FOR FOUR COMMON 2009 RAIN EVENTS

Lot	SS	VSS	COD
PA	88.9	90.2	66.2
PC	81.0	82.1	73.1
PP	77.2	83.0	56.0

TABLE II-6: INFLUENT HAZARDOUS AIR POLLUTANT CONCENTRATIONS AT THE METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO'S MAJOR WATER RECLAMATION PLANTS IN 2009[1]

HAP Organic Compound	Concentrations in µg/L Stickney	Calumet	North Side
Dichloromethane	2.2	1.4	0.7
Chloroform	3.1	2.7	3.0
Benzene	0.0	14.5	0.0
Tetrachloroethene	2.0	0.6	1.5
Toluene	29.9	12.8	0.9
Carbon disulfide	0.0	10.8	0.0
Methyl ethyl ketone	14.3	0.0	0.0
Styrene	5.1	0.2	2.5
Xylene (total)	2.8	1.0	0.0
Cresol (total)	6.3	0.0	1.1
Acetophenone	0.0	18.5	0.0
Cumene	0.0	6.5	0.0
2,4-D, salts and esters	0.0	2.8	0.0
Acetaldehyde	68.9	0.0	0.0
Propionaldehyde	19.0	0.0	0.0
Ethylbenzene	0.5	0.0	0.0
Naphthalene	0.4	0.0	0.0
Phenanthrene	0.4	0.0	0.0
2,2,4-Trimethylpentane	0.5	0.0	0.0

[1]Average results of the two influent samples collected in January and July 2009.

TABLE II-7: HAZARDOUS AIR POLLUTANT EMISSIONS FROM THE METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO'S MAJOR WATER RECLAMATION PLANTS IN 2009[1]

HAP	Emissions in tons/yr		
Organic Compound	Stickney	Calumet	North Side
Dichloromethane	0.3	0.1	0.0
Chloroform	0.3	0.1	0.1
Benzene	0.6	0.7	0.0
Tetrachloroethene	0.6	0.0	0.2
Toluene	2.7	0.5	0.0
Carbon disulfide	0.9	1.1	0.0
Methyl ethyl ketone	0.2	0.0	0.0
Styrene	0.4	0.0	0.0
Xylene (total)	0.3	0.0	0.0
Cresol (total)	0.0	0.0	0.0
Acetophenone	0.0	0.0	0.0
Cumene	0.0	0.2	0.0
2,4-D salts and esters	0.0	0.0	0.0
Acetaldehyde	1.9	0.0	0.0
Propionaldehyde	0.9	0.0	0.0
Ethylbenzene	0.0	0.0	0.0
Naphthalene	0.0	0.0	0.0
Phenanthrene	0.0	0.0	0.0
2,2,4-Trimethylpentane	0.6	0.0	0.0

[1]Emissions estimated using the BASTE model.

TABLE II-8: 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 2009

Test Start Date	Before Test		After Test*		Volatile Solids Reduction (%)	
	TS (%)	%VTS (%)	TS (%)	%VTS (%)	By Equation**	By Mass
1/15/2009	2.09	55.4	1.97	52.5	11.1	10.8
1/29/2009	2.30	53.0	2.13	49.5	13.1	13.4
2/11/2009	2.31	53.5	2.14	53.0	1.8	8.2
3/11/2009	2.73	52.3	2.48	48.0	15.5	16.4
4/9/2009	2.09	55.4	1.97	52.5	11.1	10.8
4/23/2009	3.03	48.1	2.79	43.9	15.7	16.0
5/15/2009	3.24	47.5	2.98	43.9	13.8	15.3
5/28/2009	3.43	47.4	3.19	43.7	13.7	14.2
6/11/2009	3.64	46.7	3.38	43.5	12.1	13.5
6/25/2009	3.63	46.6	3.45	43.1	13.3	12.0
7/16/2009	3.30	47.1	3.11	44.9	8.6	10.3
8/6/2009	2.79	49.5	2.63	48.0	5.8	8.5
8/20/2009	2.34	52.1	2.16	49.3	10.6	12.5
9/11/2009	2.49	54.0	2.32	49.7	15.8	14.3
9/24/2009	2.34	54.2	2.19	49.0	18.7	15.3
10/8/2009	2.10	54.7	1.96	51.3	12.8	12.4
10/15/2009	2.23	58.4	2.00	51.6	24.2	20.7
11/5/2009	2.19	55.1	2.02	48.7	22.7	18.4
11/19/2009	2.74	53.4	2.50	49.5	14.4	15.4
12/3/2009	1.76	55.4	1.60	51.3	15.1	15.7
12/17/2009	2.18	56.8	1.99	53.5	12.5	14.0
Monthly Mean						
Jan 2009					12.1	
Feb 2009					1.8	
Mar 2009					15.5	
Apr 2009					13.4	
May 2009					13.7	
Jun 2009					12.7	
Jul 2009					8.6	
Aug 2009					8.2	
Sep 2009					17.3	
Oct 2009					18.5	
Nov 2009					18.5	
Dec 2009					13.8	

TABLE II-8 (Continued): RESULTS OF ADDITIONAL ANAEROBIC DIGESTION TESTS FOR THE CALUMET WATER RECLAMATION PLANT IN 2009 PER OPTION 2 OF SECTION 503.33(b) OF THE 40 CFR PART 503 REGULATIONS for 2009

Test Start Date	Before Test		After Test*		Volatile Solids Reduction (%)	
	TS (%)	%VTS (%)	TS (%)	%VTS (%)	By Equation**	By Mass
Yearly Summary						
Mean	2.62	52.2	2.43	48.6	13.5	13.7
Min.	1.76	46.6	1.60	43.1	1.8	8.2
Max.	3.64	58.4	3.45	53.5	24.2	20.7

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

TABLE II-9: MONTHLY AVERAGE VOLATILE SOLIDS REDUCTION IN BIOSOLIDS AFTER ANAEROBIC DIGESTION AT THE CALUMET WATER RECLAMATION PLANT IN 2009

Month	Digester Feed		Digester Draw		VS Reduction (%)
	TS (%)	%VTS (%)	TS (%)	%VTS (%)	By Equation*
Jan	4.61	65.4	2.26	53.9	36.7
Feb	4.11	68.0	2.44	53.0	46.2
Mar	5.33	57.4	2.97	49.4	27.1
Apr	5.45	60.5	3.16	46.1	43.9
May	5.58	59.6	3.44	46.0	42.1
Jun	5.62	57.1	3.71	45.5	36.6
Jul	4.08	66.3	3.46	45.9	56.6
Aug	3.35	67.9	2.75	50.0	51.6
Sep	3.18	67.9	2.50	52.4	47.3
Oct	3.42	69.1	2.22	54.5	45.8
Nov	3.39	65.8	2.43	53.1	40.2
Dec	3.51	72.9	2.33	54.8	54.8
Mean	4.30	64.8	2.81	50.4	44.1
Min	3.18	57.1	2.22	45.5	27.1
Max	5.62	72.9	3.71	54.8	56.6

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

TABLE II-10: RESULTS OF ADDITIONAL ANAEROBIC DIGESTION TESTS FOR THE JOHN E. EGAN WATER RECLAMATION PLANT IN 2009 PER OPTION 2 OF SECTION 503.33(B) OF THE 40 CFR PART 503 REGULATIONS

	Before Test		After Test*		Volatile Solids Reduction (%)	
	TS (%)	%VTS (%)	TS (%)	%VTS (%)	By Equation**	By Mass
1/9/2009	2.39	58.53	2.23	54.52	15.07	13.15
1/22/2009	2.26	59.79	2.08	55.62	15.72	14.63
2/5/2009	2.26	60.57	2.07	56.28	16.21	14.98
2/19/2009	2.37	64.41	2.17	60.64	14.86	14.07
3/5/2009	2.46	65.08	2.18	60.78	16.86	17.06
3/19/2009	2.61	63.41	2.45	59.92	13.73	11.16
January Average					15.39	13.89
February Average					15.53	14.52
March Average					15.30	14.11

*After 40 day of incubation at 35.5°C in bench-scale reactors.

**The Van Kleeck Equation was used in calculations.

TABLE II-11: STAGE I WATER QUALITY ANALYTICAL DATA FOR JOHN E. EGAN WATER RECLAMATION PLANT SECONDARY AND FINAL EFFLUENTS

Date	UVT (%)	TS (mg/L)	TSS (mg/L)	TFE (mg/L)	TP (mg/L)	Initial FC (CFU/100 mL)
			Secondary Effluent			
4/1/2008	73.8	850	6	0.70	0.29	6751
4/2/2008	72.6	920	6	0.81	0.39	7021
4/3/2008	75.6	1016	6	0.53	0.13	4054
4/8/2008	74.7	962	6	0.67	0.32	1261
4/9/2008	73.1	822	6	0.79	0.43	2252
4/10/2008	73.7	922	7	0.51	0.37	1622
4/15/2008	73.5	898	44	3.48	1.26	2970
4/16/2008	74.0	862	8	1.03	0.41	3600
4/17/2008	77.0	902	0	0.1	0.27	4590
Min.	72.6	822	0	0.1	0.13	1261
Max.	77.0	1016	44	3.5	1.26	7021
Average	74.2	906	10	1.0	0.43	3791
Std. Dev.	1.4	59	13	1.0	0.32	2064
			Final Effluent			
4/1/2008	68.5	946	8	1.57	0.47	818
4/2/2008	76.1	948	0	0.15	0.17	2252
4/3/2008	77.2	988	0	0.13	0.14	1081
4/8/2008	77.1	944	1	0.15	0.17	270
4/9/2008	72.9	900	2	0.49	0.27	545
4/10/2008	77.1	918	1	0.12	0.23	273
4/15/2008	76.9	888	0	0.13	0.13	1710
4/16/2008	79.5	874	0	0.12	0.14	1620
4/17/2008	76.5	902	0	0.12	0.28	5860
Min.	68.5	874	0.0	0.1	0.13	270
Max.	79.5	988	8.0	1.6	0.47	5860
Average	75.8	923	1.3	0.3	0.22	1603
Std. Dev.	3.2	36	2.6	0.5	0.11	1736

TABLE II-12: STAGE II WATER QUALITY ANALYTICAL DATA FOR JOHN E. EGAN WATER RECLAMATION PLANT SECONDARY AND FINAL EFFLUENTS

Date	UVT (%)	TS (mg/L)	TSS (mg/L)	TFE (mg/L)	SolFe (mg/L)	TP (mg/L)	Initial FC (CFU/100 mL)
			Secondary Effluent				
3/31/09	72.8	838	11	0.17	0.077	1.42	29000
4/2/09	76.9	844	10	0.17	0.043	1.17	5856
4/7/09	75.2	869	5	0.1	0.089	2.23	3800
4/9/09	74.2	929	7	0.11	0.063	2.82	2100
4/14/09	73.6	816	6	0.1	0.059	2.65	4200
Min.	72.8	816	5	0.10	0.043	1.17	2100
Max.	76.9	929	11	0.17	0.089	2.82	29000
Average	74.5	859	8	0.13	0.066	2.06	8991
Std. Dev.	1.6	43	3	0.04	0.018	0.73	11265
			Final Effluent				
3/31/09	74.1	844	4	<0.1	0.049	1.3	21000
4/2/09	77.4	828	0	<0.1	0.041	1.05	4000
4/7/09	76	852	1	<0.1	0.064	2.05	2100
4/9/09	74.3	938	2	<0.1	0.071	2.74	909
4/14/09	73.8	812	1	<0.1	0.062	2.54	2500
Min.	73.8	812	0	n/a	0.041	1.05	909
Max.	77.4	938	4	n/a	0.071	2.74	21000
Average	75.1	855	2	n/a	0.057	1.94	6102
Std. Dev.	1.5	49	2	n/a	0.012	0.74	8401

TABLE II-13: STAGE I AND II AVERAGE WATER QUALITY ANALYTICAL DATA FOR JOHN E. EGAN WATER RECLAMATION PLANT SECONDARY AND FINAL EFFLUENTS

Sample	UVT (%)	TS (mg/L)	TSS (mg/L)	TFe (mg/L)	SolFe (mg/L)	TP (mg/L)	FC (CFU/100 mL)
				Stage I			
Secondary	74.2	906	10	0.96	n/a	0.43	3276
Final	75.8	923	1	0.33	n/a	0.22	1029
				Stage II			
Secondary	74.5	859	8	0.13	0.07	2.06	5637
Final	75.1	855	2	<0.1	0.06	1.94	3316

TABLE II-14: ULTRAVIOLET DOSES NEEDED TO ACHIEVE FECAL COLIFORM REDUCTION TARGETS FOR 2007, STAGE I, AND STAGE II JOHN E. EGAN WATER RECLAMATION PLANT EFFLUENTS

	Avg Dose to Achieve 400 CFU/100 mL (mJ/cm^2)	Max Dose to Achieve 400 CFU/100 mL (mJ/cm^2)	Max Dose to Achieve 2-Log Reduction (mJ/cm^2)	Max Dose to Achieve 3-Log Reduction (mJ/cm^2)
2007 Secondary	17.4	20	>40	>40
Stage I Secondary	13.5	30	>40	>40
Stage I Final	8.1	10	20	>40
Stage II Secondary	9.8	10	30	>40
Stage II Final	9.4	10	10	20

FIGURE II-1: DISSOLVED OXYGEN CONCENTRATION PROFILES IN AERATION TANKS 2 AND 6 AT THE JAMES C. KIRIE WATER RECLAMATION PLANT

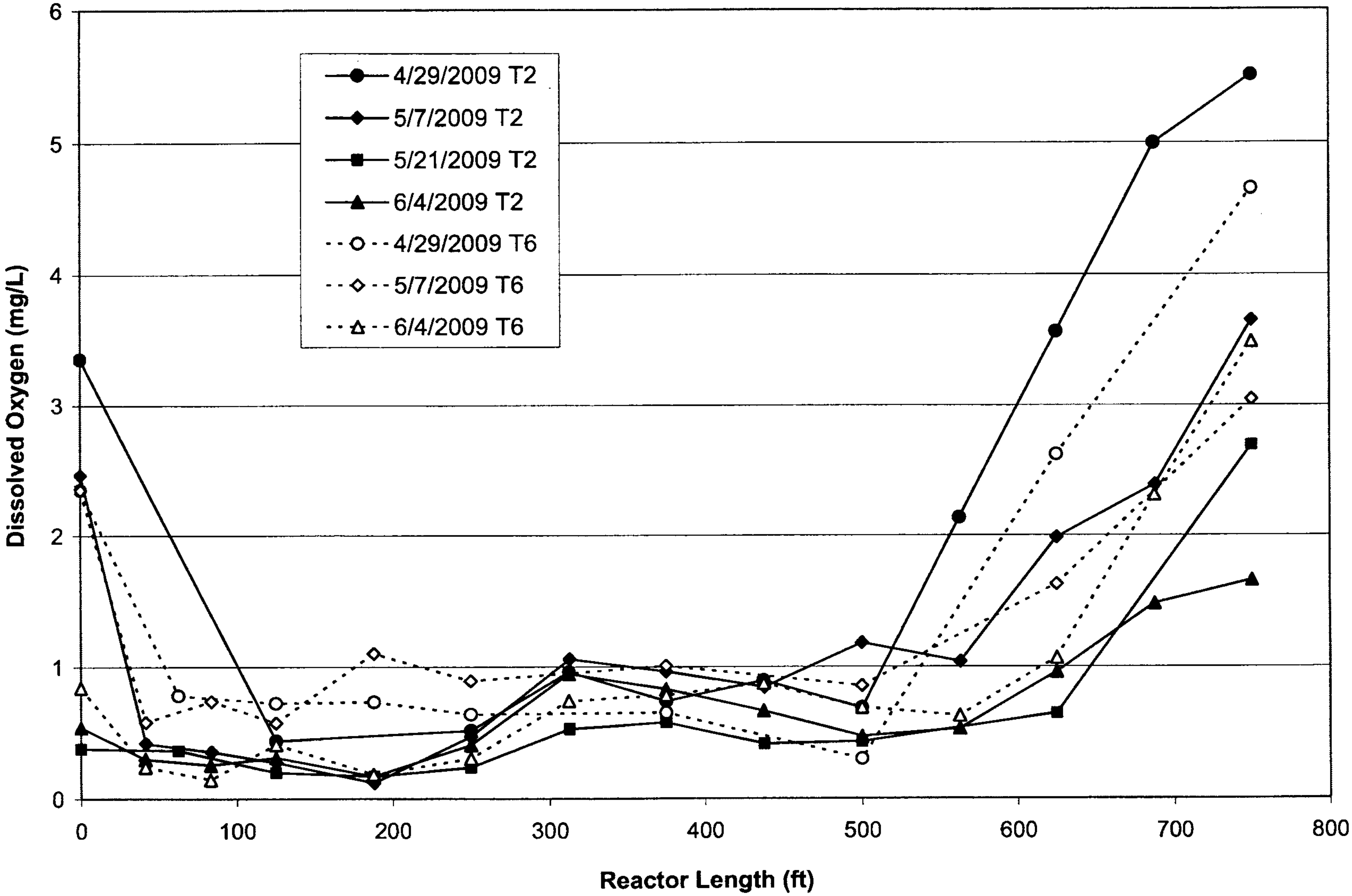


FIGURE II-2: SPECIFIC OXYGEN UPTAKE RATE PROFILE IN AERATION TANK 2 AT THE JAMES C. KIRIE WATER RECLAMATION PLANT

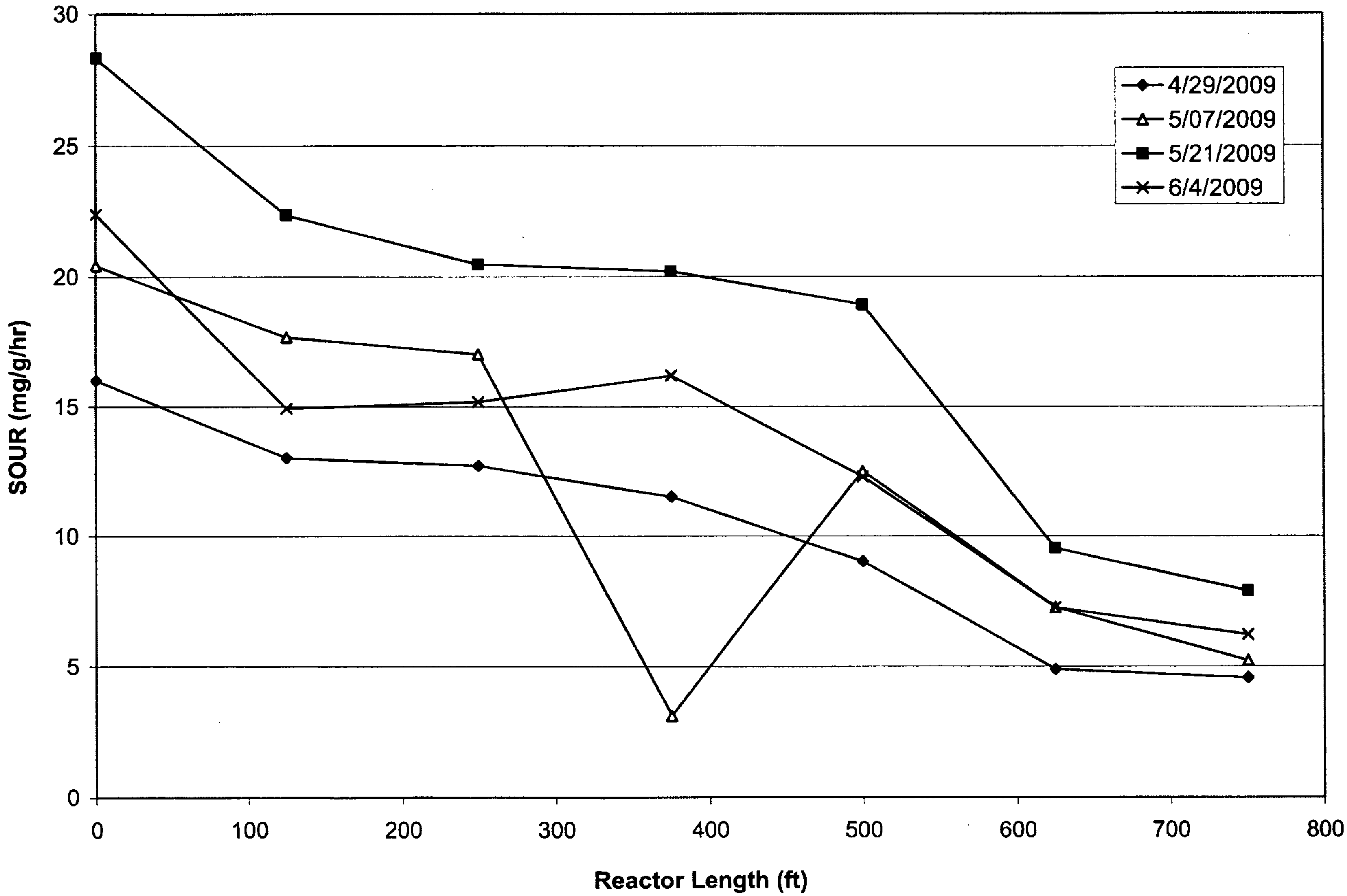


FIGURE II-3: AMMONIA CONCENTRATION PROFILE IN AERATION TANK 2 AT THE JAMES C. KIRIE WATER RECLAMATION PLANT

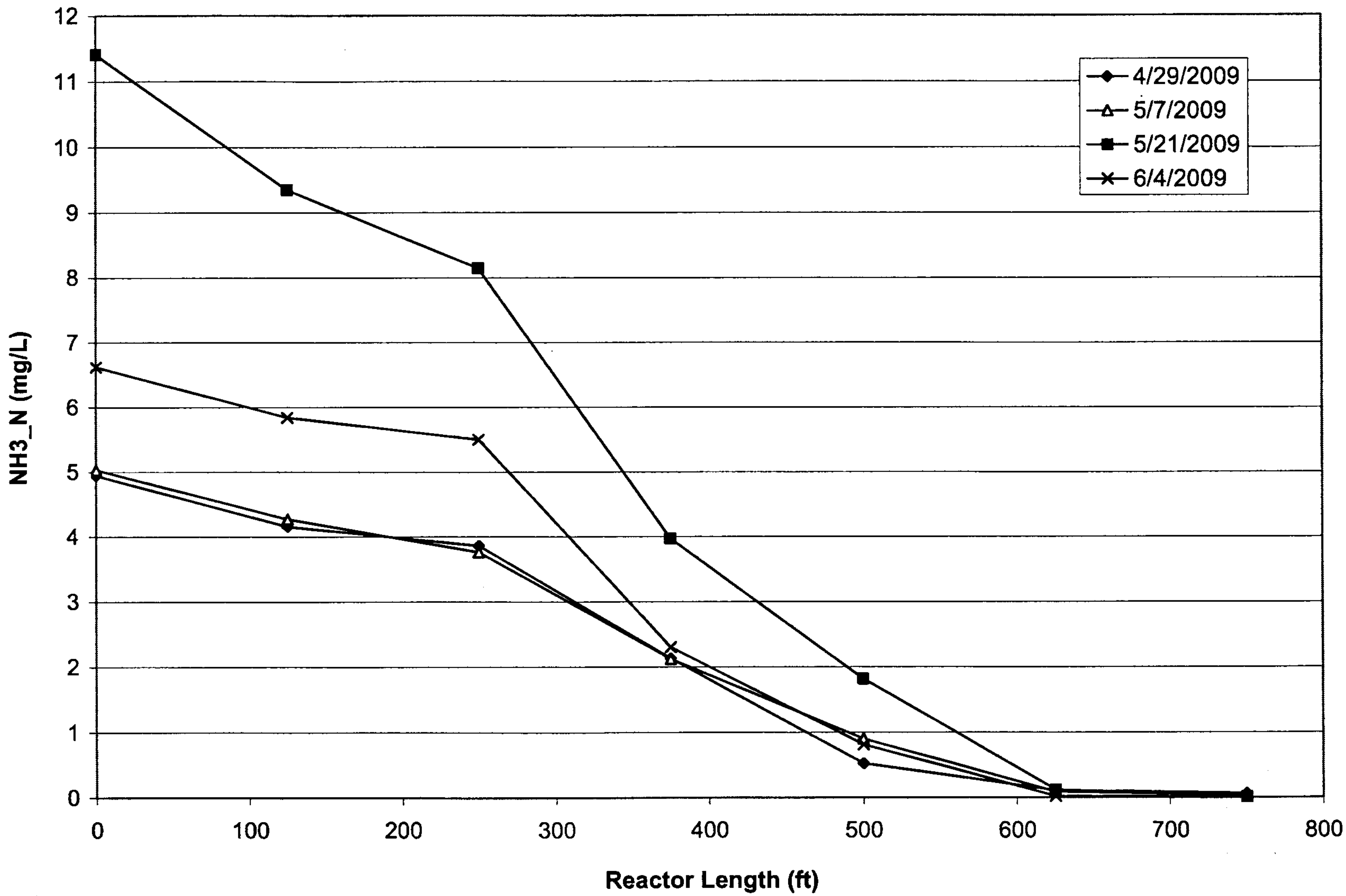


FIGURE II-4: NITRATE CONCENTRATION PROFILE IN AERATION TANK 2 AT THE JAMES C. KIRIE WATER RECLAMATION PLANT

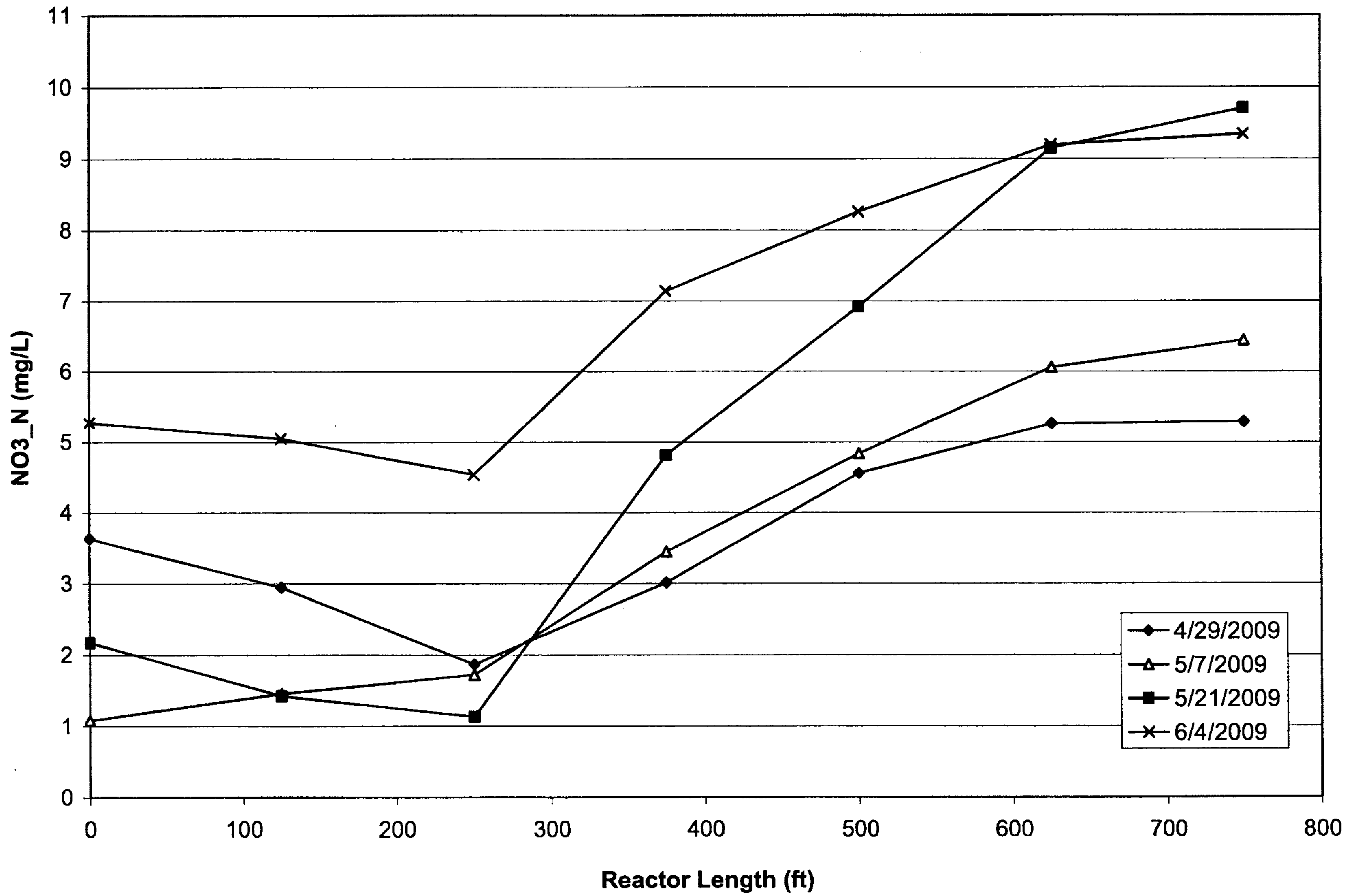


FIGURE II-5: TYPICAL PERMEABLE LOT LAYOUT

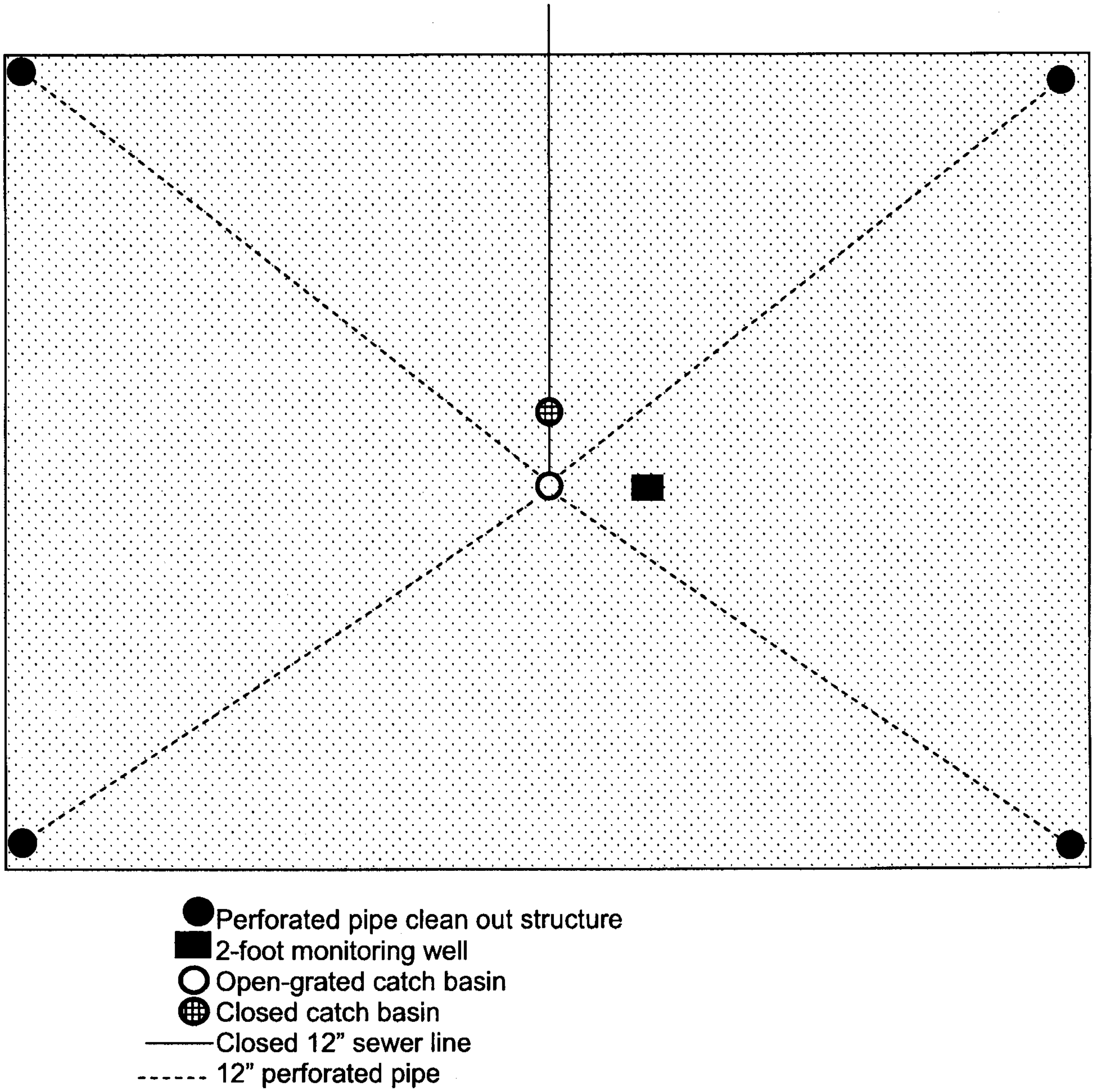
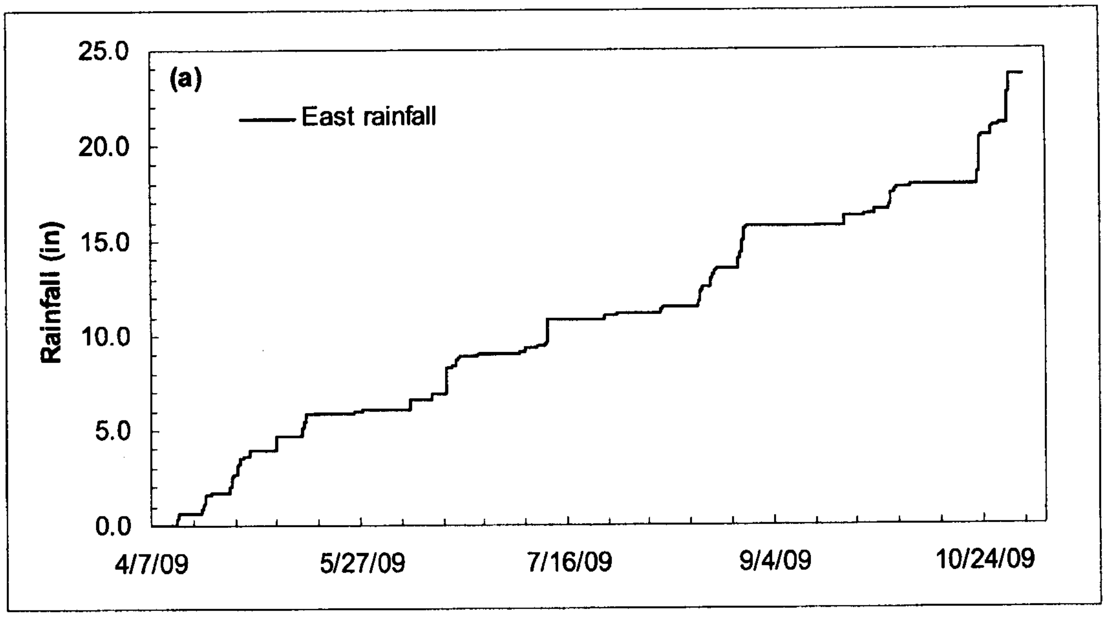


FIGURE II-6: 2009 CUMULATIVE RAINFALL FOR THE (a) EASTERN AND (b) WESTERN STICKNEY WATER RECLAMATION PLANT LOTS



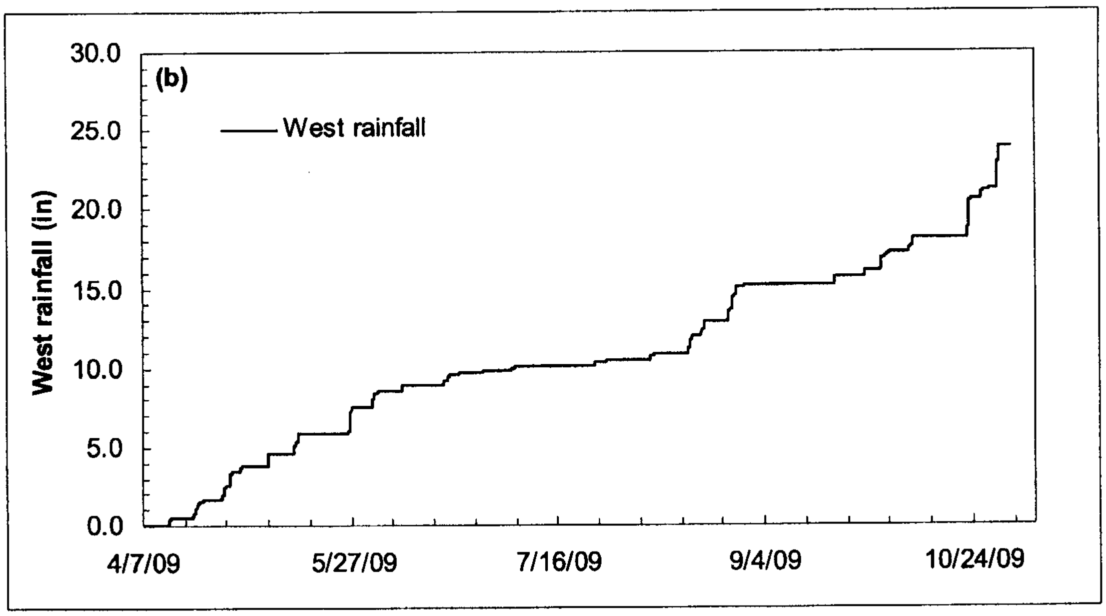


FIGURE II-7: 2009 NEAR-SURFACE WATER LEVELS FOR THE (a) PERMEABLE ASPHALT; (b) PERMEABLE CONCRETE; AND (c) PERMEABLE PAVER LOTS

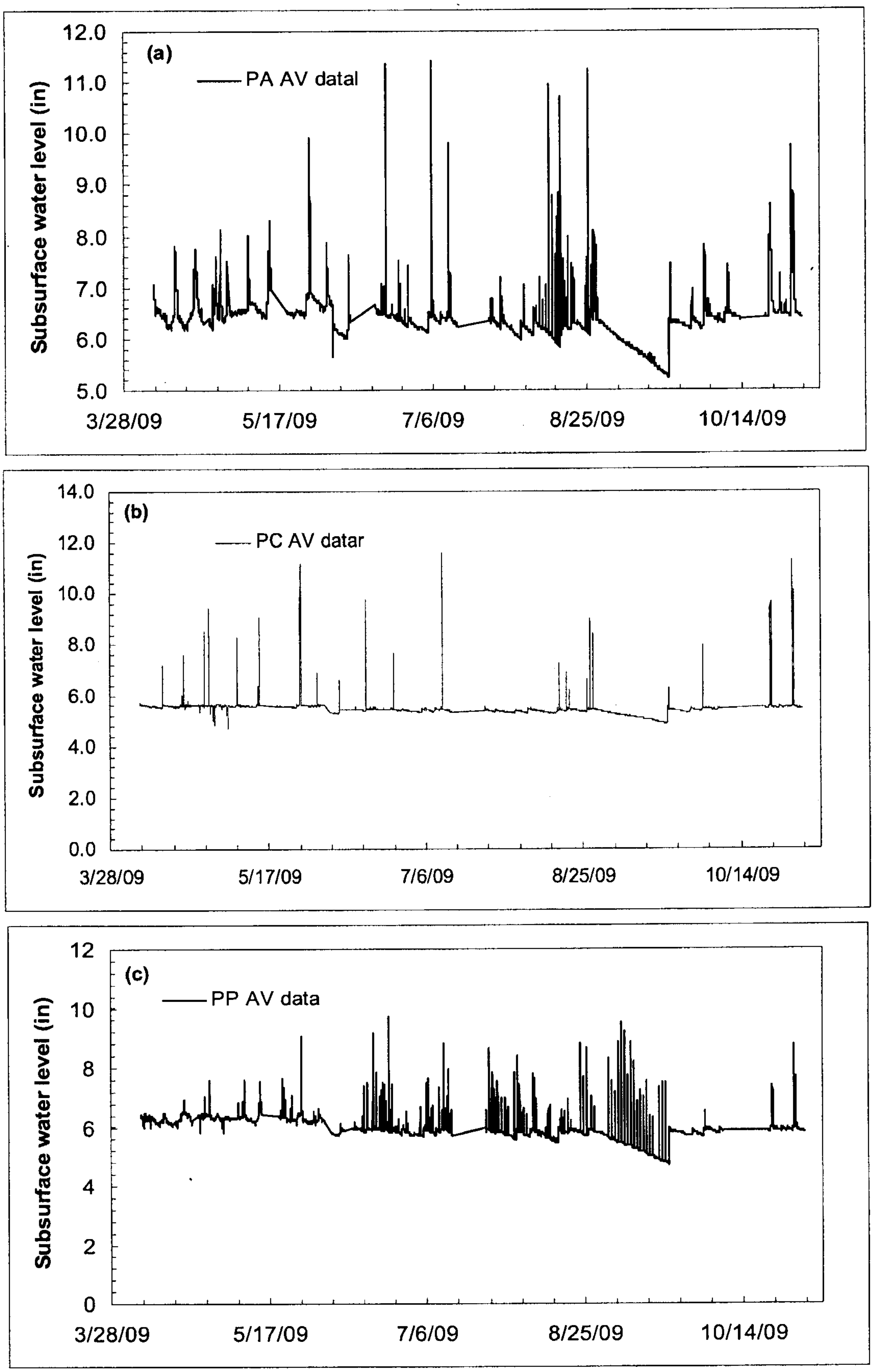


FIGURE II-8: PLOT OF ULTRAVIOLET DOSE VERSUS AVERAGE FECAL COLIFORM LOG REDUCTION FOR 2007, STAGE I, AND STAGE II JOHN E. EGAN WATER RECLAMATION PLANT SECONDARY AND FINAL EFFLUENTS

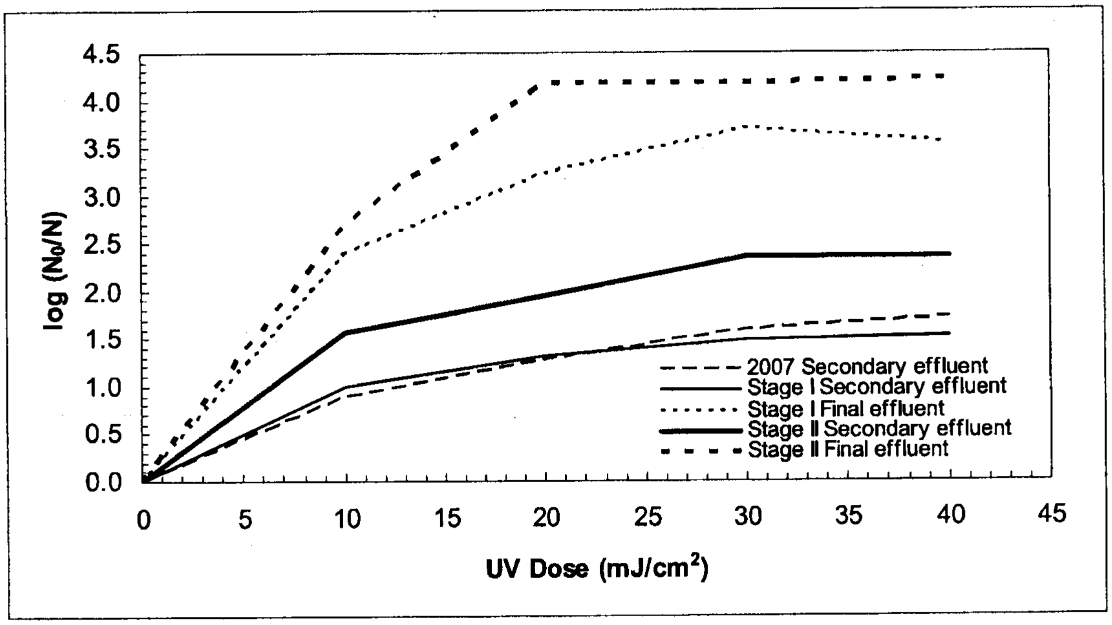


FIGURE II-9: SUSTAINABLE STREETSCAPE PROJECT STUDY AREA AND MONITORING LOCATIONS

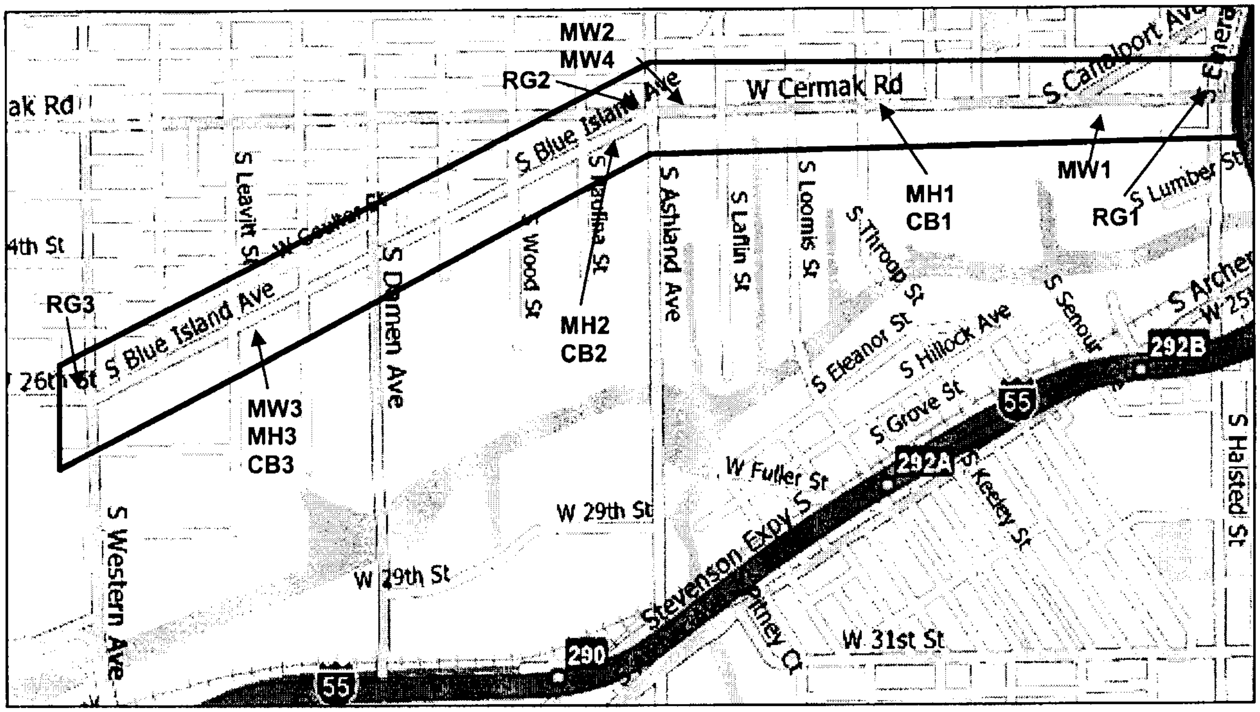


FIGURE II-10: CUMULATIVE RAINFALL FROM AUGUST 2008 THROUGH NOVEMBER 2009 FOR RAIN GAUGE 1, RAIN GAUGE 2, AND RAIN GAUGE 3

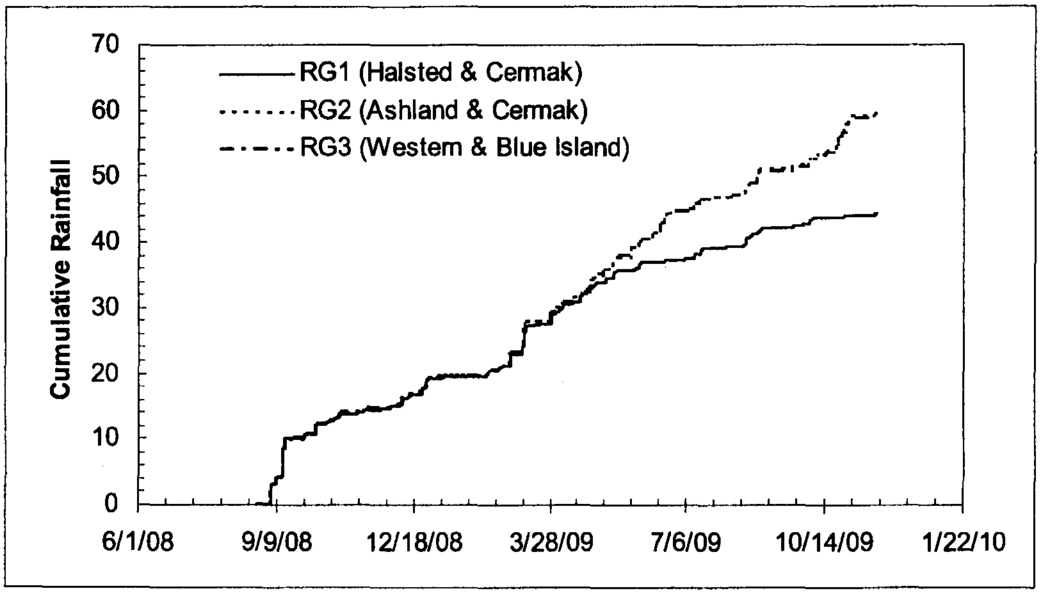


FIGURE II-11: TEMPORAL PLOTS OF DEPTH OF WATER FOR UNITED STATES GEOLOGICAL SURVEY MONITORING WELLS (a) MONITORING WELL 1, (b) MONITORING WELL 2 AND MONITORING WELL 4, AND (c) MONITORING WELL 3

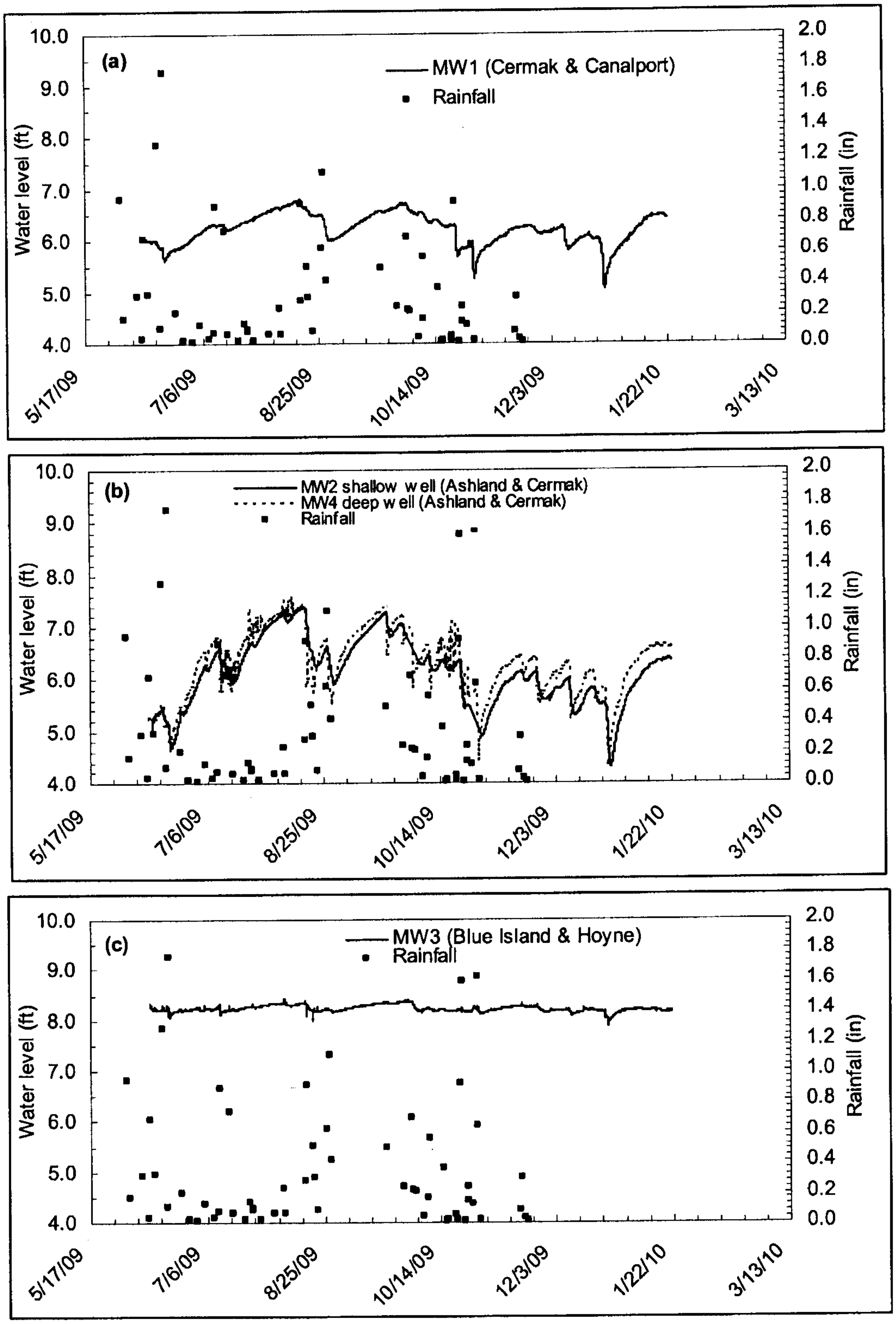
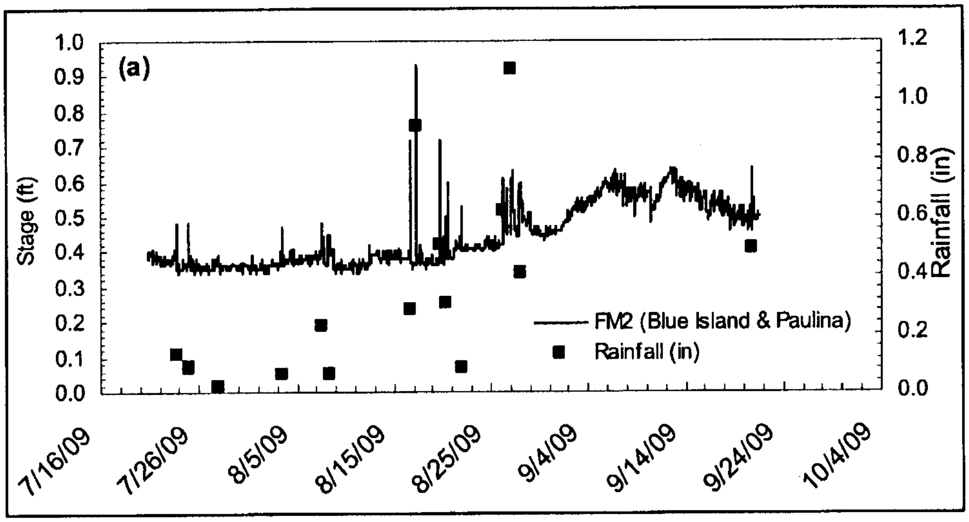


FIGURE II-12: PLOT OF FLOW METER 2 STAGE AND RAINFALL DATA FROM (a) JULY 20, 2009, TO SEPTEMBER 21, 2009, AND (b) NOVEMBER 14, 2009, TO JANUARY 22, 2010



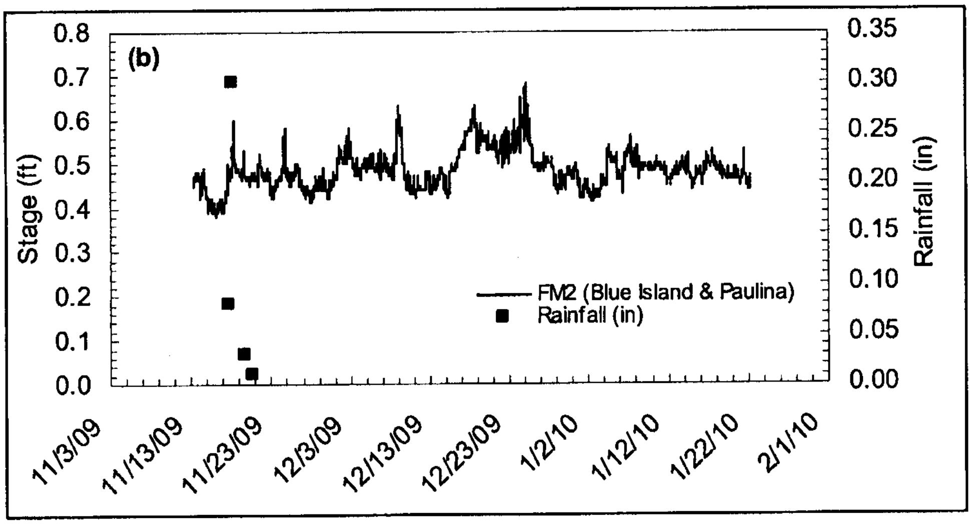
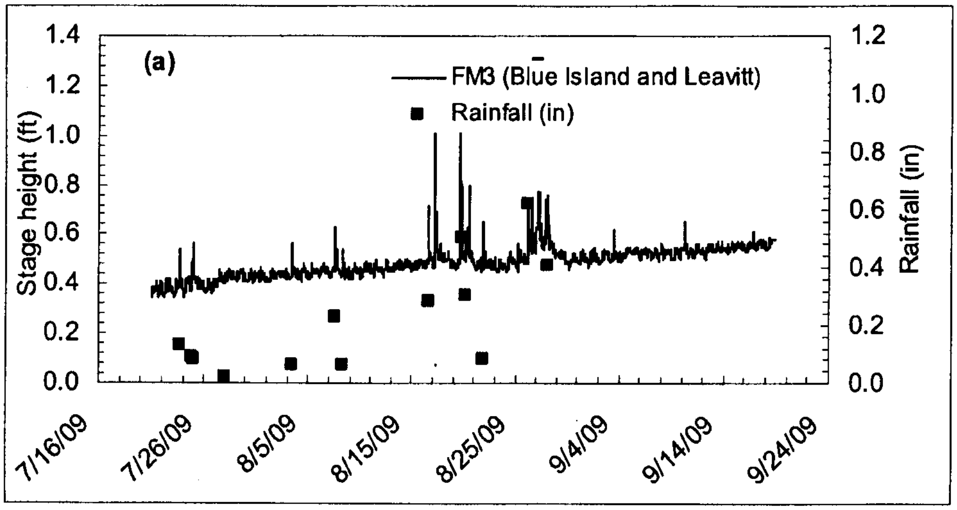
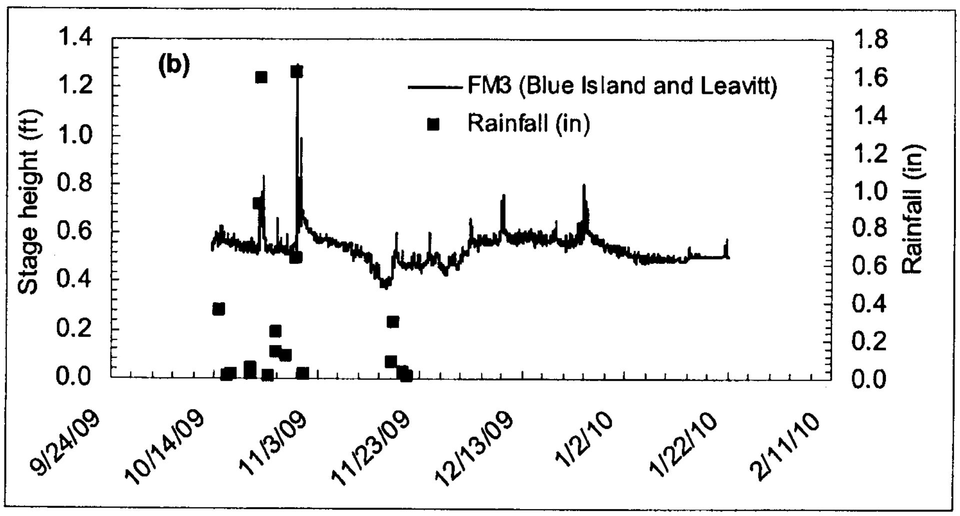


FIGURE II-13: PLOT OF FLOW METER 3 STAGE AND RAINFALL DATA FROM (a) JULY 21, 2009, TO SEPTEMBER 18, 2009, AND (b) OCTOBER 13, 2009, TO JANUARY 22, 2010





BIOSOLIDS UTILIZATION AND SOIL SCIENCE SECTION

BIOSOLIDS UTILIZATION AND SOIL SCIENCE SECTION

The role of the Biosolids Utilization and Soil Science Section is application of science for continuous improvement in the cost effectiveness of the Metropolitan Water Reclamation District of Greater Chicago's (District) 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 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. The Maintenance and Operations Department (M&O) staff located at the Fulton County site is responsible for collecting environmental monitoring samples from the site when needed, and submitting them to the Soil Science laboratory or Analytical Laboratory Division for analysis.

No supernatant or biosolids were applied to Fulton County fields during 2009. 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 resumes. On a discretionary basis, samples of soil plant tissue, groundwater, and surface water from a few locations at the site are collected every two years to add soil, plant tissue samples to the repository, and add data to the historical database for the site. The water samples are analyzed, but soil and plant tissue samples are stored without analysis.

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 2009 (Report Nos. 09-30, 09-58, 09-68, and 10-14). In 2009, a request was submitted to the IEPA to reduce the monitoring frequency of the wells. The IEPA approved discontinuation of monitoring of Well No. 1 and reduced the monitoring frequency of other wells, except Well No.7, to quarterly.

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 percent or greater. In 2009, a request was submitted to the IEPA to reduce the monitoring frequency for groundwater quality at the SMAs. The IEPA reduced the monitoring frequency to quarterly for all lysimeters, except three lysimeters which will be monitored monthly.

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 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. On June 12, 2003, sampling was discontinued following the IEPA's approval of a request from the District to discontinue monitoring. As a result, groundwater monitoring and reporting the IEPA was not required in 2009.

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 were sampled once per month. Beginning in the third quarter of 2009, all lysimeters are monitored quarterly (based on permit modifications). Analytical data were submitted to the IEPA in the quarterly reports for water samples taken in 2009 from lysimeters at the Calumet West SMA (Report Nos. 09-38, 09-56, 09-67, and 10-09) and from lysimeters at the Calumet East SMA (Report Nos. 09-34, 09-55, 09-66, and 10-08).

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 were sampled monthly and quarterly, respectively, as required by the operating permit. Beginning in the third quarter of 2009 (based on permit modifications) all lysimeters are monitored quarterly except lysimeters L-4N and L-6N, which are monitored monthly. The analytical results for lysimeter and well samples collected in 2009 were submitted to the IEPA in quarterly monitoring reports (Report Nos. 09-31, 09-52, 09-70, and 10-11).

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 were sampled biweekly, as required by the operating permit. Beginning in the third quarter of 2009 monitoring of all lysimeters has been terminated (based on permit modifications) except lysimeter L-2N, which is monitored monthly.

Analytical results for the lysimeter samples collected during 2009 at this site were submitted to the IEPA in quarterly monitoring reports (Report Nos. 09-40, 09-53, 09-71, and 10-12).

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) required biweekly groundwater monitoring. Beginning in the third quarter of 2009, all lysimeters are monitored quarterly (based on permit modifications). Analytical data for water sampled from lysimeters in 2009 were submitted in quarterly reports to the IEPA (Report Nos. 09-33, 09-57, 09-69, and 10-10).

Groundwater Quality Monitoring at the 122nd and Stony Island Solids Management Area. Commencing in 1980, biosolids have been dried at the SMA located at 122nd Street and Stony Island Avenue on clay surface drying cells. The drying cells were paved in 1992. The IEPA operating permit for this drying facility (No. 2005-AO-4283) required monthly groundwater monitoring. Beginning in the third quarter of 2009, all lysimeters are monitored quarterly (based on permit modifications) except lysimeter L-1, which is monitored monthly. Analytical results for water sampled and collected during 2009 from lysimeters at this drying facility were submitted to the IEPA in quarterly monitoring reports (Report Nos. 09-32, 09-54, 09-72, and 10-13).

Biosolids Management Regulatory Reporting. In 2009, the Section prepared the 2008 biosolids management report (Report No. 09-10) 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. 09-26, 09-29, 09-36, 09-39, 09-51, 09-61, 09-65, 09-73, 10-02, 10-04, 10-06, and 10-07). 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 2009. Table III-2 shows a four-year comparison (2006 to 2009) 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 2007 through 2009. The results show that although biosolids application increased the concentration of metals in the soil, the concentrations of metals in corn grain in the biosolids-amended plots were similar to those in the control plots. In addition, corn yield increased as the biosolids application rate increased.

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 P runoff in biosolids amended soils
- Biosolids P runoff field study

Bioavailability of Phosphorus 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). This study was completed in 2008.

Bioavailability of Phosphorus 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 triple superphosphate fertilizer P (Objective 1). This study was completed in 2006.

Biosolids Phosphorus 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.

During 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. In spring 2009, centrifuge cake biosolids were applied in three of the treatment units at a rate of 22.5 Mg/ha (10 dry tons/ac).

In 2009, runoff was collected from the plots. The weighted-mean concentrations of molybdate reactive P (MRP) and total P in the runoff collected in 2009 are presented in Table III-5. The results show that P concentrations in runoff were higher in the biosolids-amended plots than in the unamended plots. Concentrations of MRP and total P in the biosolids plots and total P in the unamended plots decreased as the vegetated buffer length increased.

Potential for Phosphorus 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.

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 been 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 a 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 2009. 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-6. The mean concentrations of nutrients and trace metals in the subsurface water samples collected from lysimeters in the Will County and Kankakee County plots during January through December 2009 are presented in Tables III-7 and III-8, respectively. The results show that NO_3-N leaching to sub-surface soil occurred both in plots amended with biosolids and the fertilizer control plots. There was no apparent movement of biosolids metals from the surface soil to the five- or ten-foot depth subsoil.

Investigation of Stabilization of Dewatered Biosolids in Lagoon. The District's exceptional quality air-dried biosolids, which are produced by lagoon-aging and air-drying, are utilized under the Controlled Solids Distribution Program in the Chicago metropolitan area on golf courses, parks, and athletic fields. If the odor potential of the dried biosolids is minimized, it will contribute significantly to biosolids management costs because it will increase public acceptance and long-term storage of the biosolids. In 2009, in collaboration with the Illinois Institute of Technology, the District initiated a project to investigate mechanisms of biosolids stability and the factors controlling odor potential during processing of District air-dried biosolids. Phase I of the project focused on determination of indices of biosolids stability during lagoon-aging. Sampling was done at three high-solids lagoons at LASMA and three low-solids lagoons at Calumet. The sampling plan consisted of two replicate biosolids samples at five depths (0-0.15, 0.15-0.45, 0.45-0.75, 0.75-1.35 and 1.35-2.0 m) of five locations along a transect of a lagoon from the loading side to the opposite side of each lagoon. The samples were analyzed for a range of parameters related to biosolids stability.

The mean analyses of the five locations and two replications for the five sample depths of Lagoon 27 at LASMA are presented in Table III-9. As the fresh dewatered cake generally contains over 50 percent volatile solids, the volatile solids content in the Table III-9 demonstrates that biosolids stabilization occurs during lagoon-aging. However, the degree of stabilization of biosolids in a lagoon varies with depth. The lower volatile solids, total Kjeldahl nitrogen, extractable protein, and oxygen uptake at surface layer (0-0.15 m) of the lagoon indicate higher oxidation and stabilization of organic matter at the surface compared to greater depths in the lagoon. These preliminary results suggest that during the lagoon-aging, there is an initial phase of stabilization throughout the entire lagoon and a subsequent phase where stabilization occurs mainly at the lagoon surface. The biosolids in the lower depths either lack stabilization or are stabilized under a different mechanism. Subsequent phases of the study will compare odor potential of air-dried biosolids collected from the surface and those collected from a subsurface depth (0.75-1.35 m).

Greenhouse Gas Accounting of the District's Biosolids Management Program. The use of biosolids are known to directly or indirectly affect the generation of CH_4 and N_2O and soil C sequestration, which can be translated into C debits and credits in greenhouse gas accounting. In collaboration with the University of Washington, the District conducted a study to evaluate the carbon credits and debits for each of the District's end uses of biosolids for both 2001 and 2008. The end uses evaluated were centrifuge cake landfill disposal, centrifuge cake as fertilizer on farmland, and air-dried biosolids utilization as landfill final cover, urban recreational areas, and for reclamation of mineland at Fulton County. In this evaluation, carbon debits are due to fossil fuel use and fugitive gas emissions, while credits are the result of replacement of fertilizer by biosolids and soil C sequestration.

A summary of the results of the evaluation are presented in Table III-10. The results indicated that the practice of landfill disposal of dewatered biosolids results in the significant debit, while centrifuge cake application to farmland, and air-dried biosolids use on urban areas, mineland reclamation and landfill final cover result in credits of relatively similar magnitude. The landfill disposal debits are due mainly to the N_2O and CH_4 emissions, and credits associated with all other practices are due to fertilizer replacement and soil C sequestration. The aging of biosolids was also another contributor to the differences in credits among the beneficial use practices. Despite the relatively high amount of fuel required for transportation to farmland, the credits associated with Class B centrifuge cake biosolids application are higher than credits associated with utilization of air-dried biosolids in urban areas. The credits associated with eliminating transportation emissions are significantly less than credits due to fertilizer avoidance and soil C sequestration. This evaluation shows that the District's biosolids beneficial reuse options contribute greater carbon credits than the practice of disposal in landfills.

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 2009 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 seven schools, 17 park districts and suburban villages, seven golf courses, two landscaping companies, three athletic clubs, one sod farm, and one District property.

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

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

4. Collaboration 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. Conducted two field days, one at the Blue Island Park District and one at the Village of Romeoville, to promote biosolids use under the Controlled Solids Distribution Program.

7. Hosted 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. Reviewed 229 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 M&O.

9. Contributed to and conducted a presentation at a field day hosted by the 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 2009, the Section reviewed the results of the National Sewage Sludge Survey and Exposure Hazard Assessment for additional pollutants being evaluated by USEPA for possible regulation under the Part 503 Rule.

Support to Green Initiatives

Stickney Permeable Pavement Project. In this project, the District is evaluating porous pavement technology for stormwater management in the Chicago metropolitan area. In 2009, the Section assisted in conducting evaluations of the permeable pavements. The Section also assisted in designing the monitoring plan to assess the performance of the pavement.

Native Landscaping. During 2009, the Section provided technical support for installation and maintenance of the conventional and native prairie landscaping at the District's facilities.

Native Prairie Research and Demonstration Plots. The Section established long-term native prairie research and demonstration plots at the Stickney WRP in November 2008 in collaboration with M&O. These plots are maintained for the long term, and no data will be collected until the native prairie landscaping 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 2009

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	588	263
½-Max	33.6	15.0	1,176	525
Max	67.2	30.0	2,352	1,050

[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 2006 – 2009

				Organic	0.1N HCl Extracted[3]						Concentrated HNO_3 Extracted							
Plot[2]	Year	pH	EC	Carbon	Zn	Cd	Cu	Cr	Ni	Pb	Zn	Cd	Cu	Cr	Ni	Pb	TKN	Tot-P
			dS/m	%	mg/kg													
Check	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
	2009	7.2	0.37	1.03	76.1	6.7	11.4	1.4	5.1	0.18	219	11.9	97.3	164	42.8	50.1	1,654	3,283
1/4	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
	2009	7.3	0.33	2.68	121	8.9	6.0	0.75	5.0	0.005	530	24.5	234	323	59.7	106	3,446	6,662
1/2	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
	2009	6.8	0.42	2.97	159	11.9	14.0	1.3	7.5	0.11	646	32.8	289	422	70.3	135	3,684	7,935
Max	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
	2009	6.7	0.53	4.62	119	7.7	5.5	0.4	5.4	0.001	835	35.8	372	452	71.9	155	5,618	11,692

[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 2009

Analyte[2]	Treatment[1]			
	Control	1/4-Max	1/2-Max	Max
	---mg/kg---			
TKN	14,226	9,359	11,003	11,579
P	2,962	2,898	2,943	2,912
Zn	20.7	26.0	25.2	25.3
Cd	<0.03	<0.03	<0.03	<0.03
Cu	1.2	1.3	1.4	1.3
Cr	0.16	0.19	0.19	0.20
Ni	0.40	1.0	0.63	0.41
Pb	<0.2	<0.2	<0.2	<0.2
K	3,907	4,204	4,143	4,115
Ca	54.5	46.3	43.4	49.0
Mg	1,236	1,319	1,296	1,220

[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 2007 TO 2009

		Treatment[1]											
		Control			1/4-Max			1/2-Max			Max		
Harvested Tissue	Unit	2007[2]	2008	2009	2007[2]	2008	2009	2007[2]	2008	2009	2007[2]	2008	2009
Grain	bu/acre	45	77	163	36	92	48.2	36	188	147	24	207	208
	Mg/ha	2.8	4.8	10.3	2.2	5.8	3.0	2.3	11.8	9.2	1.5	13.0	13.1
Stover	tons/acre	1.5	2.3	3.4	0.88	2.8	3.1	1.1	5.1	3.5	1.2	5.3	3.9
	Mg/ha	3.4	5.2	7.6	2.0	6.3	6.9	2.4	11.5	7.8	2.7	11.8	8.7

[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: WEIGHTED-MEAN[1] CONCENTRATIONS OF DISSOLVED MOLYBDATE REACTIVE AND TOTAL PHOSPHORUS IN RUNOFF COLLECTED DURING 2009 IN VEGETATED BUFFER STRIPS OF CONTROL AND BIOSOLIDS AMENDED PLOTS

Vegetated Buffer Length (ft)	Control		Biosolids	
	MRP[2]	Total P	MRP	Total P
	---------- mg P/L ----------		---------- mg P/L ----------	
0	0.012	0.56	1.02	2.97
25	0.021	0.35	0.87	1.23
50	0.024	0.31	0.59	0.83

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

TABLE III-6: 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 2009

	Will County Plots				Kankakee County Plots			
Treatment[1]	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	7.4	0.11	29.6	11.2	6.5	0.06	136.7	2.5
BS-1	7.6	0.11	44.3	12.9	7.1	0.06	93.3	3.7
BS-2	7.5	0.12	60.7	21.0	6.8	0.05	127.4	4.8
BS-3	7.4	0.12	75.7	23.0	6.4	0.07	156.8	5.2
BS-4	7.2	0.15	88.7	24.9	6.4	0.07	172.7	9.8

[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-7: MEAN CONCENTRATIONS OF NUTRIENTS AND TRACE METALS[1] IN WATER SAMPLES FROM THE LYSIMETERS[2] IN WILL COUNTY DEMONSTRATION PLOTS COLLECTED FROM JANUARY THROUGH DECEMBER 2009

		Treatment		
Parameter	Unit	40 wet tons biosolids/ac[3]	Residual, 40 wet tons biosolids/ac[4]	Residual, 80 wet tons biosolids/ac[4]
TKN	mg/L	0.46	0.39	0.77
NH_3-N	"	0.35	0.26	0.32
NO_3-N+NO_2-N	"	17.5	28.8	5.6
Total P	"	0.34	0.36	0.16
Hg	µg/L	0.20	0.20	0.20
As	mg/L	0.250	0.250	0.250
Ba	"	0.628	0.757	0.403
Cd	"	0.200	0.200	0.200
Cr	"	0.300	0.300	0.300
Cu	"	0.100	0.100	0.103
Mn	"	0.302	0.508	0.319
Mo	"	0.232	0.309	0.309
Ni	"	0.217	0.207	0.390
Pb	"	0.224	0.201	0.200
Sb	"	0.430	0.484	0.369
Se	"	0.100	0.100	0.100
Tl	"	0.306	0.312	0.300
V	"	0.200	0.200	0.230
Zn	"	0.111	0.101	0.100

[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 2009. Biosolids were applied in November 2004, 2005,and 2006.

TABLE III-8: MEAN CONCENTRATIONS OF NUTRIENTS AND TRACE METALS[1] IN WATER SAMPLES FROM THE LYSIMETERS IN KANKAKEE COUNTY DEMONSTRATION PLOTS COLLECTED FROM JANUARY THROUGH DECEMBER 2009

		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	0.77	0.33	0.24	0.52	0.37	0.77
NH_3-N	"	0.32	0.25	0.24	0.23	0.17	0.32
NO_3-N[5]	"	5.6	3.2	9.7	10.6	26.2	5.6
Total P	"	0.16	0.42	0.40	0.32	0.42	0.16
Hg	µg/L	0.20	0.20	0.20	0.20	0.20	0.20
As	mg/L	0.250	0.250	0.250	0.250	0.250	0.250
Ba	"	0.403	0.475	0.486	0.818	0.549	0.403
Cd	"	0.200	0.200	0.200	0.200	0.200	0.200
Cr	"	0.300	0.300	0.300	0.302	0.300	0.300
Cu	"	0.103	0.100	0.100	0.100	0.100	0.103
Mn	"	0.319	0.312	0.372	0.461	0.386	0.319
Mo	"	0.309	0.400	0.404	0.406	0.434	0.309
Ni	"	0.390	0.204	0.237	0.308	0.239	0.390
Pb	"	0.200	0.200	0.204	0.204	0.200	0.200
Sb	"	0.369	0.351	0.344	0.354	0.428	0.369
Se	"	0.100	0.100	0.100	0.100	0.100	0.100
Tl	"	0.300	0.300	0.342	0.290	0.305	0.300
V	"	0.230	0.200	0.200	0.200	0.200	0.230
Zn	"	0.100	0.108	0.103	0.104	0.124	0.100

[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 agronomic rate of K.
[5]Sum of NO_2-N and NO_3-N.

TABLE III-9: PHYSICAL, CHEMICAL AND BIOCHEMICAL PROPERTIES OF CENTRIFUGE CAKE BIOSOLIDS STORED IN A LAGOON FOR AN AVERAGE OF 20 MONTHS

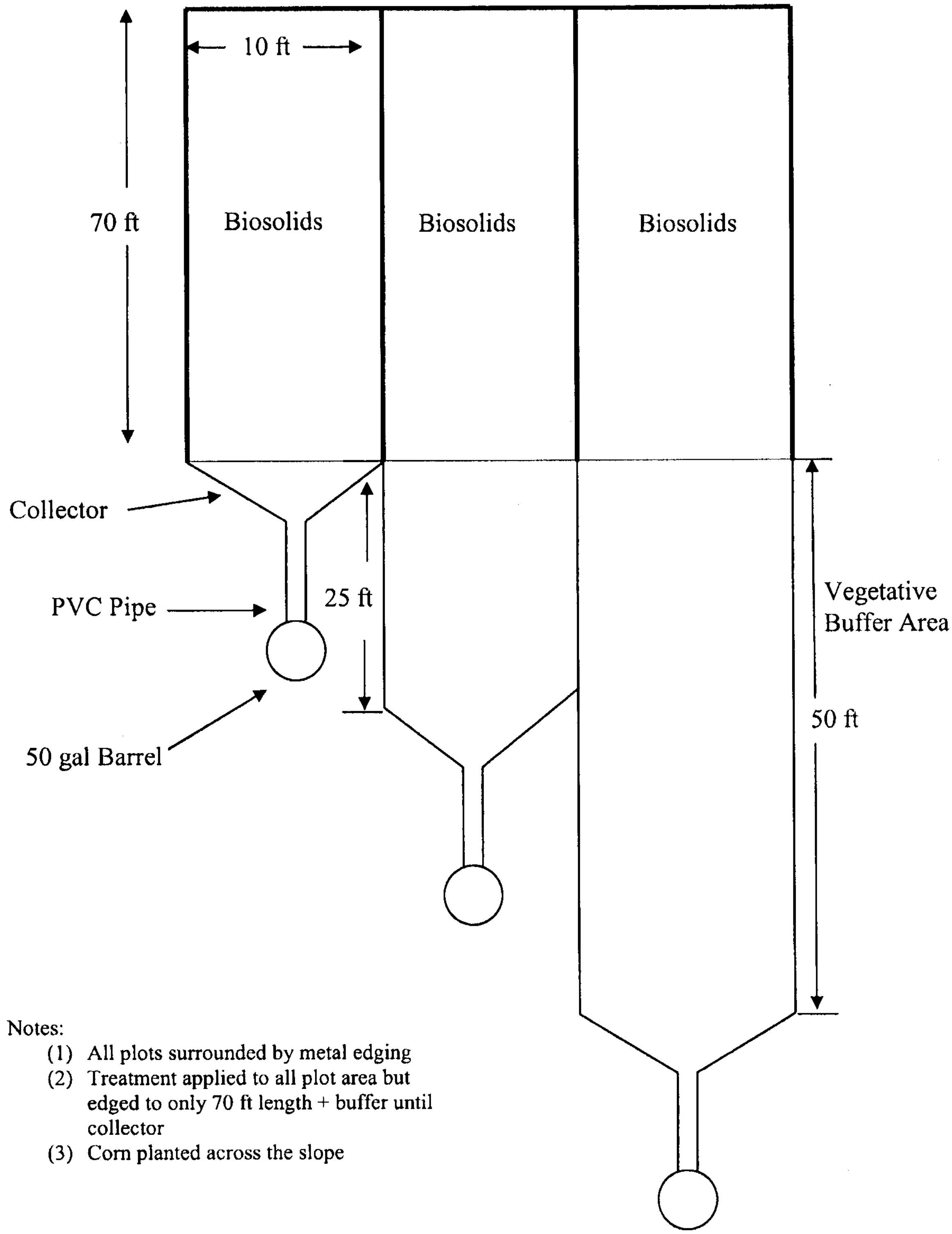
		Lagoon Depth (m)[1]				
Parameters	Units	0 - 0.15	0.15 - 0.45	0.45 - 0.75	0.75 - 1.35	1.35 - 2.00
Total Solids	%	36.7	22.1	20.3	20.5	20.1
pH		6.19	7.96	8.15	8.26	8.26
EC	mS/cm	3.09	8.86	10.3	9.88	9.53
Volatile Solids	%	44.4	46.7	47.3	47.5	47.2
TKN	%	2.75	3.97	4.28	4.36	4.43
NH_4-N	%	0.04	1.18	1.52	1.42	1.38
NO_3-N	mg/kg	959	66.1	14.1	8.73	7.82
WEP[2]	%	0.51	1.65	2.48	2.04	2.00
Oxygen Uptake (10 hr)	g/kg	3.14	5.41	4.90	5.34	6.28

[1]Data are the mean of ten samples.
[2]Water extractable protein.

TABLE III-10: RATE OF GREENHOUSE GAS EMISSION FOR EACH OF THE METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO'S BIOSOLIDS END USES

Biosolids End Use	2001	2008	Mean
	------- Emission Rate (Mg CO_2/Mg Dry Biosolids) -------		
Landfill Disposal (centrifuge cake)	2.52	2.44	2.48
Landfill Final Cover (air-dried)	-0.44	-0.46	-0.45
Farmland (centrifuge cake)	-0.53	-0.50	-0.52
Mineland Reclamation (air-dried)	-0.44	NA	-0.44
Urban Turf (air-dried)	-0.44	-0.46	-0.45

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



Notes:

(1) All plots surrounded by metal edging
(2) Treatment applied to all plot area but edged to only 70 ft length + buffer until collector
(3) Corn planted across the slope

ANALYTICAL MICROBIOLOGY AND BIOMONITORING SECTION

ANALYTICAL MICROBIOLOGY AND BIOMONITORING SECTION

Section Mission, Goals and Objectives

The Analytical Microbiology and Biomonitoring Section's (AMBS) primary mission is to provide on-time, quality-assured microbiological and biomonitoring assessment to support the District's treatment process operations and environmental stewardship research efforts dedicated to the improvements, and/or sustainable optimization of the wastewater treatment collection and operations; protection of the Chicago Area Waterway System (CAWS) water quality; and public health.

To accomplish this mission, the AMBS has the following goals:

- Microbiological and biomonitoring assessment of the District's final effluent (FE) and biosolids, and area rivers, lakes, and canals, to document the treatment effectiveness, improvements, and/or sustainable optimization of the wastewater treatment collection and operations.

- Conduct applied research to generate scientific data and up-to-date information on public health concerns (e.g. microbial risk assessment, public health epidemiology, biosolids for land application), emerging chemicals of concern (e.g. endocrine active compounds, antibiotic-resistant bacteria), optimization of the existing processes or potential changes in District operations (high flow, digester mixing, effluent disinfection, nutrient reduction, filament problems) to inform permit compliance, policy, support/guide/assess regulatory development, and support or improve operations.

- Participate in local and national regulatory review of microbial water quality criteria and standards.

- Collaborate with universities and other agencies, including the National Association of Clean Water Agencies (NACWA), the Water Environment Research Foundation (WERF), the United States Environmental Protection Agency (USEPA), etc., to share scientific information and knowledge about wastewater treatment processes and public health protection.

- Provide outreach services to promote education, awareness and acceptance of the District's operations.

Specific objectives identified for attaining the Section's first goal of assessing the treatment process, end products and their environmental impact are:

- Maintain Illinois Department of Public Health (IDPH) certification of the Analytical Microbiology Laboratory (AML).

- Employ test methods capable of meeting Quality Assurance/Quality Control (QA/QC) standards for precision, sensitivity and specificity. The test methods for detecting and enumerating indicators and pathogens in biosolids, wastewater and receiving water are those approved by the USEPA, and published as regulations under Title 40 of the Code of Federal Regulations (CFR).

- Ensure that all staff members receive training in sufficient depth by completing the demonstration of capability which enables them to carry out the analyses as required by the laboratory Standard Operating Procedures (SOPs) and Quality Assurance Program (QAP).

- Establish a baseline of quality for the laboratory's routine analytical performance by developing control chart(s) against which to measure the effectiveness of quality improvement efforts.

- Monitor the routine operational performance of the laboratory through participation in appropriate performance evaluation and/or inter-laboratory testing programs and to provide for corrective actions as necessary.

- Update SOPs and QAPs, and implement all QA policies along with essential applicable QC procedures.

- Increase the number of analyses that can be performed to more effectively support the District's monitoring and research programs.

- Replace obsolete equipment and upgrade facilities as required.

- Foster a "zero defects" commitment or course of action for all staff members. This commitment will seek to produce data and services of the highest quality attainable.

The secondary and tertiary goals are to conduct applied research to support the emerging public health and regulatory issues facing the District. Specific objectives identified for attaining these goals include:

- Develop research strategies for addressing microbial risk assessment and public health epidemiology.

- Collaborate with municipal, state, federal agencies and non-government agencies, including academic institutions and public utilities in developing public health research projects that enhance understanding of the processes and microbes in the environment.

- Conduct research to support the Process to Further Reduce Pathogens (PFRP), biosolids for land application, disinfection technologies evaluation, identification of wastewater operation problems and removal of emerging microconstituents such as antibiotics, endocrine active compounds, etc.

- Participation in the Illinois Pollution Control Board (IPCB) in the matter of the Illinois Environmental Protection Agency's (IEPA) rulemaking for the CAWS water quality and effluent limitation standards.

- Develop and/or update wastewater microbiology monitoring programs.

- Establish and foster cooperative relationships with scientific societies and organizations.

Overview of Section Activities

There are four professional and twelve technical personnel in AMBS, who are organized into four dedicated state-of-the-art laboratories to perform specialized monitoring and/or research activities. An additional fifth laboratory, the Molecular Microbiology Laboratory, is anticipated to be fully operational by 2011.

These five specialized laboratories are:

I. Analytical Microbiology

II. Biomonitoring

III. Parasitology

IV. Virology

V. Molecular Microbiology

The AMBS 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 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 (WET) methodology.
- Microbial processes.
- Enumeration of indicator bacteria, viruses, parasites, and pathogens.
- Research on emerging pathogens and methods.
- The microbiology of specific wastewater or biosolids treatment options.
- Epidemiological study of recreational use of the CAWS.
- Emerging microconstituents, including endocrine disruptors, pharmaceuticals, antibiotics and personal care products.

Use Attainability Analysis Research Projects

The AMBS staff coordinated research studies to ensure that the District is effectively dealing with emerging public health and regulatory issues such as microbial water quality, non-point sources of pollution, and public health impact assessment of District operations on the CAWS. Listed below are some important research studies coordinated by the AMBS.

Dry and Wet Weather Risk Assessment of Human Health Impacts of Disinfection versus No Disinfection of the Chicago Area Waterway System. Quantitative microbial health risk assessment (QMRA) methods were studied to model health risks based on measured concentrations of microorganisms, exposure and microbial dose data. The final report, "Dry and Wet Weather Risk Assessment of Human Health Impacts of Disinfection vs. No Disinfection of the Chicago Area Waterways System," is posted on the District website (www.mwrd.org) on the Technical Data & Reports page under "Use Attainability Analysis (UAA)." The results indicate that the levels of pathogens (bacteria, virus and protozoa) in the CAWS are low and correspond to a low probability of developing gastrointestinal illness for incidental contact recreational users in close proximity to the non-disinfected effluent from Stickney, Calumet and North Side WRPs. The risk assessment model concluded that the microbial health risks associated with incidental contact recreational practices on the CAWS are below the risk threshold that the USEPA applies to criteria for primary contact recreation.

The AMBS staff worked with Geosyntec Consultants in reviewing the USEPA comments of the final report and finalizing the manuscript for technical publication. The microbiological finding from this study has been published in *Water Science and Technology Journal* (Rijal et al, 2009).[1]

[1] G. Rijal et al. 2009. Dry and wet weather microbial characterization of the Chicago area waterway system. Water Science & Technology—WST, Vol. 60 No. 7 p. 1847-1855©IWA Publishing 2009 doi:10.2166/wst.2009.598.

Epidemiological Research Study of Recreational Use of the Chicago Area Waterway System. The study known as the Chicago Health, Environmental Exposure, and Recreation Study (CHEERS) was initiated to provide information that is valuable in the area of health risks associated with recreational use of the CAWS, and address potential deficits in the current knowledge of the health risks associated with limited contact water recreation and the measures to protect the public. The study is conducted in collaboration with a multidisciplinary team at the University of Illinois at Chicago (UIC) School of Public Health (Figure IV-1).

CHEERS is a prospective cohort epidemiology study, designed following the USEPA's National Epidemiological and Environmental Assessment of Recreational (NEEAR) Water Study to characterize the health risks of CAWS recreation. The primary objectives of CHEERS are to:

1) Determine rates of illness attributable to incidental contact recreation on the CAWS, given current wastewater treatment practices, with no disinfection.

2) Describe any observed relationship between measures of water quality and rates of acute illness among those who engage in various forms of incidental contact water recreation. Study participants are followed by phone for the development of acute gastrointestinal, respiratory, eye and skin conditions.

3) Identify pathogens responsible for illness among study participants and to explore sources of those pathogens on the CAWS.

CHEERS has undergone peer review coordinated by the Water Environment Research Foundation (WERF). WERF review panel experts include representatives from USEPA, academia, consultants and Centers for Disease Control (CDC), with backgrounds in epidemiology, infectious diseases, water microbiology, microbial ecology, risk assessment, public health, waste water management and statistics, to provide an independent review of the study. WERF facilitated the science advisory board meeting on March 30-31, 2009 at UIC and provided input to the collection, analysis and interpretation of the data generated in this study.

The health survey and data collection, which commenced in the summer of 2007 and was continued through 2009, resulted in an enrollment of 11,297 participants for the study by interviewing three groups of people who engage in outdoor recreation:

a) The CAWS group, who engage in incidental contact activities on the CAWS.

b) The general use waters group, who engage in the same activities on local rivers, lagoons and lakes, and do not have a local wastewater treatment facility.

c) The unexposed group, who engage in outdoor activities such as cycling, jogging, volleyball, softball and tennis.

The research team also collected water samples for analyses of pathogens (*Giardia*, *Cryptosporidium*, adenovirus, enteric viruses, noroviruses) and indicators [*Escherichia coli* (EC), fecal coliform (FC), enterococci, somatic and F^+ specific coliphages]. In addition, serotyping of coliphages, rapid test methods and quantitative polymerase chain reaction (qPCR) were investigated. A microbial method development plan was initiated to support exposure studies to quantify water exposure by dermal, inhalation and ingestion routes. The CHEERS study data collection was completed in 2009, and a final report will be completed in 2010.

Sources and Ecology of Fecal Indicator Bacteria in the North Shore Channel and North Branch of the Chicago River. The public health studies which are being conducted by the District focus on microbial health risks and have not directly addressed the non-point sources of microbial load contribution to the CAWS. Therefore, in July 2008 an inter-agency agreement between the District and the United States Geological Survey (USGS), Great Lakes Science Center (GLSC), Porter, Indiana was initiated to investigate the occurrence, distribution and potential sources of fecal indicator bacteria (*E. coli* and enterococci) along the north section of the CAWS. The sampling began in August 2008 and the study was completed in 2009.

A final report, titled "Distribution of *Escherichia coli* and Enterococci in Water, Sediments, and Bank Soils Along North Shore Channel Between Bridge Street and Wilson Avenue, Metropolitan Water Reclamation District of Greater Chicago," is posted on the District website (www.mwrd.org), indicating the abundance of non-point sources of fecal indicator bacteria such as river basin soil, sediments, tributary flow and storm sewers contributing to the overall fecal indicator bacteria load in the North Shore Channel (NSC).

Illinois Environmental Protection Agency Rulemaking Concerning the Chicago Area Waterway System Water Quality Standards and Effluent Disinfection. The District is involved in hearings before the IPCB regarding the IEPA's proposed "Effluent Bacteria Standard" for the District treatment facilities on the CAWS. Responsibilities in this administrative process included the review of testimonial documents and preparation of position statements, along with questions and comments.

Research Collaborations

The aim of AMBS is to develop collaboration between the District and other agencies, including research organizations. The AMBS staff generally provide support to research projects as follows:

- Development of a microbial sampling strategy for wastewater, storm water, combined sewer overflows (CSOs) and the local receiving water.

- Microbial analysis of samples from the District's wastewater treatment processes for microbial analysis.

- Provide operational data for the various wastewater treatment processes.
- Provide raw and treated wastewater samples for laboratory and pilot studies.

Water Environment Research Foundation Research Projects. The AMBS was involved in the WERF issue area team research in the fields related to microconstituents; biosolids risk assessment; and critical research and science needs for the development of recreational water quality criteria. As members of WERF's Science and Regulatory Advisory Panel (SRAP) and pathogen issue area team (IAT), staff provided technical review of the research projects and regulatory documents, attended project related meetings and teleconference calls, and evaluated the following WERF project proposals and the final report:

- Experts Scientific Workshop on Critical Research and Science Needs for the Development of Recreational Water Quality Criteria in Inland Waters.
- Measuring Water Ingestion Among Water Recreators.
- Creating the Tools for Site-Specific Microbial Risk Assessment and Communication Plans for Biosolids Land Application.
- Developing Better Indicators for Pathogen Presence in Sewage Sludges.
- Investigating Molecular Tools for Freshwater.
- Quantification of Pathogens and Sources of Microbial Indicators for QMRA in Recreational Waters.

University Research Projects. The AMBS staff collaborated with universities and provided review of their grant proposals and/or research as follows:

- University of Illinois at Urbana-Champaign Unsolicited Preproposal Review: *Solar Inactivation of Cryptosporidium parvum oocysts and Rotaviruses in Reclaimed Water.*
- University of Illinois at Chicago - Doctoral Thesis Review: *Evaluation of Indicator Microbe Sampling and Enumeration Methods for Chicago Area Surface Waters.*

Outreach Support Services. The AMBS's aim is to continue outreach support to promote public awareness and acceptance of District operations. The intent is to inform the public about the District's monitoring and research programs. On a regular basis, the AMBS staff provides a number of ongoing public outreach/education services. Some of those services include:

- Biological Nutrient Removal Hands-on Workshop: As a member of the Water Environment Federation (WEF) program, staff presented at the Water Environment Federation Technical Exhibition and Conference (WEFTEC), sharing knowledge on wastewater microbes in an interactive on-site workshop session. The workshop presented real-life examples covering several different aspects of wastewater process control.

- Guidance to Middle and High School Students. When requested, staff provided information on the role of wastewater microorganisms in waste recycling and technical advice on water quality monitoring and analytical methods.

- Laboratory Tours. Laboratory tours are encouraged and conducted upon request to any person or group wishing to learn about the District microbiology laboratory. Several individual and group tours were given in 2009.

Analytical Microbiology Laboratory Mission and Activities

The mission of the Analytical Microbiology Laboratory (AML) is to provide high quality and timely indicator bacteria detection, enumerating and identification services for the District's permit requirements, treatment process operations, monitoring the bacterial quality of waterways within its jurisdiction, and to support research investigation of emerging wastewater, public health, regulatory and treatment process issues. The AML staff includes a Supervising Environmental Microbiologist, an Associate Environmental Microbiologist, two Laboratory Technicians II, a Laboratory Technician I, and a Laboratory Assistant. Personnel in this group participated in a variety of monitoring and research activities. Listed below are the most important of these activities.

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

- Chicago Area Waterway System (CAWS). Monitoring District waterways in Cook County upstream and downstream of the Calumet, North Side, Stickney and Lemont WRPs.

- Groundwater Monitoring Wells – Tunnel and Reservoir Plan (TARP). Monitoring FC presence and density in groundwater monitoring wells near TARP tunnels, as required by IEPA operational permits.

- Groundwater Monitoring Wells - Land Reclamation. Monitoring FC in groundwater monitoring wells potentially impacted biosolids processing and application handling sites in Cook County.

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

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

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

- Study of Antibiotic Resistant Bacteria (ARB). Monitoring of ARB in District's WRP effluent and the CAWS.

- Disinfection Study. Bacterial density monitoring for FC and EC to evaluate the Ultraviolet Light Disinfection Technology.

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

- Reviews. Review of the USEPA Water Quality Criteria for Bacteria. Review research reports, proposed regulations, and federal register microbial analytical methods to determine the impact on District operations.

- Participation in the IPCB in the matter of IEPA's rulemaking for the CAWS water quality and effluent limitation standards.

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

Illinois Department of Public Health Certification. The AML is certified by the IDPH, Registry #17508, for the following laboratory examinations:

- Heterotrophic bacteria, heterotrophic plate count (HPC) for water.

- Total coliform (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 AML has been certified 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.

The AML facility, equipment, and procedures were the subject of the biennial on-site evaluation for certification by the IDPH on October 29, 2008, and were found to be in general compliance with the provisions of the 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 AML collects and analyzes potable water samples from District facilities as required.

Water Reclamation Plant Operation Monitoring and Research Support. The AML supported a variety of programs for the Environmental Monitoring and Research Division and the Industrial Waste Division in 2009: special request effluent analysis, 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-1 shows a summary of the major programs receiving support for the year 2009, and the number of analyses for each program.

The AML is responsible for bacterial population density analyses used in WRP effluent monitoring. Monitoring of Chicago's harbors is conducted when river reversals to Lake Michigan occur due to heavy rainfall in the Chicagoland area. In 2009, there were three reversals to Lake Michigan as a result of extreme precipitation. Samples were collected and analyzed for FC and EC. The report titled, "Microbiological Report of Bypass Samples in 2009" describes the results of microbiological sampling for bacteria during storm water and combined sewage bypassed by the District to Lake Michigan (District Report No. 09-25).

Bacterial indicator analyses for TC, FC and EC are used by the District as indicators of the sanitary quality of water. The indicator bacteria types and number of analyses performed in 2008-2009 are presented in Table IV-2. Coliform bacteria are identified to species (ID-CONF) using specific biochemical metabolic characteristics. Isolated colonies from culture plates are selected and inoculated to the B-D Crystal ID Systems (BBL Crystal ID System and BBl Crystal MIND Software V5.02E [Becton, Dickson and Company, Sparks, Maryland]). HPC is a procedure for estimating the number of viable heterotrophic bacteria in water. The HPC, TC and EC analyses are used to monitor the bacteriological quality of drinking water.

National Pollutant Discharge Elimination System Compliance Biomonitoring. Results of FC analysis of 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 disinfection 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 effluent disinfection 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 bypass a portion of their influent, which is then treated before being delivered to the levels. In 2009, the AML performed analyses of FC bacteria on storm-related excess flow discharge events at the District WRPs. The storm-related excess flow samples were analyzed from the Egan WRP on March 8, June 19, October 23, and December 25, 2009.

Part 503 Compliance Monitoring. In 2009, the AML performed most probable number (MPN) analyses for FC bacteria on 42 samples of biosolids to determine if the product met with the Class A pathogen requirement of less than 1,000 FC MPN/g (dry weight) as specified in the Part 503 Regulations for biosolids distribution for land application. 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.

An internal audit of the AML was conducted on June 22, 2009. Results of the audit indicated that the AML was in full compliance with all USEPA requirements for analysis to determine compliance with the Part 503 Class A pathogen standards.

Monitoring Bacterial Densities in Farm Soil. In 2009, the AML continued monitoring FC densities in farm soil after application of biosolids. A total of 21 samples were analyzed 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. Additional information on this project is in the Biosolids Utilization and Soil Science Section chapter of this report.

Study of Antibiotic Resistant Bacteria in the Chicago Area Waterway System. The District continued the ARB study to survey the CAWS. The study investigated how secondary sewage treatment at the Stickney, Calumet and North Side WRPs is affecting the number and spatial distribution of ARB in the CAWS. The study consisted 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.

The first objective of this study investigated the impact of SWRP effluent on antibiotic resistant FC densities in the CSSC. It included the collection and analyses of four sets of water samples from one upstream and four downstream locations in the CSSC along with SWRP effluent for FC enumeration and determination of percentages of those FC that exhibit some antibiotic resistance. This portion of the study was completed in 2006. Results of the analyses are presented in Table IV-3.

The second objective of this study began with sample collections in winter 2006, and the data collection was completed in 2007. It includes the collection and analyses of four sets of water samples, one location upstream of the North Side WRP in the NSC, and four locations downstream of the North Side WRP in the NSC, and the NBCR, along with North Side WRP effluent for FC enumeration and determination of percentages of those FC that exhibit some antibiotic resistance. These results are presented in Table IV-4.

The third objective of this study began with sample collections in the winter of 2007. The study included the collection and analyses of four sets of samples, one location upstream in the Little Calumet River and four locations downstream of the Calumet WRP in the Calumet-Sag Channel, along with the Calumet WRP effluent for FC enumeration and determination of percentages of those FC that exhibit some antibiotic resistance. The sample collection and sample analyses related to the third objective were completed in 2008. These results are presented in Table IV-5.

The results of the identification of ARB isolates recovered from all phases of the research are presented in Table IV-6 through Table IV-8. The majority of the presumed FC isolates taken randomly from each source were confirmed as *E. coli*; very few isolates were identified as *Klebsiella pneumoniae* and *Klebsiella oxytoca.* The results showed that the percentage of ARB FC in the effluent of North Side, Calumet and Stickney WRPs and CAWS downstream locations were either lower or equivalent to the percentage of ARB in the upstream locations. The relative percentages of ARB FC observed in the effluent and CAWS (upstream and downstream) were AMP-R>TET-R>GEN-R>AMP/TET/GEN-R. These results support the conclusion that the environments of the District's three WRPs are not conducive to the propagation of antibiotic resistant bacteria, including multiple-drug resistant FC bacteria in the CAWS.

Ultraviolet Light Disinfection Study. In 2009, the District was involved in monitoring bacterial densities to assess the challenges and applicability of its future disinfection needs. Contributing to this work included the AML performance of 637 FC and 585 EC analyses on production scale UV treated and untreated WRP effluent samples utilizing different manufacturers' UV systems in controlled scale operation at the Hanover Park WRP.

Excess Flow Disinfection Improvement Study. The AML provided analytical support for a study to improve the chlorine disinfection effectiveness of excess flow discharges (influent flow level that exceeds the plant's maximum treatment capacity) at the Egan WRP. Such discharges are the result of extreme rain events in which primary effluent is discharged at the 004 outfall of the Egan WRP. For this research, the AML performed EC analyses on 139 samples of bench scale treated and untreated primary effluent. Results of this work will be used to optimize treatment strategies at the Egan WRP.

Digester Mixer Performance Study. The AML provided analytical support to a project designed to evaluate the affect of mechanical mixers on anaerobic digestion at the Calumet WRP. For this project, 26 samples of the mixer modified digester draw, 26 samples of the digester feed material, and 26 samples from a non-modified digester draw were collected. 25 samples of each were analyzed for FC. No FC tests were conducted on the samples collected on October 20, 2009. The results of these analyses are available in Table IV-9.

Biomonitoring Laboratory Mission and Activities

The mission of the Biomonitoring Laboratory (BL) is to provide high quality whole effluent toxicity testing services for the District's treatment process operations and compliance with permit requirements, and to conduct research to support emerging public health and regulatory issues. This group is composed of three professionals: Supervising Environmental Microbiologist, Senior Environmental Microbiologist, Assistant Environmental Microbiologist; and three technical personnel. Personnel in this group participated in the following biomonitoring and research activities.

- WET Testing for NPDES Permits. Use of *Pimephales promelas* (fathead minnows) and *Ceriodaphnia dubia* (daphnids or "water fleas") to assess acute and chronic toxicity of effluents from District WRPs.

- Reviewed research reports, NPDES permits and proposed regulations for any impact on District operations.

National Pollutant Discharge Elimination System Compliance Biomonitoring. Under the NPDES program (Section 402 of the Clean Water Act), the BL (Figure IV-2) conducts WET tests to monitor and evaluate the District's Water Reclamation Plant (WRP) effluents for toxicity to aquatic life.

WET is defined as the aggregate toxic effect of an effluent or receiving water as measured with a toxicity test. In WET testing, organisms are exposed to effluent samples for a specific time period. Test treatments consist of five different concentrations of effluent. The fathead minnow and daphnids (water fleas) are the organisms used in the WET tests (Figure IV-3). Two types of WET tests are conducted in the BL – acute and chronic. Acute tests typically last 48-96 hours, and the objective is to determine the concentration of the effluent that causes organisms to die during a short-term exposure under the controlled conditions. The chronic test lasts about 7 days. Chronic tests provide estimates of effluent concentration that interferes with the normal growth or reproductive potential of test organisms.

In 2009, the BL conducted one chronic WET test on Hanover Park WRP effluent for NPDES permit compliance. No acute or chronic toxicity was observed. The results are shown in Table IV-10.

Quality Assurance/Quality Control. All laboratory procedures are conducted in accordance with an approved QAP. SOPs are prepared for each test method and laboratory procedure. A control treatment (an exposure of the test organisms to dilution water with no effluent added) is used to measure the acceptability of the test by showing the quality of the organisms and the suitability of the dilution water, test conditions, and handling procedures. For each test type performed, ongoing laboratory performance is continually evaluated by performing reference toxicant tests (RTT) using sodium chloride (NaCl). All RTTs are performed using the laboratory's control water under test conditions identical to NPDES permit required tests. Laboratory staff maintains quality control charts using RTT data from the most recent twenty tests. The results of the RTTs are shown in Table IV-10.

The acute and chronic WET test methods and procedures are followed in accordance with the following EPA established protocols:

- Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, EPA/821-R-02-012, Fifth Edition, October 2002.

- Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms, EPA/821-R-02-013, Fourth Edition, October 2002.

The laboratory assesses and evaluates the results of all quality control procedures on an ongoing basis and will not release any test results without verification that test criteria have been met for all quality control procedures. On an annual basis, the laboratory participates in the Discharge Monitoring Report Quality Assurance (DMR-QA) Program established by EPA, to conduct toxicity tests on unknown samples and demonstrate that the results are within the acceptable ranges. The results of the DMR-QA tests are shown in Table IV-10.

Parasitology Laboratory Mission and Activities

The mission of the Parasitology Laboratory (PL) is to provide high quality *Ascaris* ova testing services for the District's biosolids treatment process operations and compliance with permit requirements and to conduct research to support emerging public health and regulatory issues. This group is composed of two professionals: a Supervising Environmental Microbiologist and a Senior Environmental Microbiologist; and two technical personnel. Personnel in this group participated in the following monitoring and research activities:

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

- Monitoring of Biosolids for Coliphages (somatic and F^+ specific). Research on the use of coliphages as indicators for enteric viruses in biosolids.

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

- Technical Support to the Wastewater Treatment Process Research Section. Microbiological evaluation to solve operation problems.

Part 503 Compliance Monitoring. The 40 CFR Part 503 regulations require that biosolids applied to land meet specific pollutant limits, site restrictions, management practices, and/or pathogen vector attraction reduction processes. Biosolids at the District are processed to meet either Class A (PFRP) or Class B standards. The PL analyzes biosolids for the detection, enumeration and the determination of viability of *Ascaris* ova. An internal audit of the PL was conducted on June 22, 2009, and it was found to be in full compliance with all USEPA requirements for analysis to determine compliance with the Part 503 Class A pathogen standards.

In 2009, the laboratory analyzed 16 biosolids samples for site-specific PFRP equivalency monitoring and for compliance with the Part 503 biosolids regulations (Table IV-11). EPA Region 5 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. Three 300g and thirteen 50g samples were analyzed in 2009. Viable *Ascaris* ova densities 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). The results for the 16 samples demonstrate that biosolids generated by the processing train during the 2009 period met the Class A criteria for helminth ova pathogen.

Microscopic Image Analysis. The PL uses a state-of-the-art microscopic image analysis (MIA) system as an aid to monitor and document 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 slide to computer workstation (Figure IV-4). The video imaging allows staff to record and document images of viable *Ascaris* ova (Figure IV-5). Digital images are stored and analyzed using the MetaMorph™ imaging software. For each digital image, the length and width of the ovum, the date and time the image is recorded and the sample identification number is recorded. In 2009, the PL purchased an additional Nikon Eclipse 80*i* digital imaging system which includes a research level microscope that is optimized for digital imaging.

Monitoring of Biosolids for Coliphages (F^+ Specific and Somatic). The PL is currently conducting research to evaluate the usefulness of coliphages as an alternative indicator for the presence of enteric viruses in biosolids. Coliphages are viruses that infect *E. coli* via receptors on the cell wall. There are two main groups of coliphages: F^+ specific phages (FP) and somatic phages (SP). The EPA coliphage method 1602: Male-specific (F^+) and Somatic Coliphage in Water by a Single Agar Layer (SAL) method was modified and adapted in the District to determine coliphage concentrations in Class A and B biosolids.

In 2009, the concentrations of FP were determined to be below the detectable limit (less than one plaque forming unit (PFU) per gram total solids [dry weight basis]) for all of 16 samples of biosolids produced by the District's codified process. In 12 of 16 samples, the concentrations of SP were determined to be below the detectable limit. Results of these analyses are shown in Table IV-12. Data collected to date suggest that FP is a good indicator for predicting the presence or absence of enteric viruses in biosolids.

Farm Land Application Project. In 2009, the PL monitored coliphages (FP and SP) in three samples of centrifuged biosolids cake collected 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. Additional information on this project is in the Biosolids Utilization and Soil Science Section chapter of this report.

Quality Assurance/Quality Control. The laboratory maintains a high standard for QA and QC. All laboratory procedures are conducted in accordance with an approved Quality Assurance Plan (QAP). Standard Operating Procedures (SOP) are prepared for each test method and laboratory procedure. Accuracy and precision tests are performed on every 10th sample. Replicates are examined for precision and replicate samples spiked with a known number of *Ascaris* ova are analyzed for accuracy. The analytical method used for enumerating viable *Ascaris* ova in biosolids are followed in accordance with the EPA established protocol (EPA/625/R-92/013, July 2003).

Microscopic Evaluation of Activated Sludge Samples. Personnel in the PL worked cooperatively with the Wastewater Treatment Process Research Section to provide technical assistance in solving operational problems experienced at the Egan WRP. An excess amount of exocellular lipopolysaccharide along with a significant amount of filament Type 0916 and Type 021N were identified as the dominant causes of bulking at the Egan WRP (Figure IV-6).

Performance Study on the Operation of the Digester Mixers at the Calumet Water Reclamation Plant. The PL provided analytical support to the performance evaluation of the Calumet WRP's two mechanical digesters. A total of 126 coliphage (F^+ and somatic) analyses were conducted from digester feed (21 samples) and draw from two digesters (21 samples from each digester draw) were analyzed. The coliphage results are presented in Table IV-9.

Virology Laboratory Mission and Activities

The mission of the Virology Laboratory (VL) is to provide high quality enteric virus testing services for the District's biosolids treatment process operations and compliance with permit requirements and to conduct research to support emerging public health and regulatory issues. This group is composed of one professional, a Supervising Environmental Microbiologist, and two technical personnel. Personnel in this group participated in the following monitoring and research activities:

- Part 503 Compliance Monitoring. Analysis of biosolids for culturable enteric viruses.

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

- Evaluation of the U.S. Environmental Protection Agency's Manual of Methods for Virology, EPA.

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

Part 503 Compliance Monitoring. The 40 CFR Part 503 regulations require that biosolids applied to land meet specific pollutant limits, site restrictions, management practices, and/or pathogen vector attraction reduction processes. Biosolids at the District are processed to meet either Class A (PFRP) or Class B standards. The VL analyzes biosolids for the detection, enumeration and the determination of enteric viruses. An internal audit of the VL was conducted on June 22, 2009, and it was found to be in full compliance with all USEPA requirements for analysis to determine compliance with the Part 503 Class A pathogen standards.

In 2009, the laboratory analyzed 16 biosolids samples for site-specific PFRP equivalency monitoring and for compliance with the Part 503 biosolids regulations (Table IV-13). 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). The results for the 16 samples demonstrate that biosolids generated by the processing train during the 2009 period met the Class A criteria for enteric virus pathogen.

Quality Assurance/Quality Control. The laboratory maintains a high standard for QA & QC. All laboratory procedures are conducted in accordance with an approved QAP and SOP for determining the density of enteric viruses in biosolids. 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. The test methods and procedures are followed in accordance with the EPA established protocol (EPA/625/R-92/013, July 2003). Positive recovery studies were performed on all samples for quality assurance purposes. The mean recovery of spiked viruses was 50.3 percent. Recoveries ranged from 26.7 to 88.8 percent and were dependent upon the sample spiked (Table IV-14).

Molecular Microbiology Laboratory Mission and Activities

The mission of the Molecular Microbiology Laboratory (MML) is to develop the capability for rapid identification of fecal indicator bacteria, and pathogen source tracking by employing state-of-the-art molecular microbiology (Polymerase Chain Reaction [PCR]) analytical tools to comply with the regulatory advancement and to address emerging public health issues facing the District. Specific activities identified for attaining the mission of this group are:

- Development of rapid quantitative PCR technology capability to meet the future demands for microbial source tracking, pathogen monitoring and genetic analysis.

- Recruit and train laboratory staff to develop the capability of rapid quantitative PCR monitoring for fecal indicator bacteria and pathogens.

- Conduct research to detect pathogens in the final effluent, environmental samples and biosolids using culture and molecular methods.

Establishment of Molecular Microbiology Laboratory. The District completed its plans to construct a molecular microbiology research laboratory at the Lue-Hing Research and Development Complex in 2005. The laboratory construction began in 2007 and it is anticipated that the laboratory construction will be completed in 2010.

TABLE IV-1: INDICATOR BACTERIA ANALYSES PERFORMED BY THE ANALYTICAL MICROBIOLOGY LABORATORY FOR VARIOUS DISTRICT PROGRAMS IN 2008 AND 2009

Program	Total Coliform		Fecal Coliform		*Escherichia coli*	
	2008	2009	2008	2009	2008	2009
Effluent Analysis	12	-	711	685	2	-
Land Reclamation	-[a]	-	151	111	-	-
Biosolids Indicator Organism Density	-	-	58	63	-	-
District Waterway Surveys	-	-	720	660	222	212
Industrial Waste Surveys	-	-	6	1	-	-
Research – Support[1]	37	-	248	851	84	608
Lake Michigan Monitoring[2]	54	47	48	-	57	47
Major Treatment Facility Monitoring	-	-	9	20	-	-
Illinois Waterway	-	-	-	-	-	-
TARP	-	-	638	572	-	-
Other[3,4]	134	77	-	39	103	51
Total	237	124	2,589	3,002	468	918

[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.
[4] Includes annual performance evaluation sample testing.

TABLE IV-2: ANALYTICAL MICROBIOLOGY LABORATORY SAMPLES AND ANALYSES IN 2008 AND 2009

		Analysis or Test Performed[1]						
Year	Samples	TC	FC	HPC	EC	IQC	ID-CONF	Total
2008	2,785	237	2,589	137	468	8,451	82	11,964
2009	3,166	124	3,002	26	918	11,104	72	15,246

[1] TC = Total Coliform; FC = Fecal Coliform; HPC = Heterotrophic Plate Count; EC = *Escherichia coli*; IQC = Internal Quality Control Testing (reported as the number of procedures performed); ID-CONF = Organism Identification using specific multiple biochemical metabolic characteristics.

TABLE IV-3: AVERAGE FECAL COLIFORM CONCENTRATION AND PERCENTAGE OF ANTIBIOTIC RESISTANT FECAL COLIFORM BACTERIA DETECTED IN STICKNEY WATER RECLAMATION PLANT, UPSTREAM AND DOWNSTREAM OF THE PLANT IN THE CHICAGO SANITARY AND SHIP CANAL

Stickney WRP Location	Number of Samples[1]	Fecal Coliform CFU per 100mL[2]	Percentage of Antibiotic Resistant Fecal Coliform (FC)[3]			
			AMP-R[4]	TET-R[5]	GEN-R[6]	AMP/TET/GEN-R[7]
Upstream						
Cicero Avenue CSSC	4	270	33.70	<15	<2.59	<2.59
Stickney WRP Effluent[8]	4	11,525	20.95	9.78	<0.09	<0.08
Downstream						
Harlem Avenue	4	6,400	18.44	10.12	<0.10	<0.11
Route 83 CSSC	4	7,582	29.74	20.57	<0.10	<0.09
Stephen Street	4	1,327	31.07	9.51	<0.53	<0.49
Lockport Powerhouse	4	717	23.34	13.94	<0.98	<0.98

[1]Quarterly grab samples collected December 2005 through October 2006.
[2]mFC Agar membrane filtration method SM9222 D 18th Edition, 1992.
[3]Percent of resistant FC = (average CFU per 100mL ARB detected/average FC CFU per 100mL) * 100.
[4]Ampicillin resistant FC = growth on 16 µg/mL ampicillin sodium salt in mFC Agar.
[5]Tetracycline resistant FC = growth on 8 µg/mL tetracycline in mFC Agar.
[6]Gentamycin resistant FC = growth on 8 µg/mL gentamycin sulfate salt in mFC Agar.
[7]Multiple antibiotic resistant FC = growth on ampicillin, tetracycline and gentamycin combined in mFC Agar.
[8]Secondary treated water reclamation plant final effluent.

TABLE IV-4: AVERAGE FECAL COLIFORM CONCENTRATION AND PERCENTAGE OF ANTIBIOTIC RESISTANT FECAL COLIFORM BACTERIA DETECTED IN NORTH SIDE WATER RECLAMATION PLANT, UPSTREAM AND DOWNSTREAM OF THE PLANT IN THE NORTH SHORE CHANNEL AND NORTH BRANCH CHICAGO RIVER

North Side WRP Location	Number of Samples[1]	Fecal Coliform CFU per 100mL[2]	Percentage of Antibiotic Resistant Fecal Coliform (FC)[3]			
			AMP-R[4]	TET-R[5]	GEN-R[6]	AMP/TET/GEN-R[7]
Upstream						
Oakton Street NSC	4	2,820	<21.43	20.83	<0.54	<0.27
North Side WRP Effluent[8]	4	8,100	22.13	12.87	<0.21	<0.12
Downstream						
Foster Avenue NSC	4	7,425	20.88	16.36	<0.10	<0.10
Wilson Avenue NBCR	4	6,675	27.12	19.85	0.09	<0.12
Diversey Parkway NBCR	4	4,825	19.53	13.73	<0.12	<0.15
Grand Avenue NBCR	4	1,527	18.17	11.29	<0.43	<0.46

[1]Quarterly grab samples collected December 2006 through October 2007.
[2]mFC Agar membrane filtration method SM9222 D 18th Edition, 1992.
[3]Percent of resistant FC = (average CFU per 100mL ARB detected/average FC CFU per 100mL) * 100.
[4]Ampicillin resistant FC = growth on 16 μg/mL ampicillin sodium salt in mFC Agar.
[5]Tetracycline resistant FC = growth on 8 μg/mL tetracycline in mFC Agar.
[6]Gentamycin resistant FC = growth on 8 μg/mL gentamycin sulfate salt in mFC Agar.
[7]Multiple antibiotic resistant FC = growth on ampicillin, tetracycline and gentamycin combined in mFC Agar.
[8]Secondary treated water reclamation plant final effluent.

TABLE IV-5: AVERAGE FECAL COLIFORM CONCENTRATION AND PERCENTAGE OF ANTIBIOTIC RESISTANT FECAL COLIFORM BACTERIA DETECTED IN CALUMET WATER RECLAMATION PLANT, UPSTREAM AND DOWNSTREAM OF THE PLANT IN THE LITTLE CALUMET RIVER AND CAL SAG CHANNEL

Calumet WRP Location	Number of Samples[1]	Fecal Coliform CFU per 100mL[2]	Percentage of Antibiotic Resistant Fecal Coliform (FC)[3]			
			AMP-R[4]	TET-R[5]	GEN-R[6]	AMP/TET/GEN-R[7]
Upstream						
Indiana Avenue Little Cal.	4	428	25.13	<8.12	<1.64	<1.64
Calumet WRP Effluent[8]	5	9,260	31.47	10.15	<0.11	<0.11
Downstream						
Halsted Avenue Little Cal.	4	4,075	17.55	9.20	<0.15	<0.17
Ashland Avenue CSC	4	3,423	29.51	7.96	<0.19	<0.19
Cicero Avenue CSC	4	1,438	26.78	8.16	<0.49	<0.49
Route 83 CSC	4	545	21.89	<12.12	<1.28	<1.19

[1]Quarterly grab samples collected November 2007 through October 2008.
[2]mFC Agar membrane filtration method SM9222 D 18th Edition, 1992.
[3]Percent of resistant FC = (average CFU per 100mL ARB detected/average FC CFU per 100mL) * 100.
[4]Ampicillin resistant FC = growth on 16 µg/mL ampicillin sodium salt in mFC Agar.
[5]Tetracycline resistant FC = growth on 8 µg/mL tetracycline in mFC Agar.
[6]Gentamycin resistant FC = growth on 8 µg/mL gentamycin sulfate salt in mFC Agar.
[7]Multiple antibiotic resistant FC = growth on ampicillin, tetracycline and gentamycin combined in mFC Agar.
[8]Secondary treated water reclamation plant final effluent.

TABLE IV-6: IDENTITIES OF FC_{AMP-R}, FC_{TET-R} , FC_{GEN-R}, AND $FC_{AMP/TET/GEN-R}$ ISOLATED FROM STICKNEY WATER RECLAMATION PLANT FINAL EFFLUENT AND CHICAGO SANITARY AND SHIP CANAL LOCATIONS

Source	FC_{AMP-R}	FC_{TET-R}	FC_{GEN-R}	$FC_{AMP/TET/GEN-R}$
Upstream				
Cicero Avenue CSSC	*E. coli*[1] (6)[2] *K. pneumoniae*[3] (4)	*E. coli* (9) *K. pneumoniae* (1)		
Stickney WRP Efluent	*E. coli* (6) *K. pneumoniae* (4)	*E. coli* (8) *K. pneumoniae* (1) *K. oxytoca*[5] (1)		*K. pneumoniae* (1)[4]
Downstream				
Harlem Avenue	*E. coli* (5) *K. pneumoniae* (5)	*E. coli* (10)	*E. coli* (1)[6]	
Route 83 CSSC	*E. coli* (7) *K. pneumoniae* (3)	*E. coli* (9) *K. pneumoniae* (1)	*E. coli* (3)[6]	*E. coli* (1)[4]
Stephen Street	*E. coli* (8) *K. pneumoniae* (2)	*E. coli (9)* *K. pneumoniae* (1)		*E. coli* (1)[4]
Lockport Powerhouse	*E. coli* (4) *K. pneumoniae* (5) *K. oxytoca* (1)	*E. coli* (9) *K. pneumoniae* (1)		

[1]*Escherichia coli.*
[2]Number of isolates identified.
[3]*Klebsiella pneumoniae.*
[4]One colony of $FC_{AMP/TET/GEN-R}$ was detected/counted from Stickney WRP final effluent, CSSC (Route 83) and CSSC (Stephen St.).
[5]*Klebsiella oxytoca.*
[6]One colony of FC_{GEN-R} was detected/counted from CSSC (Harlem Ave) and three colonies from CSSC (Route 83).

TABLE IV-7: IDENTITIES OF FC_{AMP-R}, FC_{TET-R} , FC_{GEN-R}, AND $FC_{AMP/TET/GEN-R}$ ISOLATED FROM NORTH SIDE WATER RECLAMATION PLANT FINAL EFFLUENT, NORTH SHORE CHANNEL AND NORTH BRANCH CHICAGO RIVER LOCATIONS

Source	FC_{AMP-R}	FC_{TET-R}	FC_{GEN-R}	$FC_{AMP/TET/GEN-R}$
Upstream				
Oakton Street NSC	*E. coli*[1] (1)[2] *K. pneumoniae*[3](3)	*E. coli* (4)	*E. coli* (3)	*E. coli* (3)[4]
North Side WRP Efluent	*E. coli* (4) *K. pneumoniae* (1)	*E. coli* (5)	*E. coli* (4)	
Downstream				
Foster Avenue NSC	*E. coli* (3) *K. pneumoniae* (2)	*E. coli* (4) *K. pneumoniae* (1)	*E. coli* (2)	*E. coli* (2)[4]
Wilson Avenue NBCR	*E. coli* (4) *K. pneumoniae* (1)	*E. coli* (5)	*E. coli* (3)	*E. coli* (1)[4]
Diversey Parkway NBCR	*E. coli* (2) *K. pneumoniae* (2)	*E. coli* (3) *K. pneumoniae* (1)	*E. coli* (1)	
Grand Avenue NBCR	*E. coli* (3) *K. pneumoniae* (2)	*E. coli* (5)	*E. coli* (1)	

[1]*Escherichia coli.*
[2]Number of isolates identified.
[3]*Klebsiella pneumoniae.*
[4]$FC_{AMP/TET/GEN-R}$ isolates were detected/counted from Oakton Street (NSC) upstream of North Side WRP final effluent, NSC (Foster Avenue) and NBCR (Wilson Avenue).
[5]*Klebsiella oxytoca.*

TABLE IV-8: IDENTITIES OF FC_{AMP-R}, FC_{TET-R} , FC_{GEN-R}, AND $FC_{AMP/TET/GEN-R}$ ISOLATED FROM CALUMET WATER RECLAMATION PLANT FINAL EFFLUENT, LITTLE CALUMET RIVER AND CAL-SAG CHANNEL LOCATIONS

Source	FC_{AMP-R}	FC_{TET-R}	FC_{GEN-R}	$FC_{AMP/TET/GEN-R}$
Upstream				
Indiana Avenue Little Cal.	*E. coli*[1] (5)[2] *K. pneumoniae*[3] (4) *K. oxytoca*[4] (1)	*E. coli* (9) *K. pneumoniae* (1)		
Calumet WRP Efluent	*E. coli* (7) *K. pneumoniae* (6)	*E. coli* (11) *K. pneumoniae* (1) *K. oxytoca* (1)		
Downstream				
Halsted Avenue Little Cal.	*E. coli* (10) *K. pneumoniae* (3)	*E. coli* (12) *K. pneumoniae* (1)	*E. coli* (2)	
Ashland Avenue CSC	*E. coli* (7) *K. pneumoniae* (2) *K. oxytoca* (1)	*E. coli* (8) *K. pneumoniae* (2)	*E. coli* (1)	*E. coli* (1)[5]
Cicero Avenue CSC	*E. coli* (8) *K. pneumoniae* (2)	*E. coli* (9) *K. oxytoca* (1)		
Route 83 CSC	*E. coli* (7) *K. pneumoniae* (2) *K. oxytoca* (1)	*E. coli* (8) *K. pneumoniae* (1) *K. oxytoca* (1)		*E. coli* (1)[5]

[1]*Escherichia coli.*
[2]Number of isolates identified.
[3]*Klebsiella pneumoniae.*
[4]*Klebsiella oxytoca.*
[5]One colony of $FC_{AMP/TET/GEN-R}$ was detected/counted from CSC (Ashland Avenue) and CSC (Route 83)

TABLE IV-9: CALUMET DIGESTER MIXING STUDY – FECAL COLIFORM AND COLIPHAGE RESULTS

	Fecal Coliform MPN/g			Somatic Coliphage MPN/g			F^{+} Coliphage MPN/g		
Date	Feed	#5 Draw	#6 Draw	Feed	#5 Draw	#6 Draw	Feed	#5 Draw	#6 Draw
05/19/2009	2.1x10^{6}	2.6x10^{4}	3.9x10^{4}	5.1x10^{5}	1.7x10^{4}	1.9x10^{4}	6.8x10^{5}	6.6x10^{1}	5.5x10^{1}
05/26/2009	1.3x10^{7}	2.2x10^{5}	1.4x10^{5}	6.0x10^{5}	3.6x10^{4}	3.6x10^{4}	1.4x10^{5}	6.3x10^{1}	3.8x10^{2}
06/02/2009	5.0x10^{6}	8.7x10^{4}	8.5x10^{4}	3.0x10^{6}	5.5x10^{4}	1.1x10^{5}	7.6x10^{4}	1.3x10^{2}	3.1x10^{2}
06/09/2009	6.2x10^{6}	9.1x10^{4}	8.4x10^{5}	2.4x10^{6}	1.4x10^{5}	1.6x10^{5}	2.3x10^{5}	2.1x10^{3}	3.0x10^{2}
06/16/2009	1.1x10^{7}	2.0x10^{5}	8.3x10^{4}	3.1x10^{6}	1.4x10^{5}	1.0x10^{5}	1.4x10^{5}	2.5x10^{3}	1.6x10^{3}
06/23/2009	9.8x10^{6}	8.2x10^{4}	1.3x10^{5}	9.8x10^{6}	3.8x10^{4}	4.7x10^{4}	6.0x10^{4}	3.8x10^{2}	1.2x10^{3}
06/30/2009	2.2x10^{7}	1.3x10^{5}	1.3x10^{5}	NT[1]	NT[1]	NT[1]	NT[1]	NT[1]	NT[1]
07/07/2009	4.3x10^{6}	6.1x10^{4}	8.2x10^{4}	2.3x10^{6}	1.4x10^{5}	6.4x10^{5}	6.6x10^{4}	4.6x10^{2}	3.7x10^{2}
07/14/2009	1.6x10^{7}	4.9x10^{4}	6.9x10^{4}	1.6x10^{6}	5.1x10^{4}	3.9x10^{4}	1.2x10^{6}	5.5x10^{3}	1.9x10^{3}
07/21/2009	1.7x10^{7}	1.5x10^{5}	4.2x10^{5}	3.3x10^{6}	1.7x10^{5}	1.5x10^{5}	3.4x10^{4}	6.6x10^{2}	5.2x10^{2}
07/28/2009	9.0x10^{6}	5.2x10^{4}	7.1x10^{4}	1.1x10^{7}	9.0x10^{5}	1.6x10^{5}	8.7x10^{4}	2.1x10^{2}	4.3x10^{2}
08/04/2009	1.7x10^{7}	1.7x10^{5}	1.0x10^{5}	7.4x10^{6}	1.3x10^{6}	2.5x10^{5}	5.8x10^{5}	1.0x10^{3}	4.3x10^{3}
08/11/2009	2.4x10^{7}	4.6x10^{4}	8.9x10^{4}	NT[1]	NT[1]	NT[1]	NT[1]	NT[1]	NT[1]
08/18/2009	1.9x10^{7}	1.8x10^{5}	1.2x10^{5}	NT[1]	NT[1]	NT[1]	NT[1]	NT[1]	NT[1]
08/25/2009	2.0x10^{7}	5.0x10^{5}	1.9x10^{5}	NT[1]	NT[1]	NT[1]	NT[1]	NT[1]	NT[1]
09/01/2009	2.0x10^{7}	2.7x10^{5}	4.2x10^{5}	5.6x10^{6}	1.5x10^{5}	5.3x10^{4}	1.1x10^{5}	1.2x10^{3}	1.0x10^{3}
09/08/2009	1.7x10^{7}	8.4x10^{4}	1.2x10^{5}	4.7x10^{6}	2.2x10^{5}	8.2x10^{4}	3.0x10^{5}	1.9x10^{3}	3.0x10^{3}
09/15/2009	2.9x10^{7}	2.8x10^{5}	1.3x10^{5}	NT[1]	NT[1]	NT[1]	NT[1]	NT[1]	NT[1]
09/22/2009	1.2x10^{7}	2.1x10^{5}	3.5x10^{5}	7.9x10^{5}	7.3x10^{4}	3.4x10^{5}	7.9x10^{3}	1.9x10^{2}	3.0x10^{2}
09/29/2009	7.5x10^{7}	7.9x10^{5}	1.1x10^{6}	9.2x10^{7}	4.5x10^{5}	2.4x10^{5}	3.1x10^{4}	1.4x10^{4}	9.6x10^{2}
10/06/2009	1.4x10^{7}	2.3x10^{5}	1.1x10^{5}	1.0x10^{7}	3.1x10^{5}	2.4x10^{5}	5.4x10^{5}	1.7x10^{3}	2.7x10^{3}
10/13/2009	8.6x10^{7}	1.0x10^{5}	6.3x10^{4}	4.2x10^{7}	9.0x10^{6}	2.8x10^{5}	4.2x10^{5}	4.2x10^{3}	8.0x10^{2}
10/20/2009	NT[1]	NT[2]	NT[2]	2.5x10^{7}	2.0x10^{5}	3.6x10^{5}	7.3x10^{5}	3.3x10^{3}	6.2x10^{3}
10/27/2009	1.5x10^{7}	3.4x10^{5}	1.4x10^{7}	1.3x10^{6}	1.0x10^{5}	2.4x10^{5}	3.4x10^{4}	1.8x10^{3}	8.6x10^{2}
11/03/2009	1.1x10^{7}	1.3x10^{5}	1.4x10^{5}	2.4x10^{6}	2.3x10^{5}	9.6x10^{4}	1.5x10^{5}	2.3x10^{3}	6.3x10^{2}
11/17/2009	1.5x10^{7}	9.1x10^{4}	5.5x10^{4}	3.5x10^{6}	2.2x10^{5}	1.6x10^{5}	6.0x10^{3}	7.5x10^{1}	1.9x10^{2}

[1]NT - No Test.

[2] No test - electric shutdown.

TABLE IV-10: SUMMARY OF WHOLE EFFLUENT TOXICITY TESTS AND REFERENCE TOXICANT TESTS PERFORMED IN 2009

Test Description	Date	WET Test[1]	Result[2,3]
Reference Toxicant[4]	January 12-16	Acute *P. promelas*	VT
Reference Toxicant	January 13-15	Acute *C. dubia*	VT
Reference Toxicant	February 2-6	Acute *P. promelas*	VT
Reference Toxicant	February 3-5	Acute *C. dubia*	VT
Reference Toxicant	March 2-6	Acute *P. promelas*	VT
Reference Toxicant	March 3-5	Acute *C. dubia*	VT
Reference Toxicant	March 9-16	Chronic *C. dubia*	VT
Reference Toxicant	April 6-10	Acute *P. promelas*	VT
Reference Toxicant	April 7-9	Acute *C. dubia*	VT
Reference Toxicant	May 5-7	Acute *C. dubia*	VT
DMR-QA	June 2-9	Chronic *P. promelas*	VT
DMR-QA	June 3-10	Chronic *C. dubia*	VT
DMR-QA	June 15-17	Acute *P. promelas*	VT
DMR-QA	June 16-17	Acute *C. dubia*	VT
Reference Toxicant	June 22-26	Acute *P. promelas*	VT
Reference Toxicant	June 23-25	Acute *C. dubia*	VT
Hanover Park WRP	June 22-29	Chronic *P. promelas* Chronic *C. dubia*	NTE NTE

[1] WET Tests: Chronic *Pimephales promelas* (survival, growth) and Chronic *Ceriodaphnia dubia* (survival, reproduction), EPA 821/R-02013, (Fourth Edition) 2002; Acute *Pimephales promelas* (survival) and Acute *Ceriodaphnia dubia* (survival), EPA 821/R-02/012, (Fifth Edition) 2002.
[2] Result: NTE = No Toxic Effect.
[3] VT= Valid Test
[4] Ongoing laboratory performance is continually evaluated using reference toxicant tests (QAP Section 6.9).

TABLE IV-11: PARASITOLOGICAL ANALYSIS OF BIOSOLIDS GENERATED BY THE DISTRICT'S WATER RECLAMATION PLANT SOLIDS PROCESSING TRAINS IN COMPLIANCE WITH PART 503 PROCESS TO FURTHER REDUCE PATHOGENS – EQUIVALENT REQUIREMENTS JANUARY THROUGH DECEMBER 2009 MONITORING PERIOD

Date Sampled	Location	Viable Helminth Ova - No./4g -
3/24/09	Calumet West	<0.0800[1]
3/24/09	Calumet East	<0.0800
3/24/09	Calumet East	<0.0800
3/24/09	Calumet East[2]	<0.0133
4/07/09	Calumet West	<0.0800
4/21/09	Calumet West	<0.0800
5/12/09	Calumet West	<0.0800
6/2/09	HASMA[3]	<0.0800
6/11/09	LASMA[4]	<0.0800
6/18/09	Calumet East[2]	<0.0133
6/18/09	Calumet East	<0.0800
6/30/09	Vulcan	<0.0800
11/18/09	LASMA	<0.0800
12/1/09	Calumet East[2]	<0.0133
12/1/09	Calumet West	<0.0800
12/1/09	Calumet East	<0.0800

[1]Failure to detect viable helminth ova in samples is recorded as less than (<) the limit of test sensitivity.
[2]For helminth ova analysis, sample weight = 300g. For other samples, sample weight = 50g.
[3]Harlem Avenue Solids Management Area.
[4]Lawndale Avenue Solids Management Area.

TABLE IV-12: COLIPHAGE (SOMATIC AND F^+ SPECIFIC) ANALYSIS OF BIOSOLIDS IN 2009[1]

WRP/Sample Location	Total Solids (TS)[2]	Coliphage MPN/Gram Dry Wt [3,4]	
		Somatic	Male Specific (F^+)
Calumet East and West	54.41 – 94.19	<0.1062 – 3	<0.1062 - <0.1838
Stickney			
HASMA[5]	17.87	3,300	<0.5596
LASMA[6]	16.81 – 37.17	<0.2690 – 1,400	<0.2690 - <0.5949
Vulcan	26.05	380	<0.3839

[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 Solids Management Area.
[6]Lawndale Avenue Solids Management Area.

TABLE IV-13: VIROLOGICAL ANALYSIS OF BIOSOLIDS GENERATED BY THE DISTRICT'S WATER RECLAMATION PLANT SOLIDS PROCESSING TRAINS IN COMPLIANCE WITH PART 503 PROCESS TO FURTHER REDUCE PATHOGENS – EQUIVALENT REQUIREMENTS JANUARY THROUGH DECEMBER 2009 MONITORING PERIOD

Date Sampled	Location	Enteric Virus[1,2] - PFU/4g -
3/24/09	Calumet West	<0.8000[3]
3/24/09	Calumet East	<0.8000
3/24/09	Calumet East	<0.8000
3/24/09	Calumet East	<0.8000
4/07/09	Calumet West	<0.7936
4/21/09	Calumet West	<0.8000
5/12/09	Calumet West	<0.8000
6/2/09	HASMA[4]	<0.8000
6/11/09	LASMA[5]	<0.8000
6/18/09	Calumet East	<0.8000
6/18/09	Calumet East	<0.8000
6/30/09	Vulcan	<0.8000
11/18/09	LASMA	<0.8000
12/1/09	Calumet East	<0.8000
12/1/09	Calumet West	<0.8000
12/1/09	Calumet East	<0.8000

[1]Results of enteric virus analyses performed for site specific PFRP equivalency monitoring.
[2]Total culturable enteric viruses are less than 1 plaque-forming units (PFU) per 4 grams total dry solids.
[3]Failure to detect viruses in solids eluates are recorded as less than (<) the unit of test sensitivity.
[4]Harlem Avenue Solids Management Area.
[5]Lawndale Avenue Solids Management Area.

TABLE IV-14: SUMMARY OF VIROLOGICAL ANALYSIS OF CLASS A BIOSOLIDS IN COMPLIANCE WITH PART 503 PROCESS TO FURTHER REDUCE PATHOGENS – EQUIVALENTS JANUARY THROUGH DECEMBER 2009 MONITORING PERIOD[1]

WRP Sample Location	Total Number of Samples Collected	Total Number of Samples Meeting Class A Pathogen Requirement[2]	PFU/4 g dry wt Range [3,4]	Quality Control Results Percent Recovery of Seeded Viruses[5] Range
Calumet	12	12	<0.7936 - <0.8000	26.7 – 88.8
LASMA[6]	2	2	<0.8000	52.5 – 62.6
Vulcan	1	1	<0.8000	87.8
HASMA[7]	1	1	<0.8000	31.7

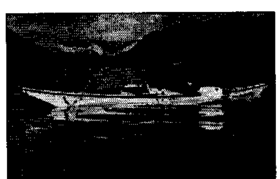
[1]Results of analyses performed in the District's Virology Laboratory for site-specific PFRP equivalency monitoring.
[2]Total Culturable Enteric Viruses are less than 1 plaque forming units (PFU) per 4 grams total dry solids.
[3]Confirmed PFU/4 grams total dry solids.
[4]Failure to detect viruses in 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 4 g (dry wt) aliquot of sample. A positive recovery control was performed for each sample analyzed.
[6]Lawndale Avenue Solids Management Area.
[7]Harlem Avenue Solids Management Area.

FIGURE IV-1: CHICAGO HEALTH, ENVIRONMENTAL EXPOSURE, AND RECREATION STUDY

CHEERS

WATER CHICAGO SPORTS

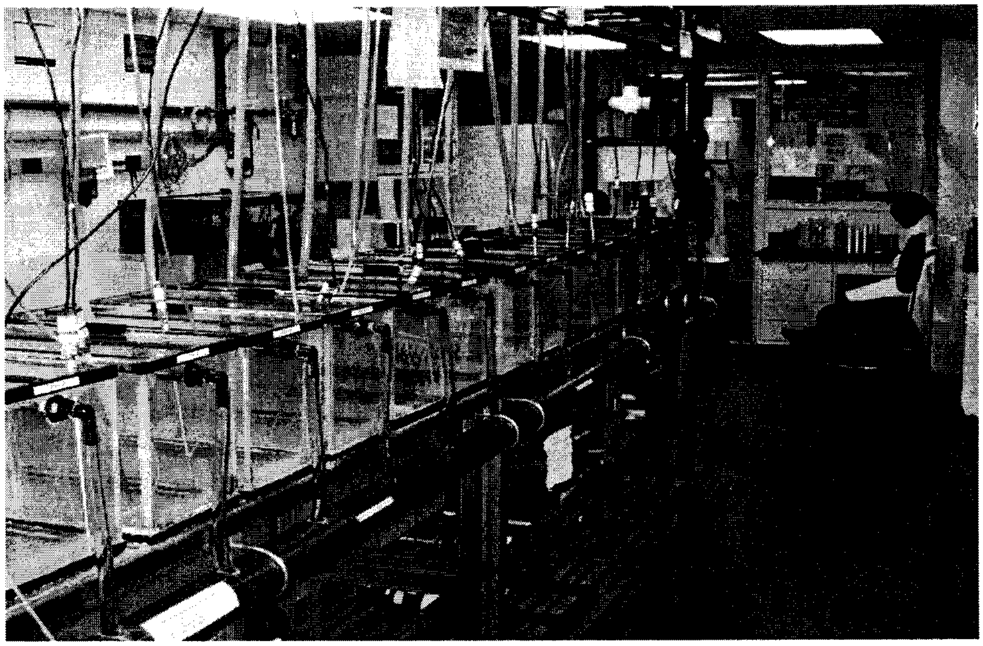
Unexposed recreators



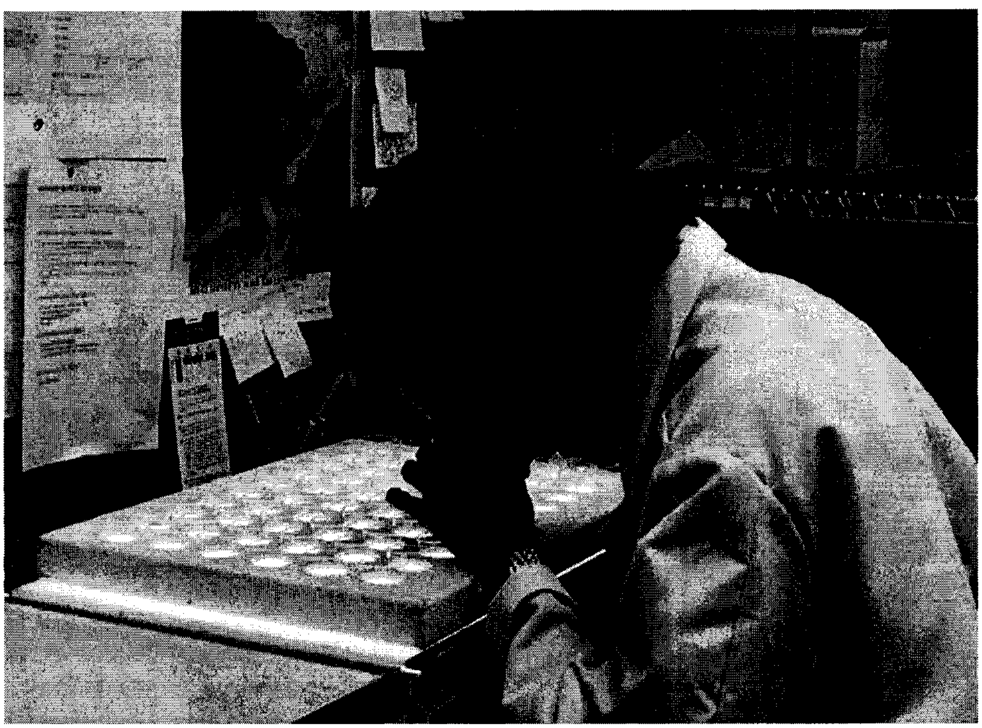
General use recreators

CAWS recreators

FIGURE IV-2: BIOMONITORING LABORATORY

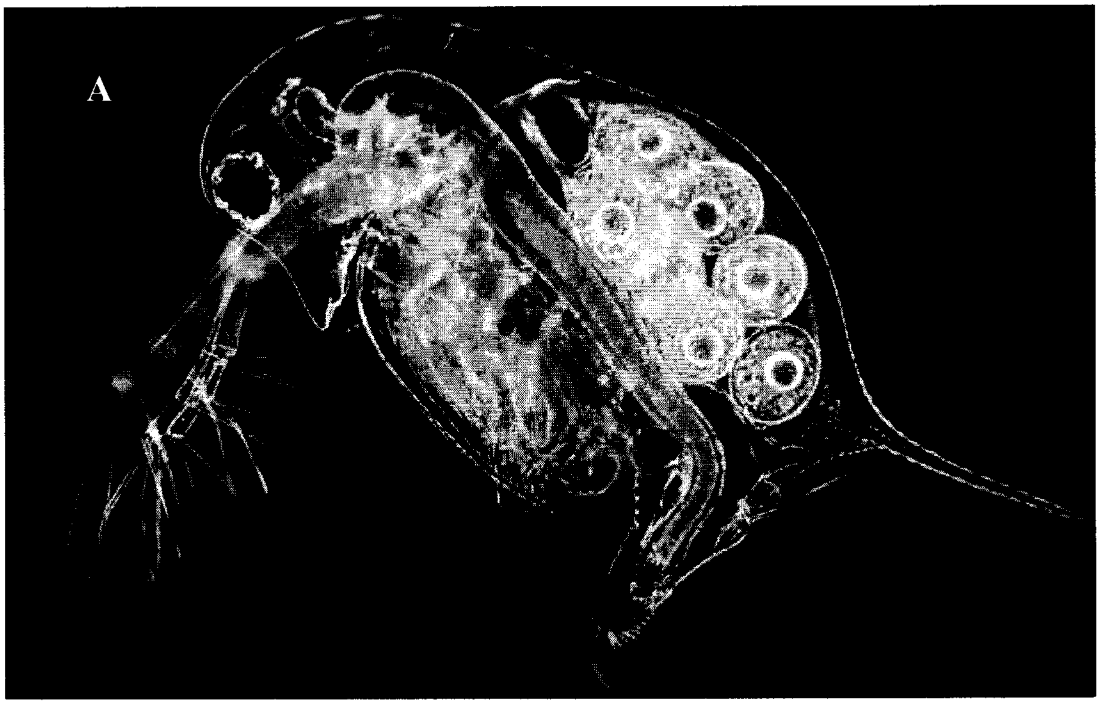


A. Biomonitoring Lab fish spawning tanks

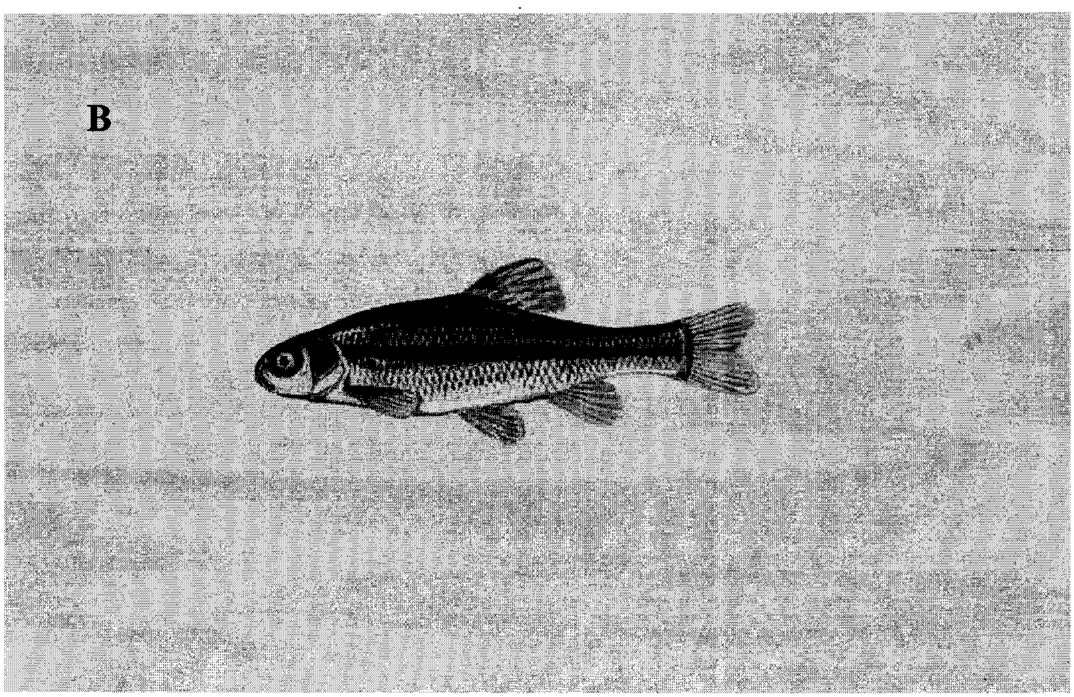


B. Staff viewing *C. dubia* culture trays for neonate production

FIGURE IV-3: WHOLE EFFLUENT TOXICITY TEST ORGANISMS

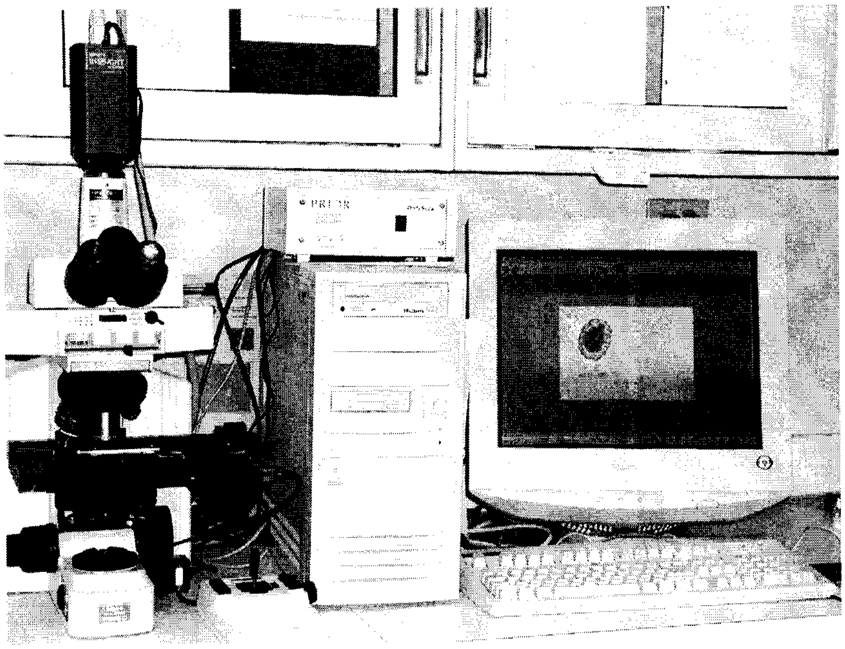


A. *Ceriodaphnia dubia* (Water Flea)

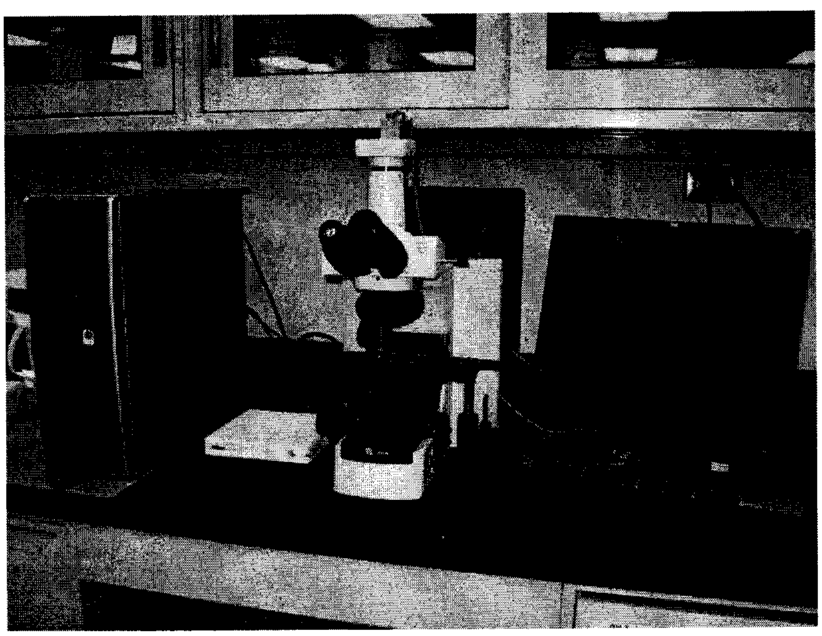


B. *Pimephales promelas* (Fathead Minnow)

FIGURE IV-4: MICROSCOPIC IMAGE ANALYSIS SYSTEM



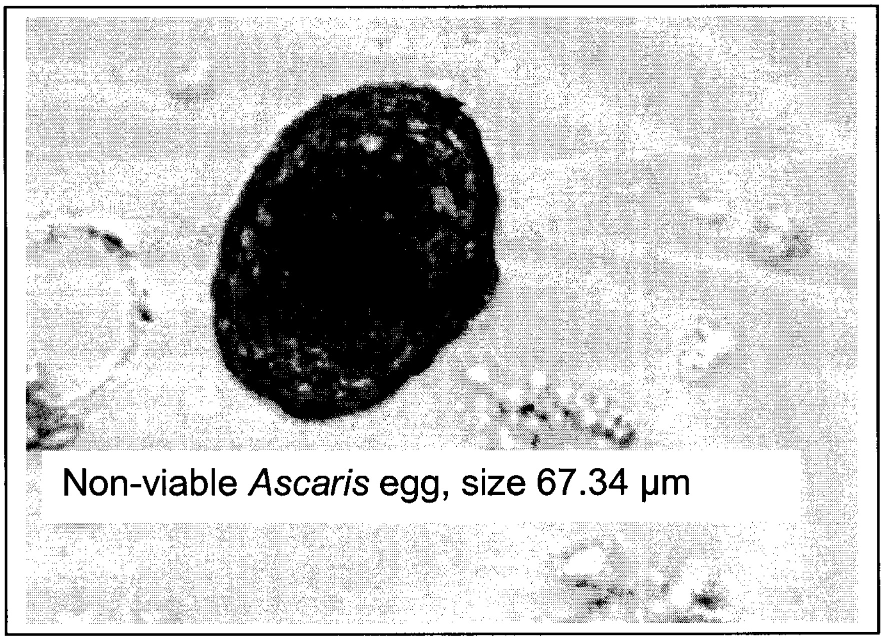
A. Nikon E600 Research Phase Contrast Microscope with a Digital Snap Video Camera Transmitting Microscopic Images from Slide to a Computer Workstation with a Metamorph Software Program.



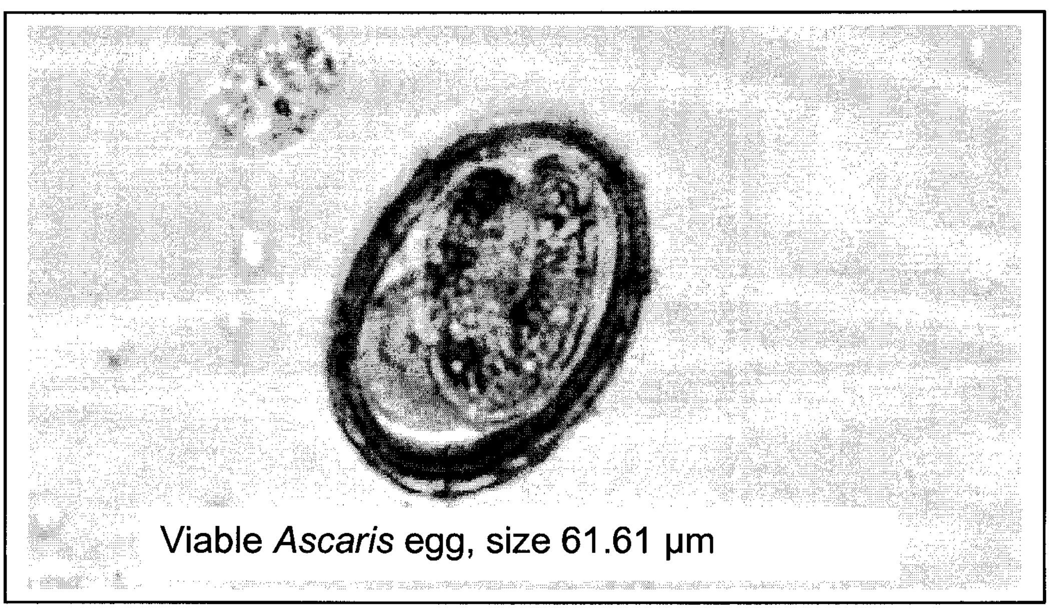
B. Nikon Eclipse 80*i* digital imaging system which includes a research-microscope that is optimized for digital imaging.

FIGURE IV-5: DIGITAL IMAGES OF *ASCARIS LUMBRICOIDES*

A

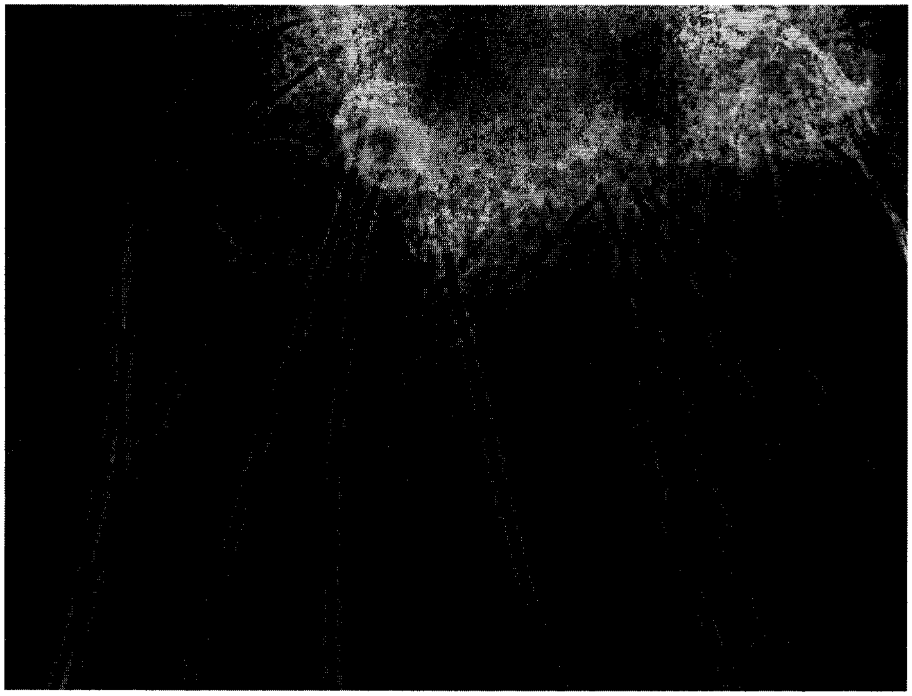


B

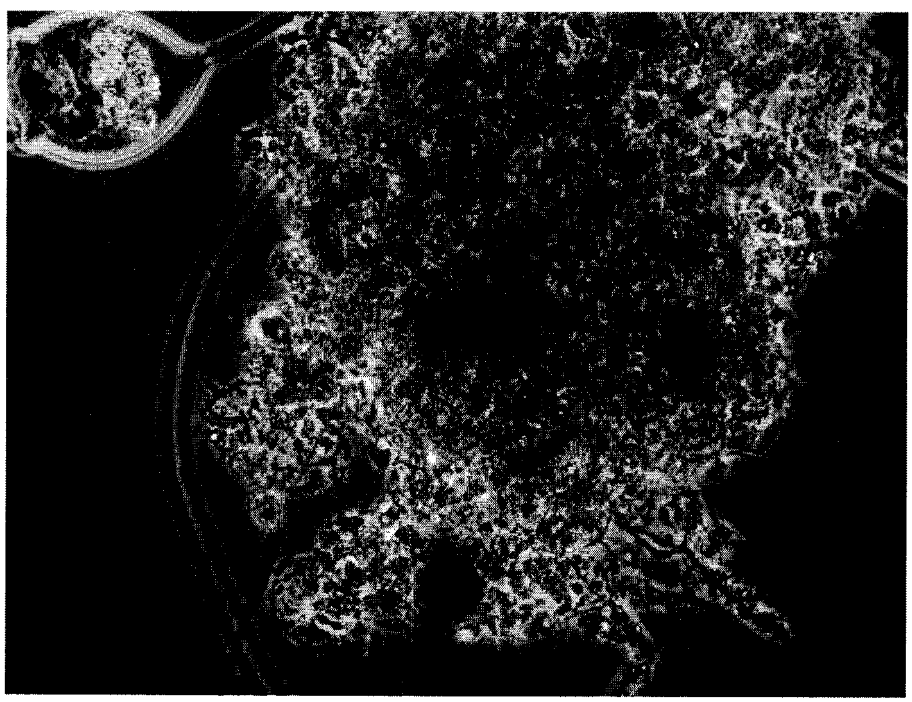


A. Non viable ovum; 67.34 µm long
B. Viable, fertile ovum; 61.61 µm long.

FIGURE IV-6: EGAN WRP NORTH AERATION BATTERY



A. Phase contrast 40X – Excess lipopolysaccharide along with Type 0961 filament identified as the cause of bulking.



B. Phase Contrast 40X – Healthy floc with few filament Type 0961.

AQUATIC ECOLOGY AND WATER QUALITY SECTION

AQUATIC ECOLOGY AND WATER QUALITY SECTION

Section Mission and Goals

The mission of the section is to provide scientific and technical support to assess the waterways impacted by District wastewater treatment operations. The goals of the Aquatic Ecology and Water Quality Section are to:

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

2. Conduct fish and benthic invertebrate monitoring in order to evaluate the biological health of waterways and assess changes in waterway condition over time especially as it may be associated with District operations.

3. Perform laboratory analysis of chlorophyll in accordance with the Standard Operating Procedure.

4. Design and conduct research projects to address potential changes in District operations, such as effluent disinfection and phosphorus removal.

5. Design and conduct research projects to explore emerging issues in water quality and treatment as they arise, such as endocrine disrupting compounds.

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

7. Cooperate with other governmental and non-governmental agencies and academic institutions to develop water quality and aquatic ecology research projects.

8. Promote public awareness and acceptance of District operations by communicating monitoring and research results through our website, public meetings and presentations, and assisting Public Affairs Section in preparing accurate fact sheets and press releases.

9. Complete all research and monitoring projects using accepted ethical and scientific methods to protect the integrity of the District.

Ambient Water Quality Monitoring Program

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) and Chicago Area General Use waterways. 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 in the Chicago area waterways (Figure V-1). Fifteen of the 59 sampling stations are assessed annually, with the remaining 44 stations assessed once every four years.

Fish Monitoring

During June through September of 2009, fish were collected by electrofishing and seining at 27 biological monitoring stations on the CAWS. In 2009, 3,315 fish, comprised of 42 species and two 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 pumpkinseed sunfish, bluntnose minnow, carp, bluegill, gizzard shad, and spotfin shiner. In the wadeable waterways, green sunfish, largemouth bass, white sucker, fathead minnow, blackstripe topminnow, and bluegill were the most abundant.

Benthic Invertebrate Monitoring

Benthic invertebrates were collected from side and center locations using a petite ponar grab and Hester Dendy larval plate samplers at 27 AWQM stations during 2009. Invertebrates other than worms were sent to a consultant to be identified and examined for head capsule deformities. A comprehensive report of the benthic invertebrate sampling results will be available at www.mwrd.org early in 2010.

Chlorophyll Monitoring

As a photosynthetic component of all algae cells, chlorophyll *a* is a surrogate for 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 2009 are shown in Table V-3. The highest mean values of chlorophyll *a* were 34 µg/L at Oakton Street on the Des Plaines River, 31µg/L at Burnham Avenue on the Grand Calumet River, and 30 µg/L at Stephen Street on the Des Plaines River.

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 2009, 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. 10-50 entitled, "Water and Sediment Quality Along the Illinois Waterway from the Lockport Lock to the Peoria Lock During 2009."

Continuous Dissolved Oxygen Monitoring

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 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. In the Calumet River System, the monitors were located at eight stations on the Calumet River, Grand Calumet River, Little Calumet River, and the Calumet-Sag Channel. Nine stations were located in the Des Plaines River System on the Des Plaines River and Salt Creek.

The DO results for 2009 can be found in the reports entitled, "Continuous Dissolved Oxygen Monitoring in the Deep-Draft Chicago Waterway System During 2009" (M&R Report No. 10-39) and "Continuous Dissolved Oxygen Monitoring in Chicago Area Wadeable Streams During 2009" (M&R Report No. 10-40).

Chicago Area Waterway System Habitat Evaluation and Improvement Study

In order to assess the relative importance of water quality and physical habitat to aquatic communities in the CAWS, the District conducted the Habitat Evaluation and Improvement Study during 2008 and 2009. The major goal of this study was to inform testimony at the Illinois Pollution Control Board hearings regarding the CAWS Use Attainability Analysis. Another goal was to create a habitat index that was specifically appropriate for the CAWS, which is comprised of manmade or irreparably altered waterways. The Habitat Evaluation portion of the study aimed to determine what physical habitat improvements may be feasible in the CAWS, how they would be expected to affect the fish community, and the potential cost of these improvements.

The major conclusions of the CAWS Habitat Evaluation Report were as follows:

1. Aquatic habitat is inherently limited in the CAWS since they were manmade and altered to support stormwater and water reclamation plant effluent conveyance and commercial navigation.

2. Physical habitat was relatively more important to fish communities than water quality. Dominant habitat variables explained about half of the variability in fish data during 2001-2008.

3. Dissolved oxygen concentrations were a relatively poor indicator of fish communities in the CAWS.

4. The six key habitat variables that were identified by multiple linear regression to explain fish data and to be used in the CAWS physical habitat index include: Maximum depth of channel (positive correlation), off-channel bays (positive correlation), percent of vertical wall banks in reach (negative correlation), percent of riprap banks in reach (negative correlation), manmade structures in reach (negative correlation), and percent macrophyte cover (positive correlation) in reach.

The major conclusions of the CAWS Habitat Improvement Report were as follows:

1. Not all of the primary habitat variables can be improved in the CAWS

2. Potential habitat improvements outlined in the report would not be expected to significantly increase the relative habitat index scores of CAWS reaches.

3. Implementing the described habitat improvements in the CAWS would cost an estimated $460 million, *not including* land acquisition, demolition of existing structures, or relocation of utilities and infrastructure.

The final LimnoTech habitat reports can be accessed on the District website under the heading, *CAWS Habitat Evaluation and Improvement Study* at:

http://www.mwrd.org/irj/portal/anonymous?NavigationTarget=navurl://2fae5b019
43893ee9aa519d1a3363d5c

Investigation of Endocrine Disruption in the Chicago Area Waterway System

A three-year study began in March 2009 in collaboration with St. Cloud State University to conduct a comprehensive assessment of the potential for endocrine active compounds (EACs) to impact the reproductive potential of fish populations in the CAWS and Chicago Area General Use Waterways. The objectives of this study are to determine: (1) the spatial and temporal occurrence of EACs; (2) the occurrence of endocrine disruption in wild fish populations; and (3) the likely sources contributing to any occurrence of endocrine disruption.

Waterway samples were collected monthly from 38 AWQM stations and final effluent samples were obtained from all seven District treatment plants. Water samples are being analyzed for total estrogenicity and a subset of common estrogenic compounds. Caged fish were deployed at select locations within the CAWS and Chicago Area General Use Waterways for at least two weeks during two periods in 2009 (May/June and September/October). Wild fish were also collected in June using various collection gear. Wild and caged fish are examined for endocrine disruption using histopathology and plasma vitellogenin analysis. Results will be published at the conclusion of this study in 2012.

TABLE V-1: FISH COLLECTED FROM DEEP-DRAFT WATERWAYS DURING 2009

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			
35	Central Street	207	57.8	16	7	Pumpkinseed
102	Oakton Street	356	12.1	20	9	Pumpkinseed
36	Touhy Avenue	84	113.8	11	4	Carp
101	Foster Avenue	226	28.4	13	5	Bluegill
			NORTH BRANCH CHICAGO RIVER			
37	Wilson Avenue	264	48.6	17	8	Golden shiner and Spotfin shiner
73	Diversey Parkway	189	66.9	15	5	Spotfin shiner
46	Grand Avenue	118	20.2	9	3	Gizzard shad
			CHICAGO SANITARY AND SHIP CANAL			
75	Cicero Avenue	285	209.7	15	7	Carp
41	Harlem Avenue	266	125.0	13	4	Pumpkinseed
92	16^{th} St., Lockport	148	14.2	10	6	Gizzard shad
			CALUMET RIVER			
55	130^{th} Street	221	84.3	17	7	Bluntnose minnow
			LITTLE CALUMET RIVER			
76	Halsted Street	392	203.2	19	8	Goldfish
			CALUMET-SAG CHANNEL			
59	Cicero Avenue	86	55.5	10	4	Bluntnose minnow

TABLE V-2: FISH COLLECTED FROM WADEABLE WATERWAYS DURING 2009

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
	NORTH BRANCH CHICAGO RIVER					
104	Glenview Road	3	18.5	1	0	Central mudminnow
34	Dempster Street	31	304.9	6	4	Green Sunfish
96	Albany Avenue	38	133.7	6	2	Goldfish
	MIDDLE FORK NORTH BRANCH CHICAGO RIVER					
31	Lake-Cook Road	10	79.0	4	2	Central mudminnow, Green sunfish
	WEST FORK NORTH BRANCH CHICAGO RIVER					
106	Dundee Road	46	155.5	6	2	White sucker
103	Golf Road	17	123.5	8	3	Green sunfish
	SKOKIE RIVER					
32	Lake-Cook Road	76	234.4	9	4	Largemouth bass
105	Frontage Road	42	374.5	6	3	Largemouth bass
	HIGGINS CREEK					
78	Wille Road	28	44.4	2	1	Fathead minnow
	DES PLAINES RIVER					
13	Lake-Cook Road	89	1,331.0	9	5	Green sunfish
22	Ogden Avenue	59	2,442.1	13	6	Green sunfish
91	Material Services Rd.	32	248.2	10	2	Green sunfish
	SALT CREEK					
18	Devon Avenue	28	314.2	6	5	Largemouth bass
	WEST BRANCH DUPAGE RIVER					
64	Lake Street	41	2,999.9	9	5	Largemouth bass

TABLE V-3: MEAN AND RANGE OF CHLOROPHYLL *a* VALUES FROM THE CHICAGO AREA WATERWAY SYSTEM (CAWS) AND CHICAGO AREA GENERAL USE WATERWAYS DURING 2009

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	7	3	11	2
103	Golf Road	11	8	2	22	5
	MIDDLE FORK NORTH BRANCH CHICAGO RIVER					
31	Lake-Cook Road	10	5	1	13	4
	SKOKIE RIVER					
32	Lake-Cook Road	10	6	2	11	3
105	Frontage Road	12	10	<1	18	6
	NORTH BRANCH CHICAGO RIVER (Wadeable Portion)					
104	Glenview Road	12	6	2	13	4
34	Dempster Street	12	6	2	14	3
96	Albany Avenue	12	7	1	24	7
	NORTHSHORE CHANNEL					
35	Central Street	9	10	1	74	24
102	Oakton Street	11	11	1	72	21
36	Touhy Avenue	9	2	1	10	3
101	Foster Avenue	12	2	<1	9	2
	NORTH BRANCH CHICAGO RIVER (Deep-Draft Portion)					
37	Wilson Avenue	12	3	<1	7	2
73	Diversey Avenue	12	2	1	5	1
46	Grand Avenue	12	3	2	5	1
	CHICAGO RIVER					
74	Lake Shore Drive	9	1	1	2	1
100	Wells Street	11	2	1	4	1

TABLE V-3 (Continued): MEAN AND RANGE OF CHLOROPHYLL *a* VALUES FROM THE CHICAGO AREA WATERWAY SYSTEM (CAWS) AND CHICAGO AREA GENERAL USE WATERWAYS DURING 2009

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	11	2	1	4	1
108	Loomis Street	11	2	1	4	1
	BUBBLY CREEK (South Fork South Branch Chicago River)					
99	Archer Avenue	11	9	2	25	8
	CHICAGO SANITARY AND SHIP CANAL					
40	Damen Avenue	11	8	2	58	17
75	Cicero Avenue	11	3	1	5	2
41	Harlem Avenue	11	2	1	6	2
42	Route 83	9	3	1	6	2
48	Stephen Street	9	5	2	20	6
92	Lockport	50	6	1	32	6
	CALUMET RIVER					
49	Ewing Avenue	7	2	<1	6	2
55	130th Street	9	6	2	15	4
	WOLF LAKE					
50	Burnham Avenue	9	6	2	10	3
	GRAND CALUMET RIVER					
86	Burnham Avenue	5	31	3	137	59
	LITTLE CALUMET RIVER					
56	Indiana Avenue	8	27	2	99	36
76	Halsted Street	10	13	1	51	16
52	Wentworth Avenue	10	8	3	25	6
57	Ashland Avenue	9	10	4	18	5

TABLE V-3 (Continued): MEAN AND RANGE OF CHLOROPHYLL *a* VALUES FROM THE CHICAGO AREA WATERWAY SYSTEM (CAWS) AND CHICAGO AREA GENERAL USE WATERWAYS DURING 2009

Station No.	Location	Number of Samples	Mean (µg/L)	Minimum (µg/L)	Maximum (µg/L)	Standard Deviation (µg/L)
		THORN CREEK				
54	Joe Orr Road	9	5	1	11	3
97	170th Street	9	9	5	16	4
		CALUMET-SAG CHANNEL				
58	Ashland Avenue	11	11	1	40	11
59	Cicero Avenue	10	12	2	49	15
43	Route 83	10	9	2	30	9
		BUFFALO CREEK				
12	Lake-Cook Road	9	19	2	47	13
		HIGGINS CREEK				
77	Elmhurst Road	4	8	1	16	7
78	Wille Road	12	2	1	5	1
		DES PLAINES RIVER				
13	Lake-Cook Road	12	11	2	27	7
17	Oakton Street	12	34	9	124	35
19	Belmont Avenue	12	14	1	51	14
20	Roosevelt Road	11	20	2	106	30
22	Ogden Avenue	11	20	2	106	29
23	Willow Springs Road	11	28	2	157	45
29	Stephen Street	11	30	2	123	39
91	Material Service Road	12	24	<1	130	36
		SALT CREEK				
79	Higgins Road	8	21	5	40	12
80	Arlington Heights Road	12	12	2	36	11
18	Devon Avenue	11	15	2	47	13
24	Wolf Road	12	8	1	19	7
109	Brookfield Avenue	11	9	2	23	7

TABLE V-3 (Continued): MEAN AND RANGE OF CHLOROPHYLL *a* VALUES FROM THE CHICAGO AREA WATERWAY SYSTEM (CAWS) AND CHICAGO AREA GENERAL USE WATERWAYS DURING 2009

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	9	14	1	34	12
89	Walnut Lane	12	7	1	20	7
64	Lake Street	12	19	2	40	12
			POPLAR CREEK			
90	Route 19	11	9	2	14	3

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

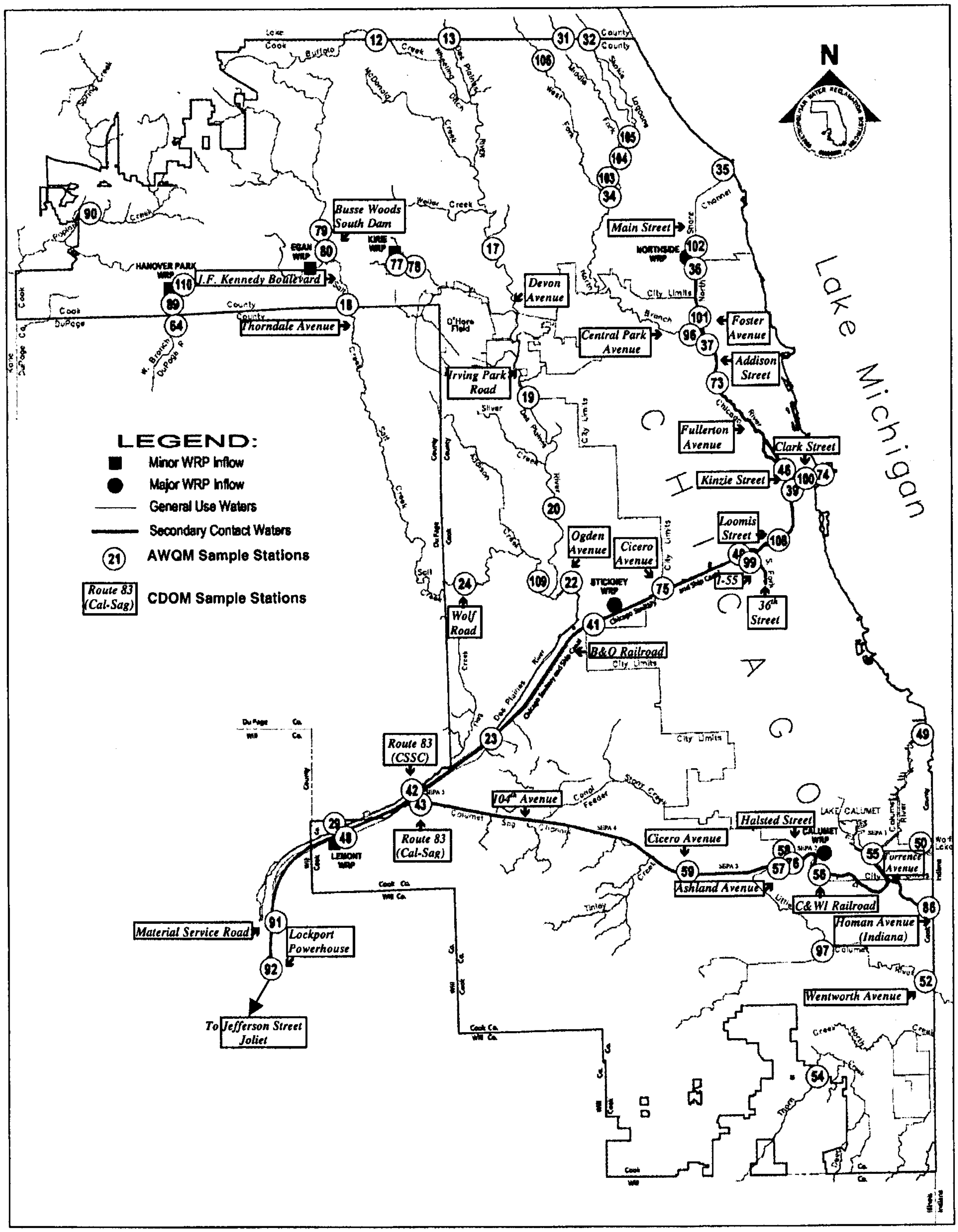


FIGURE V-2: MAP OF THE ILLINOIS WATERWAY FROM LOCKPORT TO MARSEILLES SHOWING SAMPLING STATIONS 1 TO 21

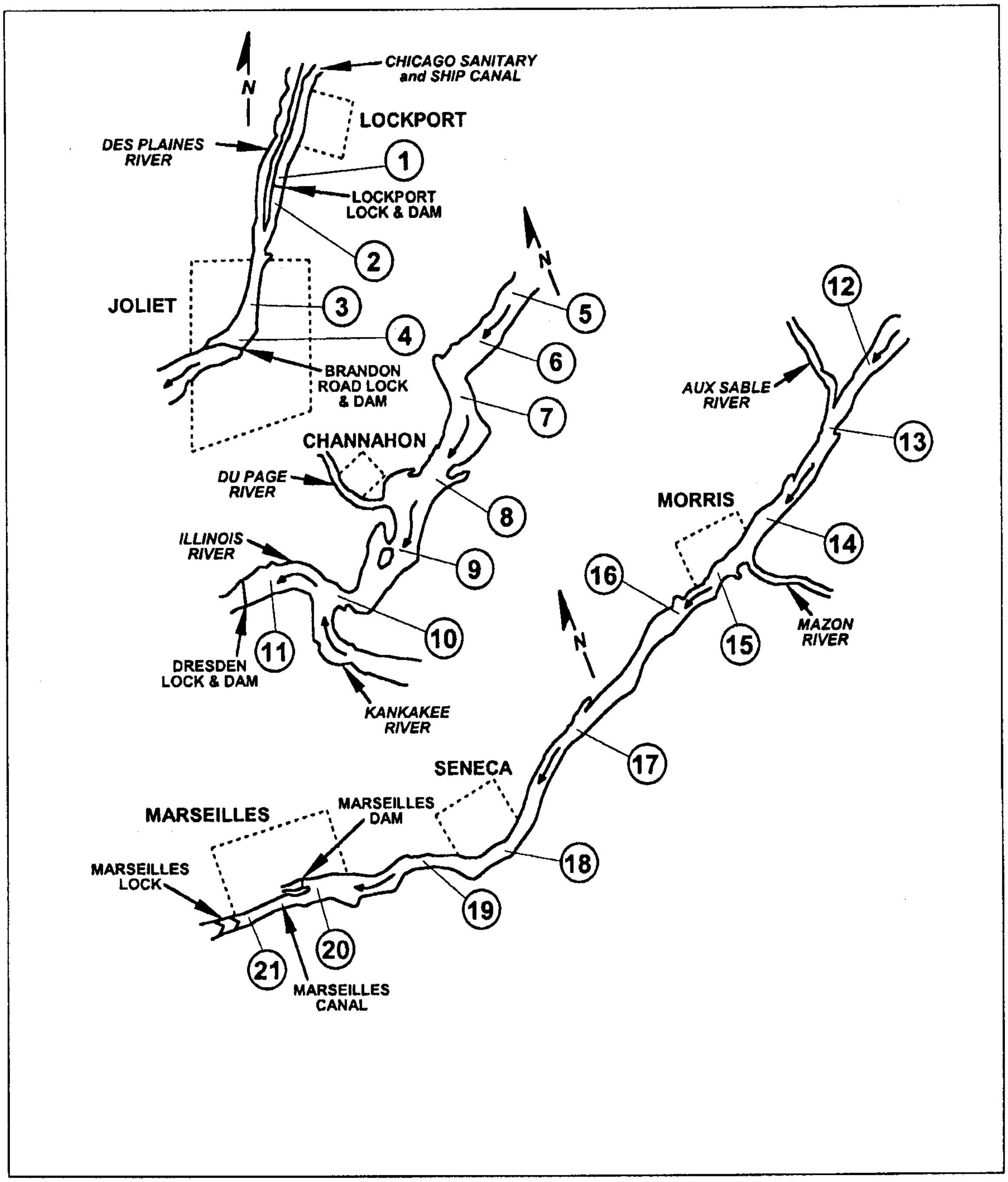
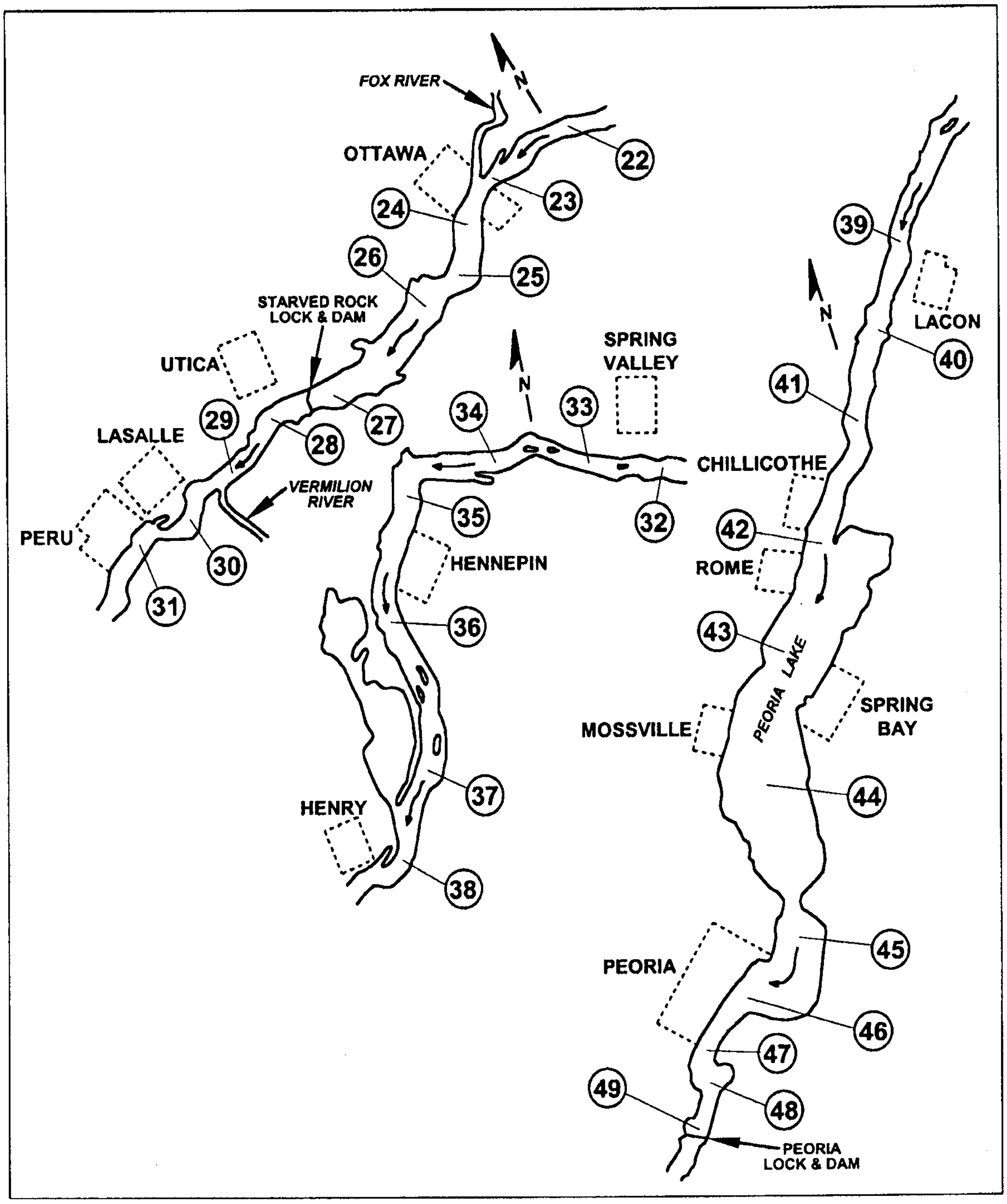


FIGURE V-3: MAP OF THE ILLINOIS WATERWAY FROM OTTAWA TO PEORIA SHOWING SAMPLING STATIONS 22 TO 49



APPENDIX I

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MEETINGS AND SEMINARS 2009
ENVIRONMENTAL MONITORING & RESEARCH DIVISION

1. Illinois Association of Park Districts/Illinois Parks and Recreation Association Conference, Chicago, Illinois, *January 2009.*

2. Illinois Water Environment Association and Central States Water Environment Association, Government Affairs in Water Pollution Control Conference, Willowbrook, Illinois, *January 2009.*

3. Midwest Water Analysts Association, Winter Expo 2009, Kenosha, Wisconsin, *January 2009.*

4. The Seminar Group, Carbon Credits Seminar, Chicago, Illinois, *January 2009.*

5. United States Department of Agriculture, Regional Research Committee W-1170 Annual Meeting, Las Vegas, Nevada, *January 2009.*

6. United States Environmental Protection Agency, Aquatic Nuisance Species Barrier Advisory Panel Meeting (and follow-up committee meetings throughout the year), Chicago, Illinois, *January 2009.*

7. United States Fish and Wildlife Service, Hines Emerald Dragonfly Critical Habitat Planning Meeting, Romeoville, Illinois, *January 2009.*

8. University of Illinois at Urbana-Champaign, 18th Annual Research-Oriented Science Job and Information Fair, Urbana, Illinois, *January 2009.*

9. Battelle Fifth International Conference on the Remediation of Contaminated Sediment, Jacksonville, Florida, *February 2009.*

10. Illinois Chapter of the American Fisheries Society, Annual Meeting, Moline, Illinois, *February 2009.*

11. Illinois Pollution Control Board, Use Attainability Analysis Hearings (and follow-up hearings throughout the year), Chicago, Illinois, *February 2009.*

12. United States Environmental Protection Agency, Surface Water Monitoring and Standards (SWiMS), 8th Annual Meeting, Chicago, Illinois, *February 2009.*

13. University of Illinois at Chicago, Chicago Wilderness Wild Things 2009 Conference, Chicago, Illinois, *February 2009.*

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MEETINGS AND SEMINARS 2009
ENVIRONMENTAL MONITORING & RESEARCH DIVISION

14. Water Environment Federation, Specialty Conference: Disinfection, Atlanta, Georgia, *February 2009.*

15. Water Environment Research Foundation, Experts Scientific Workshop on Critical Research and Science Needs for the Development of Recreational Water Quality Criteria in Inland Waters, Dallas, Texas, *February 2009.*

16. DuPage River, Salt Creek Watershed Workgroup Meeting (and follow-up Chloride and Monitoring committee meetings throughout the year), Downers Grove, Illinois, *March 2009.*

17. Illinois Association of Wastewater Agencies, Mini-Conference, Springfield, Illinois, *March 2009.*

18. Illinois Water Environment Association and Illinois Section of the American Water Works Association, Joint Water Conference and Expo, Springfield, Illinois, *March 2009.*

19. Water Environment Research Foundation, Research Council Meeting, Alexandria, Virginia, *March 2009.*

20. Calumet Government Working Group Meeting, Chicago, Illinois, *April 2009.*

21. Central States Water Environment Association, Educational Seminar: Nutrient Removal, Madison, Wisconsin, *April 2009.*

22. Environmental Systems Research Institute, Geographic Information Systems Training, Chicago, Illinois, *April 2009.*

23. Illinois Chapter of the American Fisheries Society, Biology and Identification of Crayfish Workshop, Warsaw, Illinois, *April 2009.*

24. United States Environmental Protection Agency, National Beach Conference, Huntington Beach, California, *April 2009.*

25. American Society for Microbiologists, 109^{th} General Meeting, Philadelphia, Pennsylvania, *May 2009.*

26. Chicago State University, Calumet Grand Challenges Symposium, Chicago, Illinois, *May 2009.*

MEETINGS AND SEMINARS 2009
ENVIRONMENTAL MONITORING & RESEARCH DIVISION

27. Illinois Institute of Technology, Dewatering Using Hydrogel Demonstration, Chicago, Illinois, *May 2009.*

28. International Water Association, 15th International Symposium on Health-Related Water Microbiology, Naxos, Greece, *May 2009.*

29. United States Environmental Protection Agency, Asian Carp Rapid Response Committee Meeting (and follow-up committee meetings throughout the year), Chicago, Illinois, *May 2009.*

30. Water Environment Federation, Residuals and Biosolids Conference, Portland, Oregon, *May 2009.*

31. Air and Waste Management Association, 102th Annual Conference, Detroit, Michigan, *June 2009.*

32. Chicago Metropolitan Agency for Planning, Sustainable Streets for Chicagoland Workshop, Chicago, Illinois, *June 2009.*

33. National Operator Trainer Conference, Chicago, Illinois, *June 2009.*

34. Water Environment Federation, Specialty Conference: Nutrient Removal 2009, Washington, D. C., *June 2009.*

35. Illinois Environmental Regulatory Group, 2009 Title V Compliance, Springfield, Illinois, *July 2009.*

36. Illinois Professional Turf Conference, Exposition, Lemont, Illinois, *July 2009.*

37. Illinois River Coordinating Council Meeting, Chicago Botanical Gardens, Chicago, Illinois, *July 2009.*

38. United States Department of Agriculture, Agricultural Research Service, International Symposium of Soil Organic Matter Dynamics, Colorado Springs, Colorado, *July 2009.*

39. Water Environment Federation, Microconstituents and Industrial Water Quality Conference, Baltimore, Maryland, *July 2009.*

40. EmCon, Second International Conference, Occurrence, Fate, Effects, and Analysis of Emerging Contaminants in the Environment, Fort Collins, Colorado, *August 2009.*

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MEETINGS AND SEMINARS 2009
ENVIRONMENTAL MONITORING & RESEARCH DIVISION

41. Metropolitan Water Reclamation District of Greater Chicago, Laboratory Comparable Facility Tours, Phoenix, Arizona; Los Angeles, Sacramento, and San Diego, California, *August 2009.*

42. National Science Foundation, Industry University Cooperative Research Center Workshop, Milwaukee, Wisconsin, *August 2009.*

43. American Society of Landscape Architects, Annual Meeting and Exposition, Chicago, Illinois, *September 2009.*

44. Illinois Section American Water Works Association, Pandemic Awareness and Planning for Water Utilities Seminar, Countryside, Illinois, *September 2009.*

45. American Institute of Chemical Engineers, Midwest Regional Conference, Chicago, Illinois, *October 2009.*

46. Great Lakes Observing System Mapping Workshop, Chicago Illinois, *October 2009.*

47. Water Environment Federation, 82^{nd} Annual Technical Exhibition and Conference, Orlando, Florida, *October 2009.*

48. American Water Works Association, Water Quality Technical Conference and Exposition, Seattle, Washington, *November 2009.*

49. Lake Michigan Section of the Air and Waste Management Association, 2009 Air Quality Management Conference, Downers Grove, Illinois, *November 2009.*

50. Midwest Water Analysts Association, 2009 Fall Meeting, Zion, Illinois, *November 2009.*

51. Soil Science Society of America, Annual Meeting, Pittsburg, Pennsylvania, *November 2009.*

52. Water Environment Research Foundation, Quantification of Pathogens and Sources of Microbial Indicators for QMRA in Recreation Waters Project Meeting, Sacramento, California, *November 2009.*

53. World Resources Institute, Nutrient Trading Meeting, Chicago, Illinois, *December 2009.*

APPENDIX II

APPENDIX II

PRESENTATIONS 2009
ENVIRONMENTAL MONITORING & RESEARCH DIVISION

1. "Concerns About Endocrine Disrupting Chemicals in Land-Applied Biosolids – An Overview?" Presented at the United States Department of Agriculture, Regional Research Committee W-1170 Annual Meeting, Las Vegas, Nevada, by L. S. Hundal. *January 2009.* PP

2. "The Carbon and Energy Footprint of Water Reclamation and Waterway Management in Greater Chicago." Presented at the Midwest Water Analysts Association, Winter Expo 2009, Kenosha, Wisconsin, by J. A. Kozak, C. O'Connor, and T. C. Granato. *January 2009.* PP

3. "Restoring Prairies and Managing Stormwater and Local Waterways with Environmental Stewardship Vision: The Metropolitan Water Reclamation District of Greater Chicago Leading by Example." Presented at the University of Illinois at Chicago, Chicago Wilderness Wild Things 2009 Conference, Chicago, Illinois, by S. Dennison. *February 2009.* PP

4. "An Overview of Climate Change, the Controversy, Proposed Legislation, and Projected Impacts on Wastewater Treatment Operations." Presented at the Illinois Water Environment Association and Illinois Section of the American Water Works Association, Joint Water Conference and Exhibition, Springfield, Illinois, by J. Moran, C. O'Connor, J. A. Kozak, and T. C. Granato. *March 2009.* PP

5. "Determination of Methane and Nitrous Oxide Emissions from the Stickney Water Reclamation Plant." Presented at the Illinois Water Environment Association and Illinois Section of the American Water Works Association, Joint Water Conference and Exhibition, Springfield, Illinois, by J. A. Kozak and A. Oskouie. *March 2009.* PP

6. "Metropolitan Water Reclamation District of Greater Chicago's Role in Protecting Public Health and Chicago Area Waterways." Presented at the Illinois Water Environment Association and Illinois Section of the American Water Works Association, Joint Water Conference and Exhibition, Springfield, Illinois, by G. Rijal. *March 2009.* PP

7. "Phosphorous Reduction Demonstration Project at the John E. Egan Water Reclamation Plant." Presented at the Illinois Association of Wastewater Agencies, Mini-Conference, Springfield, Illinois, by H. Zhang. *March 2009.* PP

8. "Operating the Sidestream Elevated Pool Aeration Stations to Meet the Proposed Water Quality Standards." Presented at the Illinois Water Environment Association and Illinois

Section of the American Water Works Association, Joint Water Conference and Exhibition, Springfield, Illinois, by T. Minarik. *March 2009.* PP

9. "Stream Response to Phosphorus Reduction at the Metropolitan Water Reclamation District of Greater Chicago's Egan Water Reclamation Plant." Presented at the Illinois Water Environment Association and Illinois Section of the American Water Works Association, Joint Water Conference and Exhibition, Springfield, Illinois, by J. Wasik. *March 2009.* PP

10. "Microbial Risk Assessment of the Chicago Area Waterways." Presented at the United States Environmental Protection Agency, National Beach Conference, Huntington Beach, California, by G. Rijal. *April 2009.* PP

11. "A Novel Approach to *Ascaris* Analysis in Biosolids." Presented at the Midwest Water Analyst Association, 2009 Spring Meeting, Cicero, Illinois, by R. Gore. *May 2009.* PP

12. "Biosolids Use in Calumet Area Restoration – A Cost-Effective and Sensible Option." Presented at the Chicago State University, Calumet Grand Challenges Symposium, Chicago, Illinois, by L. S. Hundal. *May 2009.* PP

13. "Long-Term Assessments of Microconstituents Fate in Biosolids-Amended Soils." Presented at the Water Environment Federation, Residuals and Biosolids Conference, Portland, Oregon, by L. S. Hundal, K. Xia, K. Kumar, A. E. Cox, and T. C. Granato. *May 2009.* PP

14. "Microbial Health Risk Assessment of the Chicago Area Waterway System." Presented at the International Water Association, 15th International Symposium on Health-Related Water Microbiology, Naxos, Greece, by G. Rijal. *May 2009.* PS

15. "Occurrence of Endocrine Disrupting Compounds in Wastewater Effluent and Biosolids – An Overview." Presented at the Midwest Water Analyst Association, 2009 Spring Meeting, Cicero, Illinois, by L. S. Hundal. *May 2009.* PP

16. "Monitoring and Modeling of the CDOT Blue Island/Cermak Streetscape." Presented at the Chicago Metropolitan Agency for Planning, Sustainable Streets for Chicagoland Workshop, Chicago, Illinois, by J. A. Kozak. *June 2009.* PP

17. "Management of Soil Organic Matter with Biosolids." Presented at the United States Department of Agriculture, Agricultural Research Service, International Symposium of Soil

Organic Matter Dynamics, Colorado Springs, Colorado, by G. Tian, A. E. Cox, and T. C. Granato. *July 2009.* PP

18. "Using Stormwater to Make Great Places and Spaces." Presented at the American Society of Landscape Architects, Annual Meeting and Exposition, Chicago, Illinois, by J. Attarian, J. Wight, and J. A. Kozak. *September 2009.* PP

19. "Activated Sludge and BNR Process Control – Hands-on in the Real World: Wastewater Microscopy." Presented at the Water Environment Federation, 82nd Annual Technical Exhibition and Conference, Pre-Conference Workshop, Orlando, Florida, by T. Glymph. *October 2009.* PP

20. "Chicago's Sustainable Streetscape and Greenhouse Gas Emissions from Wastewater Treatment Processes." Presented at the American Institute of Chemical Engineers, Midwest Regional Conference, Chicago, Illinois, by J. A. Kozak. *October 2009.* PP

21. "Comparison of Fecal Coliform Concentrations and Trends in a Secondary Contact and General Use Urban River." Presented at the Water Environment Federation, 82nd Annual Technical Exhibition and Conference, Orlando, Florida, by T. Glymph. *October 2009.* PP

22. "Implementing an Information Infrastructure to Support Biological Assessments in the Chicago Area Waterways System." Presented at the Water Environment Federation, 82nd Annual Technical Exhibition and Conference, Orlando, Florida, by T. Minarik. *October 2009.* PP

23. "Methane and Nitrous Oxide Emissions from Wastewater Treatment Plant Processes." Presented at the Water Environment Federation, 82nd Annual Technical Exhibition and Conference, Orlando, Florida, by J. A. Kozak, F. Belluci, C. O'Connor, T. C. Granato, L. Kollias, and N. Sturchio. *October 2009.* B

24. "Argonomic Effectiveness and Environmental Risk of Phosphorus in Biosolids." Presented at the Soil Science Society of America, Annual Meeting, Pittsburg, Pennsylvania, by G. Tian, A. E. Cox, K. Kumar, T. C. Granato, G. A. O'Connor, and H. A. Elliott. *November 2009.* PP

25. "Nitrogen Mineralization in Centrifuge Cake and Lagoon-Aged Air-Dried Biosolids." Presented a the Soil Science Society of America, Annual Meeting, Pittsburg, Pennsylvania, by K. Kumar, L. S. Hundal, A. E. Cox, and T. C. Granato. *November 2009.* P

APPENDIX II

PRESENTATIONS 2009
ENVIRONMENTAL MONITORING & RESEARCH DIVISION

26. "Uptake of Pharmaceutical and Personal Care Products by Plants-Potential Mechanisms." Presented at the Soil Science Society of America, Annual Meeting, Pittsburg, Pennsylvania, by K. Kumar, L. S. Hundal, S. C. Gupta, A. E. Cox, and T. C. Granato. *November 2009.* 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

APPENDIX III

PAPERS PUBLISHED 2009
ENVIRONMENTAL MONITORING & RESEARCH DIVISION

1. Andrews, N., S. A. Deslauriers, D. Kerr, S. E. Lorenz, C. O'Connor, and R. C. Porter. "Protocols for Estimating Greenhouse Gas Emissions from Municipal Wastewater Sources." *Water Environment Federation, Technical Practice Update. 2009.*

2. Kozak, J. A., C. O'Connor, T. C. Granato, L. Kollias, F. Bellucci, and N. Sturchio. "Methane and Nitrous Oxide Emissions from Wastewater Treatment Plant Processes." Proceedings of the Water Environment Federation, 82nd Annual Technical Exhibition and Conference, Orlando, Florida. *2009.*

3. Rijal, G. K., Z. Abedin, J. T. Zmuda, R. Gore, B. Sawyer, and R. Lanyon. "Comparison of Fecal Coliform Concentrations and Trends in a Secondary Contact and General Use Urban River." Proceedings of the Water Environment Federation, 82nd Annual Technical Exhibition and Conference, Orlando, Florida. *2009.*

4. Rijal, G. K., T. Glymph, R. Gore, T. C. Granato, C. Petropoulou, K. Tolson, C. Gerba, R. M. McCuin, L. Kollias, and R. Lanyon. "Microbial Health Risk Assessment of the Chicago Area Waterway System." Proceedings of the International Water Association, 15th International Symposium on Health-Related Water Microbiology, Naxos, Greece. *2009.*

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7. Sneen, M. E., K. S. Cummings, T. Minarik, and J. Wasik. "The Discovery of the Nonindigenous, Mottled Fingernail Clam *Eupera cubensis* (Prime, 1865) (Bivalvia:Sphaeriidae) in the Chicago Sanitary and Ship Canal (Illinois River Drainage), Cook County, Illinois." *Journal of Great Lakes Research*, 35: 627-629. *2009.*

8. Tian, G., T. C. Granato, A. E. Cox, R. I. Pietz, C. R. Carlson Jr., and Z. Abedin. "Soil Carbon Sequestration Resulting from Long-Term Application of Biosolids for Land Reclamation." *Journal of Environmental Quality*, 38: 61-74. *2009.*

APPENDIX IV

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO
MONITORING AND RESEARCH DEPARTMENT 2009 SEMINAR SERIES

January 30, 2009	***Anaerobic Co-digestion of Food Wastes and Biosolids at Municipal Wastewater Treatment Plants in Wisconsin*** Dr. Dan Zitomer, Marquette University, Milwaukee, WI
February 27, 2009	***Update on the Metropolitan Water Reclamation District of Greater Chicago's (District) Stormwater Management Program*** Ms. Maureen Durkin, Principal Civil Engineer, Engineering Department, District, Chicago, IL
March 27, 2009	***Sources and Ecology of E. coli in the North Shore Channel and North Branch of the Chicago River*** Dr. Muruleedhara Byappanahalli, United States Geological Survey, Lake Michigan Ecological Research Station, Porter, IN
May 1, 2009	***Industrial Pretreatment: Where We Were, Where We Are, and the Challenges Ahead*** Dr. Cecil Lue-Hing, Cecil Lue-Hing & Associates, Burr Ridge, IL
May 29, 2009	***Sustainable Water Use in Cities and Industry: Future Challenges and Promising Strategies*** Dr. Kimberly Gray, Northwestern University, Evanston, IL
June 26, 2009	***Overview of the Benefits and Potential Risks Associated with Environmental Quality Applications of Nanotechnologies*** Dr. Rao Surampalli, United States Environmental Protection Agency (USEPA), Kansas City, MO
July 31, 2009	***State of the Science on Cogeneration of Heat and Power from Anaerobic Digestion of Municipal Biosolids*** Dr. James Smith, USEPA, Cincinnati, OH
August 28, 2009	***Evaluation of the Effectiveness of District Biosolids Compared with other Organic and Conventional Commercial Fertilizers for Turfgrass Management at Golf Courses and Parks*** Dr. Thomas Voigt, University of Illinois, Urbana, IL
September 25, 2009	***Nitrogen Isotope Studies in the Illinois River*** Dr. Neil Sturchio, University of Illinois at Chicago, Chicago, IL
October 30, 2009	***An Integrated Strategy for Meeting Dissolved Oxygen Standards Proposed for the Chicago Area Waterway System*** Dr. David R. Zenz, CTE Engineers/AECOM, Chicago, IL
November 20, 2009	***Chicago Area Waterways Habitat Evaluation and Improvement Study*** Mr. Scott R. Bell, LimnoTech, Inc., Ann Arbor, MI
December 11, 2009	***On the Road to 2040: A Progress Report on the Implementation of the District's Master Plans*** Mr. Thomas Kunetz, Assistant Director of Engineering, Engineering 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 Monitoring and Research, 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

APPENDIX V

Environmental Monitoring and Research Division

Section 121
Administrative Section

O'Connor, Catherine, Assistant Director of M&R
Messina, Deborah, Secretary

Lordi, David, Acting Research Scientist 4
Urlacher, Nancy, Administrative Assistant

Abedin, Zainul, Biostatistician
Khalique, Abdul, Radiation Chemist

Section 122
Wastewater Treatment Process Research

Patel, Kamlesh, Acting Research Scientist 3
Zhang, Heng, Research Scientist 3
Franklin, Laura, Prin. Office Support
Oskouie, Ali, Research Scientist 2
Vacant, Research Scientist 2
Bernstein, Doris, Research Scientist 1
Kozak, Joseph, Research Scientist 1
MacDonald, Dale, Research Scientist 1
Moran, Judith, Research Scientist 1
Haizel, Anthony, Lab Tech 2
Reddy, Thota, Lab Tech 2
Bodnar, Robert, Lab Tech 1
Byrnes, Marc, Lab Tech 1
Qin, Dongqi, Lab Tech 1
Kowalski, Shawn, Lab Tech 1
Robinson, Harold, 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
Mehta, Atulkumar, Lab Tech 1
Holic, Lawrence, Lab Assistant
Horvath, Beverly, Lab Assistant

Section 124
Analytical Microbiology and Biomonitoring

Rijal, Geeta, Microbiologist 4
Slaby, Pamela, Prin. Office Support
Glymph, Auralene, Microbiologist 3
Gore, Richard, Microbiologist 2
Vacant, 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
Latimore, Thomas, Lab Assistant
Saverson, Amanda, Lab Assistant

Section 126
Aquatic Ecology and Water Quality

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

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