Metropolitan Water Reclamation District of Greater Chicago

MONITORING AND RESEARCH DEPARTMENT

REPORT NO. 12-59

ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

2011

ANNUAL REPORT

December 2012

Metropolitan Water Reclamation District of Greater Chicago
100 East Erie Street * Chicago, IL 60611-2803 * (312) 751-5600

ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

2011

ANNUAL REPORT

Monitoring and Research Department
Thomas C. Granato, Director

December 2012

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ACKNOWLEDGMENTS

This 2011 Annual Report is the result of the efforts of not only the scientists, microbiologist and biologists, 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 Marie Biron, Laura Franklin, Bettina Gregor, Coleen Maurovich, Deborah Messina, and Kathleen Quinlan 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 Division (EM&RD) 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:

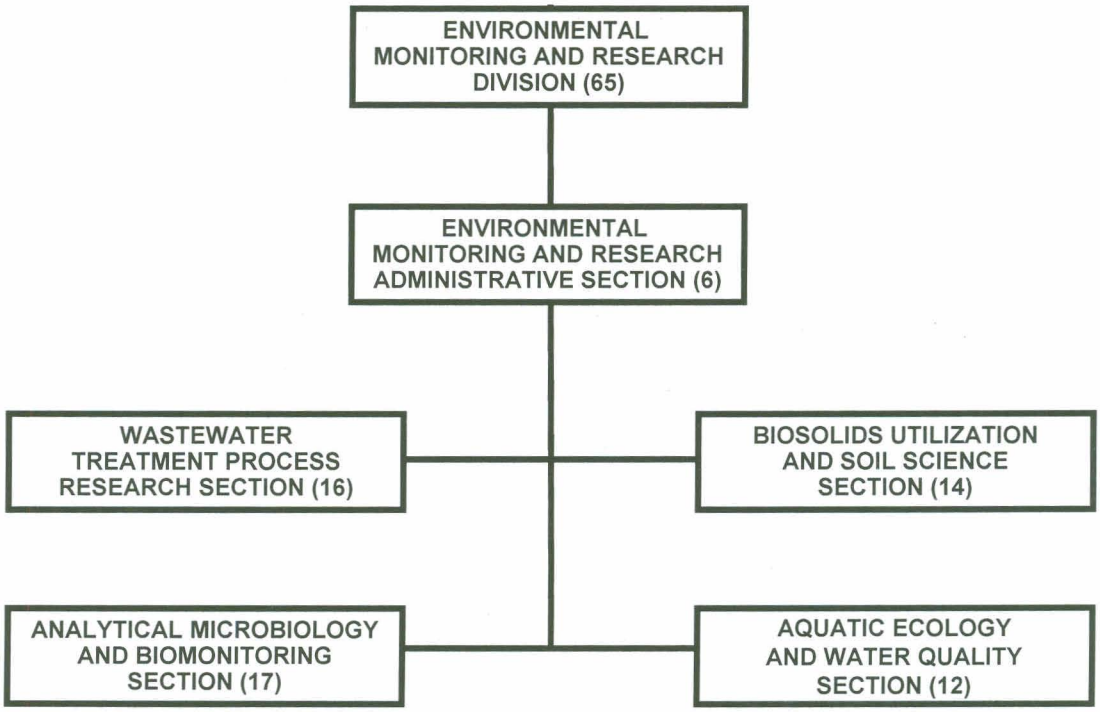
1. Administrative
2. Wastewater Treatment Process Research
3. Biosolids Utilization and Soil Science
4. Analytical Microbiology and Biomonitoring
5. Aquatic Ecology and Water Quality

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 Metropolitan Water Reclamation District of Greater Chicago's (District) wastewater treatment program.
- Assisting in the resolution of sewage treatment and solids management 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 operations and applied 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 2011, the Division continued formulating the District's case in the Illinois Pollution Control Board (IPCB) Rulemaking R08-9 Chicago Area Waterway System (CAWS) 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 (WRP) National Pollutant Discharge

FIGURE 1

ENVIRONMENTAL MONITORING AND RESEARCH DIVISION ORGANIZATION CHART



Elimination System (NPDES), and biosolids processing and utilization permits.

- During 2011, EM&RD 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).

ADMINISTRATIVE SECTION

ADMINISTRATIVE SECTION

The Administrative Section provides technical guidance, scientific review, and administrative support for the work being carried out by EM&RD staff. The Section also organizes a monthly seminar series, open to all District employees and interested public individuals through prior registration, which presents information on areas of interest to the District operations. In 2011, 1,603 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&RD.

During 2011, the EM&RD performed activities under the following five program goals:

Goal 1: Operations Monitoring (4650) – Monitor liquid and solids process trains for operational control and regulatory reporting requirements and compliance.

Goal 2: Waste Monitoring (4670) – Monitoring and control of waste discharged into District's sewage collection system.

Goal 3: Environmental Monitoring (4670) – Monitor the environmental impacts of District operations to assess compliance with all regulations and properly assess the impacts of District operations in a cost efficient manner.

Goal 4: Technical Assistance (4680) – Evaluate process control and monitoring information to improve process efficiency, inform design and support effective regulatory developments.

Goal 5: Operations and Applied Research (4690) – Conduct applied and operations research to achieve improvement and cost reductions in District wastewater treatment, waterways management, and solids processing activities.

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 in this Group also develop multistage automation programs to interconnect

different software programs such as LATEX, Visual Basic, SAS, Access, Excel, Outlook, and PowerPoint. This computer automation has enabled the Group to produce reports, tables, and texts in suitable format more efficiently.

Statistical and Computing Support. During 2011, a Biostatistician provided statistical and computing support to various projects. The following is a description of some of the activities.

1. Statistical analyses and summaries of historical lysimeter monitoring data to support a request to the Illinois Environmental Protection Agency (IEPA) to reduce monitoring frequency at the solids management areas.

2. The EDSEG provided data management support to the Biosolids Utilization and Soil Science Section (Section 123) to produce quarterly reports on the District's solids management areas in accordance with IEPA permit requirements. Groundwater and biosolids monitoring reports were produced for the Harlem Avenue, Lawndale Avenue, Ridgeland Avenue, 122nd and Stony Island Avenue, Calumet East, and Calumet West Solids Management Areas. Quarterly monitoring reports are also generated for the Hanover Park Fischer Farm.

3. Statistical support was provided to a Section 123 research project on bioavailability of phosphorus in biosolids.

4. Statistical support was provided to the Wastewater Treatment Process Research Section for the evaluation of a polymer reduction project.

5. Continuous support is being provided to the Aquatic Ecology and Water Quality Section (Section 126) on the production of Continuous Dissolved Oxygen Monitoring Reports (Deep-Draft, and Wadeable) annually.

6. Statistical support was provided to Section 126 on the study of fish abundance in the District's waters.

7. Two Ambient Water Quality Monitoring Exceedance Reports were produced by this Group for the first two quarters of 2011.

8. Numerous statistical support was provided to the Assistant Director of Monitoring and Research to address IEPA regulations.

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

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 2011 were evaluated regarding compliance with water quality standards set by the IPCB. In 2011, a total of 70 water quality parameters were analyzed and reported.

Radiochemistry Group

The Radiochemistry Group is responsible for the radiological monitoring of waters, wastewaters, 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 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 Environmental, Inc. Midwest Laboratory, Northbrook, Illinois (EIML). The data is presented in the 2011 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. 11-59). 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 wastewater and final effluent samples from the District's seven WRPs continued in 2011. 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 radioactivity as the reference for monitoring WRP effluent.

The analysis of radioisotopes was conducted on 24-hour composite samples of raw sewage and final effluent collected monthly at all WRPs. The samples were analyzed by EIML. The data are presented in the 2011 Annual Report entitled Radiological Monitoring of the Raw Sewage, Final Effluent, Sludge, and Biosolids of the Metropolitan Water Reclamation District of Greater Chicago (M&R Report No. 11-56).

The results show that the amount of gross alpha, gross beta, combined radium-226 and radium-228, and strontium-90 radioactivity in the final effluent of all the WRPs, except for combined radium-226 and radium-228 in the Lemont WRP, is less than the allowable contaminant levels in drinking water standards set by the USEPA National Primary Drinking Water Regulations 40 Code of Federal Regulations Part 141. The concentration of radioactivity in the final effluent, with the exception of combined radium-226 and radium-228 in the Lemont WRP, 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 District's receiving streams.

Levels of Radioactivity in Biosolids. In 1993, the Radiochemistry Group revised and expanded its radiological monitoring program of District biosolids in response to the increased emphasis on monitoring biosolids quality by the USEPA's Part 503 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 as a result of incidents that occurred at other publicly owned treatment works (POTWs) where high levels of radioactivity were discovered in sludges and incinerator ash.

During 2011, biosolids samples were collected quarterly from the John E. Egan and Stickney WRPs. The samples were analyzed for gross alpha, gross beta and gamma radioactivity by EIML. The 2011 data are presented in M&R Report No. 11-56.

The Illinois Emergency Management Agency adopted the final rule in 2011 and exempted the District from radioactivity monitoring requirements in biosolids produced at its WRPs. The District terminated its biosolids monitoring program effective December 31, 2011.

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 radiate+on 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 2011, 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 2011.

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 2011.

Nickel-63 sources constitute a part of the electron capture detectors of the gas chromatographs used by M&R. Leak tests were performed on six detectors from three gas chromatographs in 2011. 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 2011 on the APD2000 CW Detector owned by the Safety Section of the Human Resources Department. No leaks were discovered in this detector.

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 in 2011.

A physical inventory of the radioactive sealed sources possessed by the District was carried out twice in 2011. 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's mission is to provide technical support to the Maintenance and Operations Department (M&O) and Engineering Department (Engineering), to conduct applied research regarding both current treatment processes and new technologies, to conduct regulatory required monitoring, and to review, and develop technical information for pending regulations. Technical assistance is provided to M&O for solving 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 Engineering for the purpose of optimizing process design criteria. The Section is responsible for conducting research aimed to solve problems and evaluate various wastewater and sludge treatment processes currently utilized by the 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 are performed through 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.

During 2011, the WTPR Section performed activities under the following four program goals:

Goal 1: Operations Monitoring

Aeration Tank Profile Study. Aeration tank air usage and energy efficiencies were evaluated at District WRPs through review of historical operational data and characterization of the mixed liquor along the length of select tanks (profiling). The profiling occurred in Fall 2010, but all data review and analyses were performed in 2011. Table II-1 summarizes the 2002-2009 historical operating data for each plant, and Table II-2 summarizes the historical air to sewage and air to oxygen demand ratios for each plant during the same time period. All seven plants, except for the Lemont WRP, were within the recommended range of 0.4 to 1.6 cubic feet per gallon treated (cf/gal) according to the USEPA's Manual for Wastewater Treatment Operations.

The District's aeration tanks are operated to achieve complete nitrification and to meet a dissolved oxygen (DO) target level based on the plant's NPDES limits. The typical profiles for each plant indicated that ammonia nitrogen (NH_3-N) decreased over the length of the tank while nitrate nitrogen (NO_3-N) concentrations increased. DO levels generally were very low at the beginning of the studied tanks due to high oxygen demand and then increased over the length of the tank as oxygen demand decreases.

The tanks examined and the average tank length when complete nitrification, which is defined as the ammonia nitrogen concentration being reduced to less than 0.5 mg/L was achieved, is summarized in Table II-3. The Hanover Park and James C. Kirie WRPs had the

most consistent operation of aeration tanks. The Hanover Park aeration tanks had complete nitrification by 74 to 86 percent of the tank length in three of the four batteries; Battery C only achieved nitrification on two of three monitoring days. At the Kirie WRP complete nitrification occurred at 83 percent of the tank length. Conversely, the aeration tank profiles at the John E. Egan (Egan) WRP indicated complete nitrification at 64 to 68 percent of the tank length. Complete nitrification in the beginning or middle of the aeration tanks indicates excessive energy usage. The aeration tanks at the Lemont WRP used much more air than tanks at other WRPs, indicating operational changes may decrease energy usage. However, complete nitrification too close to the end of the tank reduces the buffer capacity during high ammonia loadings.

Additional Digestion Tests for the Calumet Water Reclamation Plant. During 2011 the WTPR Section conducted a monitoring program that assesses the completeness of volatile solids reduction in the Calumet WRP anaerobic sludge digesters. This monitoring program followed the same test method as directed in Option 2 of Section 503.33(b) of the 40 CFR Part 503 Regulation. Because the digester draw has been lagooned instead of dewatered and land applied the results of these tests are used to assess digester performance only. In 2011, the M&R WTPR laboratory performed a total of 26 additional anaerobic digestion tests for the Calumet WRP at the frequency of two to three tests per month except for November in which only one test was performed. The monthly average results from these tests are summarized in Table II-4.

John E. Egan Water Reclamation Plant Profile Sampling. A DO and NH_3-N profile evaluation was performed on a quarterly basis in the North and South aeration batteries at the Egan WRP as part of an ongoing support to M&O plant operations. Based on the results of this monitoring, it was determined that NH_3-N was completely removed by mid-tank length in many cases for both the North and South Batteries, and recommendations on reducing the air input to the system were made to M&O to save energy at the plant. Overall, based on the results of the quarterly sampling and analysis during 2011, the plant was operated optimally.

Goal 3: Environmental Monitoring

Estimation of Emission of Hazardous Air Pollutants. Part A, Title I, of the Clean Air Act, states that 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 single 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 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 BASTE computer model developed by CH2M Hill. The average concentration of each HAP detected in the influent sewage and the annual running average operating conditions were used as input to the model. The physical properties, such as vapor pressure and molecular weight of the individual compounds, were taken from the USEPA database for use in the model as well. During 2011, influent samples were collected in January and July. The average influent

concentrations of the HAPs are presented in Table II-5 for the three largest District WRPs (Calumet, Terrence J. O'Brien [O'Brien-formally North Side], and Stickney WRPs). The estimated emissions of individual HAPs for these WRPs are summarized in Table II-6.

According to the BASTE model, all of the individual HAP emissions were less than the ten ton/year criterion. Propionaldehyde, acetaldehyde and toluene were the predominant compounds emitted from the wastewater treatment processes at the Stickney WRP. Toluene was the predominant compound emitted from the Calumet WRP liquid stream. The HAP emissions from the O'Brien WRP were very low, mostly less than 0.2 ton/year. The total measured HAP emissions were substantially less than the 25 ton/year threshold at each of the three WRPs. Therefore, the wastewater treatment process units at the District's WRPs are not considered major sources of HAPs. Additionally, as part of the IEPA's Environmental Emissions Reduction Market System, an annual HAPs report was filed.

John E. Egan Water Reclamation Plant Air Quality Permit. As part of the Egan WRP's Federally Enforceable State Operating Permit, the monthly hydrogen sulfide monitoring performed at the facility's compressor room was recorded. The monthly permit limit for the digester hydrogen sulfide is 1000 parts per million by volume. In year 2011, there was no permit violation in regard to hydrogen sulfide concentration of the digester gas at the Egan WRP.

Goal 4: Technical Assistance

Terrence J. O'Brien Water Reclamation Plant Aeration Tank Evaluation. Ammonia nitrogen and DO profiling of the separate bays of select O'Brien WRP aeration battery tanks were performed in conjunction with air valve adjustments conducted by M&O. The profiling and valve adjustments were completed in an attempt to balance significantly different performances of the two bays, which were thought to be the result of unequal air distribution. Tanks 7, 8, and 11 of Battery A were used for this evaluation. Profiles were first taken with normal operation of all the air valves. Normal operation typically included completely opened valves in the first half of the tank and partially opened valves in the second half. An iterative process was used which included small changes to the degree the valves were open, followed by DO measurements and occasionally NH_3-N measurements, in an attempt to balance the DO in the two bays.

Figure II-1 shows (1) the DO profile from Tank 8 of Battery A with the normal valve positions, (2) the DO profile following the second round of adjustments, (3) the DO profile with the same second valve adjustments after a few days, and (4) the DO profile with the same second valve adjustments after the air lines were purged of accumulated water. Based on the results from Tank 8, the valve adjustments balanced the air distribution between the two bays for a short period. However, ten days later, with no additional changes to the valve positions, the air distribution between bays was significantly different as under normal operation.

The results of this evaluation show that adjusting the air valves feeding the two bays of one tank may alleviate performance differences in the two bays only temporarily. Additional investigations should be performed to determine the cause of the unequal performance and how this could be corrected.

James C. Kirie Water Reclamation Plant Filter Test. The suspended solids (SS) removal efficiency and hydraulic capacity of the Kirie WRP filters were evaluated using the effluent from Battery A, currently used for the activated sludge process. Battery A is planned to be out of service during future construction activities. Battery B, currently used for an additional settling process, will then be needed for the activated sludge process, and the additional settling process will be temporarily eliminated. The filters will be needed to remove the SS previously removed in Battery B.

The method used to test the dual media filters consisted of collecting samples of filter influent and effluent and analyzing the samples for SS concentration. Two-hour composite samples were collected for a total of 24 samples each test day. A summary of the operating conditions and test results are shown in Table II-7.

Goal 5: Operations and Applied Research

Recycle Stream Characterization. The wastewater quality of the side and recycle streams at the Calumet, Stickney, and Egan WRPs was examined to identify nutrient-rich streams for potential recovery opportunities. Up to nine grab sampling events were performed at each plant and included analysis for Total Kjeldahl nitrogen (TKN), soluble TKN (sol TKN), NH_3-N, total phosphorus (Tot P), soluble orthophosphate (ortho P), iron (Fe), magnesium (Mg), and pH. The average concentrations of the monitored streams are summarized in Table II-8. It was determined that the Stickney post-digester centrifuge centrate and the Calumet lagoon decant had elevated ortho P concentrations (>75 mg/L), and are potential candidates for phosphorus (P) recovery which could reduce P in the respective WRP effluents and recycle streams.

John E. Egan Water Reclamation Plant Enhanced Settling of Primary Solids. Polymer- and ferric chloride ($FeCl_3$)-aided enhanced primary solids settling in the primary settling tanks was investigated at the Egan WRP for energy saving. A series of bench-scale tests were conducted with Mannich polymers and different cationic and anionic emulsion polymers to determine the most suitable polymer for enhanced primary settling with and without $FeCl_3$ as an additional coagulant. Based on the results, the Mannich polymers were removed from further consideration due to excess additional tankage and piping requirements. The preliminary results indicated that anionic emulsion polymers generally outperformed the cationic emulsion polymers. In general, Praestol anionic polymers of Ashland Chemicals seemed to be best suited for enhanced settling of the primary influent and hence, its anionic polymer, Praestol A3040, was selected for further bench-scale tests.

The subsequent bench-scale settling tests were performed at 15°C to evaluate the performance of polymers with and without $FeCl_3$ to develop design dose criteria. The recommended design doses and estimated quantities of polymer and $FeCl_3$ for full-scale application were: (1) an of average of 1.25 parts per million (ppm) for the polymer alone and (2) an average of 0.83 ppm polymer and 15 mg/L $FeCl_3$ in combination.

Carbon Footprint. The carbon footprint for all seven District WRPs for 2005, 2008, 2009, and 2010 was calculated as a measure to manage climate change risk, indicate inefficiencies in operations, and prepare the District for regulations concerning carbon emissions using the Local Government Protocol Methodology. Collectively, the District's carbon footprint was derived from greenhouse gas (GHG) emissions from stationary combustion of natural gas and biogas; indirect GHG emissions from electricity use; direct GHG emissions from vehicular diesel and unleaded gasoline fuel combustion; methane emissions from incomplete combustion of biogas; methane and nitrous oxide emissions from biogas combustion; nitrous oxide emissions from nitrifying wastewater treatment plants without denitrification; and nitrous oxide emissions from nitrogen discharge to receiving waters. Carbon offsets were also considered due to carbon sequestration from the District's forested property and biosolids application to disturbed land. The carbon footprints for the respective years are summarized in Table II-9.

The total carbon footprints were 452,344 metric tons carbon dioxide equivalents (MT CO_2e), 495,417 MT CO_2e, 510,680 MT CO_2e, and 489,300 MT CO_2e, respectively, for these studied four years. Approximately 83 percent of the net positive emissions are a function of electricity use. The second highest contributor to the carbon footprint is the nitrous oxide emissions from nitrogen release to the receiving waters (~10.5 percent). Approximately 19,240 MT CO_2e are sequestered every year through forested and biosolids applied land.

Sustainable Streetscape Project. In support of the Engineering Department, the EM&RD are involved in the continued collaboration with the United States Geological Survey (USGS) to evaluate the effect of Best Management Practices (BMPs) such as permeable pavements, bioswales, and planters on stormwater flow and pollutant load reduction in the Sustainable Streetscape Project 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. Baseline and partial construction data of precipitation, CSO, groundwater levels, wastewater quality, and groundwater quality were collected in 2011. Total rainfalls across the study area based on three rain gauge locations ranged from 34 to 52 inches.

Up to seven daily composite sampling events during dry weather to characterize baseline conditions of wastewater quality were performed in two sewer locations in the west and center of the study site; each location showed different wastewater characteristics. In the center of the study area wastewaters with low chemical oxygen demand (COD) concentrations of 85 mg/L and SS concentrations of 21 mg/L concentrations were observed, but extremely high chloride concentrations (1,398 mg/L) were observed, possibly a residual from deicing activities. At the western monitoring location, wastewaters with higher SS (33 mg/L) and COD (180 mg/L)

concentrations were observed, but lower chloride concentrations (247 mg/L) were observed. At the time of this report, the USGS was still analyzing its sewer flow and monitoring well data.

Nitrification Rate Test. Through technology review and empirical study, a standard operating procedure (SOP) was developed for estimating maximum nitrification rates of mixed liquor using respirometry. This SOP will be used as part of a routine monitoring program to document the nitrification capacities of the District's activated sludge processes.

Evaluation of a Quick Biochemical Oxygen Demand Test. A preliminary evaluation of the CheckLight Ltd. early biochemical oxygen demand test kit (Early BOD) was performed to determine if it could be used to predict five-day biochemical oxygen demand (BOD_5) concentrations of primary effluent with reasonable accuracy and reliability relative to the standard analyses performed by the District's Analytical Laboratory Division (ALD). Early BOD could be useful to the District for plant monitoring, decision making, and model development. The tested method uses the bioluminescence of an organism as an indicator of BOD_5 concentration. Stickney WRP Imhoff Tank effluent was used for the evaluation; however, the Early BOD results were significantly less than the BOD_5 results from ALD analyses (Table II-10). Based on the preliminary evaluation, there is not a good correlation between the BOD results from the early BOD tests for the Stickney WRP Imhoff tank effluent and the standard 5-day laboratory test.

TABLE II-1: 2002-2009 METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO WATER RECLAMATION PLANT BATTERY AVERAGE DAILY OPERATIONAL DATA

WRP	Battery or Tank	Sewage Flow (mgd)	BOD5 Load (tpd)	TKN Load (tpd)	MLSS (mg/L)	VSS (mg/L)	Air Flow (MCFD)	Temp. (°C)	F/M (lb BOD5/ lb MLVSS-day)	SRT (days)	HRT (hrs)	RAS Flow (%)
Calumet	A	50.7	17.3	3.7	2,452	1,704	22.9	nd	0.14	11	9.2	87
Calumet	B	47.0	15.9	3.4	2,446	1,705	25.5	nd	0.13	11	10.1	94
Calumet	C	42.2	14.5	3.1	2,742	1,903	27.1	nd	0.16	10	8.3	95
Calumet	E2	61.2	20.7	4.4	3,153	2,100	45.2	nd	0.15	9	7.4	105
Egan	North	13.0	4.8	1.2	2,184	1,856	11.7	17.2	0.23	10	6.2	75
Egan	South	13.0	4.8	1.2	1,892	1,608	11.7	17.2	0.26	16	6.2	75
Hanover Park	A	1.0	0.5	0.12	2,357	1,978	0.93	16.6	0.12	14	15.3	88
Hanover Park	B	2.7	1.4	0.31	2,411	2,024	2.24	16.6	0.17	13	10.2	56
Hanover Park	C	2.6	1.4	0.30	2,407	2,021	3.01	16.6	0.16	11	10.2	56
Hanover Park	D	2.6	1.4	0.30	2,432	2,048	2.85	16.6	0.16	10	10.2	56
Kirie	A	35.5	21.0	3.4	3,052	2,293	18.0	17.3	0.16	9	11.0	76
Lemont	Tank 1	0.7	0.3	0.07	2,475	1,975	1.22	20.3	0.12	18	10.1	nd
Lemont	Tank 3	0.7	0.3	0.07	2,500	1,980	1.22	20.3	0.13	18	10.5	nd
O'Brien	A	59.0	19.7	4.2	2,037	1,546	44.7	15.6	0.15	10	7.5	56
O'Brien	B	60.3	20.3	4.4	2,022	1,539	45.7	15.6	0.16	10	7.2	53
O'Brien	C	59.1	20.0	4.3	2,016	1,534	43.4	15.6	0.16	12	7.4	50
O'Brien	D	63.2	21.2	4.5	2,349	1,773	36.2	15.6	0.11	9	5.2	56

TABLE II-1 (Continued): 2002-2009 METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO
WATER RECLAMATION PLANT BATTERY AVERAGE DAILY OPERATIONAL DATA

WRP	Battery or Tank	Sewage Flow (mgd)	BOD5 Load (tpd)	TKN Load (tpd)	MLSS (mg/L)	VSS (mg/L)	Air Flow (MCFD)	Temp. (°C)	F/M (lb BOD5/ lb MLVSS-day)	SRT (days)	HRT (hrs)	RAS Flow (%)
Stickney	A	170.0	81.2	18.0	3,118	2,093	139	17.5	0.18	10	7.6	51
Stickney	B	171.0	71.9	18.1	3,124	2,062	137	17.5	0.19	8	7.6	66
Stickney	C	179.0	81.9	18.1	3,273	2,201	139	17.5	0.18	6	7.5	67
Stickney	D	87.0	85.6	19.1	3,105	2,165	166	17.5	0.19	8	7.1	90

nd = No data.

TABLE II-2: 2002-2009 METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO WATER RECLAMATION PLANT BATTERY AERATION BATTERY ENERGY COMPARISON

WRP	Battery/Tank	Air Flow/Sewage Flow (cf/gal)	Air Flow/Oxygen Demand (cf/lb)
Calumet	A	0.45	394
Calumet	B	0.54	479
Calumet	C	0.64	562
Calumet	E2	0.74	665
Egan	North	0.90	653
Egan	South	0.90	627
Hanover Park	A	0.91	569
Hanover Park	B	0.83	523
Hanover Park	C	1.14	706
Hanover Park	D	1.10	552
Kirie	A	0.59	310
Lemont	1	1.80	1,065
Lemont	3	1.80	1,052
O'Brien	A	0.81	708
O'Brien	B	0.76	696
O'Brien	C	0.78	672
O'Brien	D	0.62	545
Stickney	A	0.90	510
Stickney	B	0.88	501
Stickney	C	0.85	540
Stickney	D	0.96	558

TABLE II-3: AVERAGE PERCENT TANK LENGTH FOR COMPLETE NITRIFICATION DURING THE STUDY OF AERATION TANK PROFILES AT SEVEN WATER RECLAMATION PLANTS

Water Reclamation Plant	Battery/Tank	Average Percent Tank Length for Nitrification*
Calumet	A-1	62
Calumet	B-2	NNA
Calumet	C-5	90
Calumet	E2-14	33
Egan	N-1	64
Egan	S-1	68
Hanover Park	A-2	74
Hanover Park	B-4	86
Hanover Park	C-6	NNA
Hanover Park	D-8	80
Kirie	A-2	83
Kirie	A-4	83
Lemont	1	70
Lemont	3	42
O'Brien	A-5	NNA
O'Brien	B-8	NNA
O'Brien	C-5	NNA
O'Brien	D-2	NNA
O'Brien	D-4	70
Stickney	A-1	72
Stickney	B-2	NNA
Stickney	C-5	63
Stickney	D-1	NNA

NNA = Nitrification was not achieved by the end of studied tank for all monitoring days.

* = Nitrification is considered complete when the measured NH_3-N concentration at a tank location is below 0.5 mg/L. An average percent tank length for nitrification was only calculated if this standard was met on each monitoring day.

TABLE II-4: SUMMARY OF ADDITIONAL ANAEROBIC DIGESTION TESTS MONTHLY AVERAGE AND CALUMET WATER RECLAMATION PLANT PRIMARY DIGESTER MONTHLY AVERAGE FOR 2011

Month	Additional Digestion Tests Volatile Solids Reduction		Calumet Primary Digester VS Reduction (%)
	By Equation*	By Mass	By Equation*
January	14.14	14.29	43.91
February	11.06	10.88	53.29
March	19.65	17.86	49.52
April	21.75	18.87	44.47
May	16.82	16.20	35.81
June	15.73	16.42	26.56
July	13.69	15.63	40.49
August	7.42	11.00	28.15
September	1.68	9.84	43.69
October	15.04	12.39	45.95
November	24.55	24.57	43.64
December	13.35	15.45	44.12
Average	14.57	15.28	41.63
Minimum	1.68	9.84	26.56
Maximum	24.55	24.57	53.29

*Using the Van Kleeck Equation.

TABLE II-5: INFLUENT HAZARDOUS AIR POLLUTANT CONCENTRATIONS AT THE METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO'S THREE LARGEST WATER RECLAMATION PLANTS IN 2011[1]

Hazardous Air Pollutant Organic Compound	Concentrations (µg/L)		
	Stickney	Calumet	O'Brien
Dichloromethane	0.8	0.0	1.7
Chloroform	3.0	0.8	2.7
Benzene	0.0	1.0	0.0
Tetrachloroethene	0.0	0.0	0.4
Toluene	13.1	35.9	2.8
Carbon disulfide	0.0	3.0	0.0
Methyl ethyl ketone	6.2	0.0	0.0
Styrene	1.4	0.0	0.0
Xylene (total)	0.1	0.0	0.0
Cresol (total)	5.7	12.6	12.1
Acetophenone	0.0	25.9	0.0
Cumene	0.0	5.0	0.0
2,4-D, salts and esters	0.0	0.8	0.0
Acetaldehyde	49.3	0.0	0.0
Propionaldehyde	31.5	0.0	0.0
Acetonitrile	1.5	0.0	0.0

[1]Average results of the two influent samples collected in January and July 2011.

TABLE II-6: ESTIMATED HAZARDOUS AIR POLLUTANT EMISSIONS FROM THE METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO'S THREE LARGEST WATER RECLAMATION PLANTS IN 2011[1]

Hazardous Air Pollutant Organic Compound	Emissions (tons/yr)		
	Stickney	Calumet	O'Brien
Dichloromethane	0.1	0.0	0.1
Chloroform	0.3	0.0	0.1
Toluene	1.2	1.2	0.1
Carbon Disulfide	0.0	0.2	0.0
Methyl Ethyl Ketone	0.1	0.0	0.0
Styrene	0.1	0.0	0.0
Cumene	0.0	0.2	0.0
Acetaldehyde	1.3	0.0	0.0
Propionaldehyde	1.5	0.0	0.0

[1]Emissions estimated using the BASTE model.

TABLE II-7: SUMMARY OF JAMES C. KIRIE WATER RECLAMATION PLANT FILTER EVALUATION

Date[1]	Plant Flow, MGD[2]	Filters[3]	Filters Backwashing[4]	Net Filters in Service[5]	Low Lift Pumps in Service[6]	Average SS, mg/L		Maximum SS, mg/L	
						Pre-Filter	Post-Filter	Pre-Filter	Post-Filter
11/2/2010[7]	20.8	12	0	12.0	1	2	2	2	3
11/3/2010[7]	20.8	12	4	11.7	1	2	1	2	2
11/4/2010	20.1	12	0	12.0	1	9	5	50	32
11/8/2010	21.3	12	0	12.0	1	4	3	16	4
11/9/2010	20.6	12	0	12.0	1	2	1	3	3
11/15/2010	21.1	8	2	7.8	1	4	3	21	10
11/17/2010	19.1	8	4	7.7	1	2	1	3	2
11/22/2010	33.9	8	0	8.0	1	na[8]	3	na	5
11/23/2010	30.5	8	4	7.7	1	3	1	6	2
4/4/2011	37.9	12	0	12.0	1	9	6	28	21
4/5/2011	37.4	12	11	11.1	1	6	2	8	5
4/7/2011	28.6	12	6	11.5	1 (23 hrs); 2 (1 hr)	8	5	25	42
4/8/2011	57.3	12	11	11.1	1 (19 hrs); 2 (5 hrs)	7	3	14	6
4/12/2011	33.2	8	5	7.6	1	3	1	5	2
4/13/2011	30.8	8	6	7.5	1	3	1	5	2
4/14/2011	29.7	8	6	7.5	1	4	2	5	2
4/18/2011	57.7	8	6	7.5	1	8	5	8	9
4/19/2011	80.5	8	6	7.5	1	8	4	25	9

[1]Filter testing for each date was conducted for 24 hours beginning at 8 AM.
[2]Daily average plant flow beginning at 12 AM.
[3]Number of filters in service (12 total).
[4]Number of filters backwashing during measurement period (each filter backwash is approximately 2 hours).
[5]Net filters in service = (filters is service x 24 hrs. - number of backwashes x 2 hrs.)/24 hrs.
[6]Approximate Low Lift (or filter) Pump flow is 40 MGD.
[7]The filter influent was from Battery B, which provided additional settling after secondary clarifiers.
[8]Data not available due to sampler power failure.

TABLE II-8: CALUMET, STICKNEY, AND JOHN E. EGAN WATER RECLAMATION PLANT RECYCLE AND SIDESTREAM WATER QUALITY IN SAMPLES COLLECTED IN 2011[1]

	TKN (mg/L)	Sol TKN (mg/L)	NH_3-N (mg/L)	Tot P (mg/L)	Ortho P (mg/L)	Fe (mg/L)	Mg (mg/L)	pH
Calumet Gravity Concentration Tanks	118	91.0	42.4	49.0	21.2	32.9	42.2	7.0
Calumet Drying Cell Runoff	329	269.7	231.8	139.8	38.5	141.2	145.7	7.8
Calumet Lagoon Decant	1,185	899.5	824.8	127.7	85.9	19.6	15.7	7.9
Stickney Gravity Concentration Tanks	67	45.1	10.6	31.2	10.8	17.9	44.1	7.1
Stickney Post-Digester Centrate (North)	749	695.9	639.4	107.4	84.8	8.5	50.0	7.4
Stickney Post-Digester Centrate (South)	776	732.3	635.9	113.4	78.9	5.3	48.0	7.4
Stickney Pre-Digester Centrate	112	72.5	11.3	51.4	18.4	17.3	36.6	7.2
Egan Gravity Belt Thickener Filtrate	17	6.0	3.6	19.2	15.1	1.2	28.7	7.3
Egan Post-Digester Centrate	1,199	697.1	1,072.6	43.9	0.3	44.0	53.8	7.0

[1]Values are means of up to nine composite samples.

TABLE II-9: METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO CARBON FOOTPRINT 2005 AND 2008 THROUGH 2010

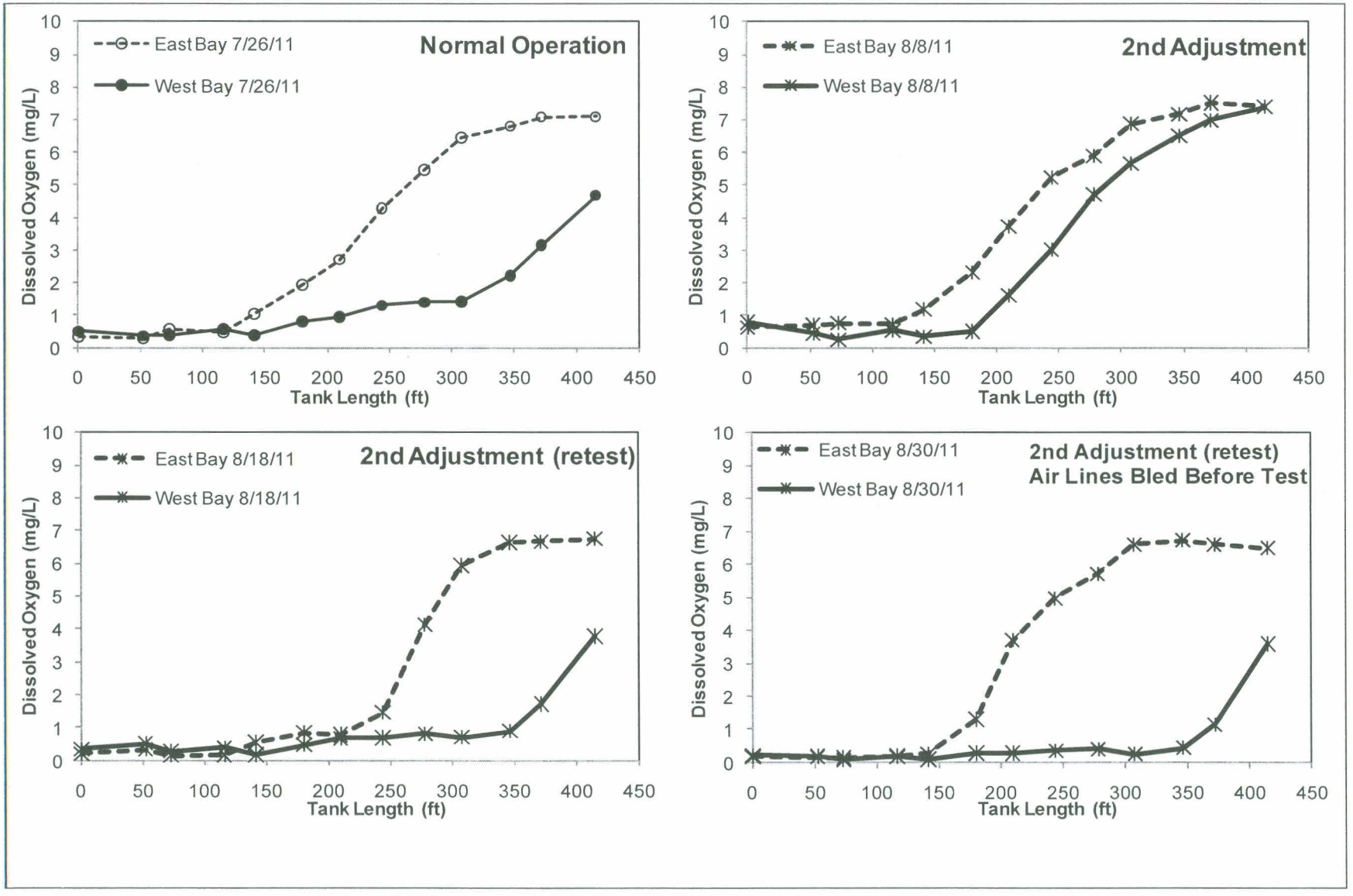
	CO_2-Equivalent (metric tons)			
	2005	2008	2009	2010
Electricity	383,927	431,789	437,000	422,415
Natural Gas	17,897	13,457	13,497	12,435
Diesel Fuel	712	1,722	1,341	1,255
Unleaded Fuel	1,807	1,542	1,461	1,398
Incomplete biogas combustion	4,242	4,947	4,493	4,289
Nonbiogenic biogas combustion emissions	0.28	0.33	0.3	0.28
Nitrous oxide emissions from plant	12,834	12,834	12,834	12,834
Nitrous oxide emissions from effluent	50,155	48,366	59,294	53,913
CO_2 Sequestration				
Forested land	-7,895	-7,895	-7,895	-7,895
Land-applied biosolids	-11,345	-11,345	-11,345	-11,345
Carbon footprint	452,334	495,417	510,680	489,300

TABLE II-10: RESULTS OF CHECK LIGHT EARLY BIOCHEMICAL OXYGEN DEMAND EVALUATION WITH A 150 MINUTE INCUBATION

Date	Early BOD, (mg/L)	BOD_5, (mg/L)	SS, (mg/L)
1/5/2011	11.12	70	85
2/16/2011	17.32	154	122
2/24/2011	12.84	84	114
2/24/2011	19.90	83	106
2/28/2011	14.12	88	108
3/15/2011	10.26	85	52
3/15/2011	14.32	44	174
3/24/2011	9.88	77	86
3/24/2011	16.61	84	126

BOD_5 determined by the Stickney WRP Analytical Laboratory.

FIGURE II-1: DISSOLVED OXYGEN PROFILES FROM TANK 8 OF BATTERY A AT THE TERRENCE J. O'BRIEN WATER RECLAMATION PLANT DURING THE AERATION TANK AIR VALVE ADJUSTMENT EVALUATION



BIOSOLIDS UTILIZATION AND SOIL SCIENCE SECTION

BIOSOLIDS UTILIZATION AND SOIL SCIENCE SECTION

The role of the Biosolids Utilization and Soil Science (BU&SS) Section is the application of science for continuous improvement in the cost effectiveness of the District's biosolids management program and environmental stewardship through:

1. Research, technical assistance, and public outreach;
2. Contribution to formulation of relevant regulations;
3. Compliance with applicable regulatory requirements;
4. National leadership in biosolids management;
5. Assistance on the District's green initiatives.

The long-range goals of the BU&SS 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 the 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 the 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.

During 2011, the BU&SS performed activities under the following three program goals:

Goal 1: Operations Monitoring

The activities conducted under the goal of monitoring environmental impacts include sampling and analysis of biosolids, waters, and soils as required at biosolids land application sites, landfills, and biosolids drying facilities. The results of this monitoring are reported to the IEPA and the USEPA.

Fulton County Environmental Monitoring. The Fulton County Land Reclamation Site consists of 6,122.5 hectares (15,264.5 acres) of land the District owns 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. 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 the Analytical Laboratory Division for analysis.

No supernatant or biosolids were applied to Fulton County fields during 2011. Supernatant was last applied in 1995, and biosolids were last applied in 2004. Termination of monitoring for 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 and 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) site located on the south side of the Hanover Park WRP, which utilizes all biosolids generated at the WRP. The farm has seven gently sloping fields, each surrounded by a berm to control surface runoff. Anaerobically digested biosolids are applied by subsurface injection. The IEPA operating permit (No. 2007-SC-2951-1) 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 are sampled quarterly, except Well No.7, which is monitored monthly. The analytical data for groundwater sampled from these wells were submitted to the IEPA in the quarterly monitoring reports for 2011 (Report Nos. 11-11, 11-34, 11-52, and 11-70).

Groundwater Quality Monitoring at Solids Management Areas. Groundwater quality is monitored at the 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. Following a request to the IEPA to reduce the monitoring frequency for groundwater quality at the SMAs, beginning January 2010, monitoring frequency was modified to quarterly for all lysimeters, except three, which are 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 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. 2010-AO-0266) 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 to the IEPA were not required in 2011.

Groundwater Quality Monitoring at the Calumet Water Reclamation Plant Solids Management Area. The paved drying cells at the Calumet West and Calumet East SMAs were constructed at the Calumet WRP in 1986 and 1990, respectively. The IEPA operating permit (No. 2010-AO-0265) for both facilities requires quarterly groundwater monitoring. Analytical data were submitted to the IEPA in the quarterly reports for water samples in 2011 from lysimeters at the Calumet West SMA (Report Nos. 11-08, 11-33, 11-48, and 11-66) and from lysimeters at the Calumet East SMA (Report Nos. 11-09, 11-31, 11-47, and 11-65).

Groundwater Quality Monitoring at the Lawndale Avenue Solids Management Area. In 1983, the District began biosolids drying operations on clay-lined cells at the Lawndale Avenue Solids Management Area (LASMA). These drying cells were paved with asphalt in 1984. The IEPA operating permit for this site (No. 2010-AO-0267) requires quarterly groundwater monitoring, except lysimeters L-4N and L-6N, which are monitored monthly. The analytical results for lysimeter and well samples collected in 2011 were submitted to the IEPA in quarterly monitoring reports (Report Nos. 11-12, 11-36, 11-50, and 11-69).

Groundwater Quality Monitoring at the Ridgeland Avenue Solids Management Area. In 1987, the District began biosolids drying operations on clay-lined cells at the Ridgeland Avenue Solids Management Area. These drying cells were paved with asphalt in 1992 and 1993. The IEPA operating permit for this site (No. 2010-AO-0267) requires groundwater monitoring. Beginning in 2010, monitoring of all lysimeters has been terminated, except lysimeter L-2N, which is monitored monthly. Analytical data for the lysimeter samples collected during 2011 at this site were submitted to the IEPA in quarterly monitoring reports (Report Nos. 11-13, 11-37, 11-51, and 11-68).

Groundwater Quality Monitoring at the Harlem Avenue Solids Management Area. In 1990, the District began biosolids drying operations at the Harlem Avenue Solids Management Area (HASMA). The IEPA operating permit for this site (No. 2009-AO-2715-1) requires quarterly monitoring of all lysimeters. Analytical data from lysimeter samples collected in 2011 were submitted in quarterly reports to the IEPA (Report Nos.11-10, 11-35, 11-49, and 11-67).

Groundwater Quality Monitoring at the 122nd and Stony Island Solids Management Area. In 1980, the District began biosolids drying operations on clay-lined cells at the SMA located at 122nd Street and Stony Island Avenue on clay surface drying cells. The drying cells were paved

with asphalt in 1992. The IEPA operating permit for this site (No. 2010-AO-0267) requires quarterly monitoring of all lysimeters, except lysimeter L-1, which is monitored monthly. Analytical data for lysimeter samples collected during 2011 from lysimeters at this drying facility were submitted to the IEPA in quarterly monitoring reports (Report Nos.11-14, 11-32, 11-46, and 11-64).

Biosolids Monitoring Under Process to Further Reduce Pathogens Certification. The BU&SS Section is responsible for maintaining the District's site-specific certification of process to further reduce pathogens (PFRP) for biosolids processing trains at the Stickney and Calumet WRPs, as awarded by the USEPA. In this certification, the District's air-dried biosolids generated according to a codified operation is designated as Class A according to pathogen standards under the USEPA 40 Code of Federal Regulations Part 503 Rule (Part 503). The monitoring program for this certification includes pathogen analysis of biosolids and semi-annual reporting to the USEPA. In 2011, two monitoring reports, 11-18 and 11-60 (as required by the certification), were submitted to the USEPA. The operation of PFRP-codified biosolids processing trains at the Stickney and Calumet WRPs and the Analytical Microbiology Laboratory, which conducts the pathogen analysis, were audited in 2011.

Biosolids Management Regulatory Reporting. In 2011, the BU&SS Section prepared the 2010 biosolids management report (Report No.11-06) to the USEPA. This report was prepared to satisfy the reporting requirements of the Part 503 regulation.

In addition, 12 monthly reports for the District's Controlled Solids Distribution (CSD) permit were submitted to the IEPA (Report Nos.11-20, 11-24, 11-27, 11-40, 11-44, 11-54, 11-58, 11-61, 11-71, 12-02, 12-03, and 12-04). The reports document the biosolids users, project descriptions and locations, and biosolids analyses. The CSD Program is the District's urban land-application program.

Goal 4: Technical Assistance

The BU&SS Section provides technical support to projects under the CSD Program in which exceptional quality, air-dried biosolids are used in the Chicago metropolitan area and to the Class B Biosolids Farmland Application Program. The technical support is done to help biosolids users maximize the benefits they receive from the program and to ensure that the District and the users comply with applicable regulations and permits. The BU&SS Section also conducts marketing activities to promote the use of biosolids under the CSD Program.

Controlled Solids Distribution Program. The activities the BU&SS Section conducted in 2011 to promote and support the CSD Program include:

1. Marketing activities and technical support on projects where 7,279 dry tons of biosolids were used as a soil conditioner or fertilizer topdressing by 14

schools, 34 park districts and suburban villages, eight golf courses, five landscaping companies, and two District properties.

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

3. Preparation of biosolids information pamphlets.

4. Conducted one field day at which attendees toured the Stickney WRP, biosolids demonstration plots and biosolids processing facilities.

Class B Biosolids Farmland Application Program. The activities the BU&SS Section conducted in 2011 to support the program include:

1. Reviewed 188 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.

2. Conducted field inspections and meetings with individuals and community groups in response to public concerns regarding the program.

Regulatory Review. The BU&SS Section conducts regulatory reviews in response to imminent regulations that can potentially affect District operations. Some of these reviews are requested by professional affiliations or organizations. In 2011, the BU&SS section conducted the following regulatory reviews:

1. At the request of the National Association of Clean Water Agencies, comments were provided on the USEPA's proposal to include sewage sludge destined for incineration in "Solid Waste" definition.

2 Two Illinois House Bills to amend the Illinois Environmental Protection Act:

   i. HB 1441 – proposal to allow municipalities to impose a penalty for substances released from land that can be deemed as hazardous.

   ii. HB 806 – proposal to reduce the duration of stockpiling of biosolids and to impose a requirement for land appliers to notify the community before application of biosolids on farmland.

Part of M&R's response to these bills included preparation of a report on the operations and public relations program of the District's Farmland Application Program (Report No. 11-16).

Stickney Water Reclamation Plant's Permeable Pavement Project. In this project, the District is evaluating porous pavement technology for stormwater management in the Chicago metropolitan area. Three different permeable pavements (paver stone, concrete and asphalt) were established on driving areas and parking slots on the general parking lot at the Stickney WRP. In 2011, the BU&SS Section assisted in conducting evaluations of the permeable pavements. Permeability of the pavements measured in 2011 is shown in Table III-1. Permeability of different surfaces varied and was in the order concrete > asphalt > paver stone and was generally lower in the driving area than in the parking area.

Native Landscaping. During 2011, the BU&SS Section provided technical support for maintenance of the conventional and native prairie landscaping at the District's facilities.

Goal 5: Applied and Operations 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 organizations and institutions.

Corn Fertility Experiment at Fulton County Site. 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. In 2010, these plots were abandoned and new plots were established in 2011.

The new long-term biosolids experimental plots were established in Field 83, which consists of unmined land at the Fulton County site. The experiment was designed to obtain more information compared to the information received from the abandoned plots. The experiment will evaluate the effect of unaged biosolids to support the Farmland Application Program and the effect of aged, air-dried biosolids to support the CSD Program. The effect of applying biosolids every three years is compared to the annual application to evaluate the three-year rotation as an option to minimize build up of biosolids-borne P in soil, as future state regulations may stipulate P-based agronomic rates of biosolids. The effect of removing corn stover is studied to evaluate crop production and harvesting for bioenergy. Therefore, the study includes 32 plots consisting of four replicates of the following treatments:

1. AB1: Aged biosolids (annually)
2. AB3: Aged biosolids (every 3 years)
3. UAB1: Unaged biosolids (annually)
4. UAB3: Unaged biosolids (every 3 years)
5. AB1-R: Aged biosolids (annually) with stover removal
6. UAB1-R: Unaged biosolids (annually) with stover removal
7. NPK+FYM: NPK fertilizer with farmyard manure
8. C: NPK fertilizer control

No reportable data were obtained from the study in 2011 because the corn crop planted in the plots was severely damaged by turkeys, and no reliable yield data or samples could be collected. An extended buffer of corn crop will be used in the future to protect the plots from damage by wildlife.

Tracking Sources of Phosphorus into the Metropolitan Water Reclamation District of Greater Chicago's Water Reclamation Plants. The District is evaluating the potential of reducing P input into its wastewater treatment streams as an approach to reduction of P in WRP effluents to meet future wastewater effluent P regulatory limits and reduce P loading to surface waters. A study was conducted to quantify the sources of P in wastewater influent at the District's Calumet, North Side, and Stickney WRPs and the potential of controlling P input by harvesting P from sources such as industries. To estimate industrial input into the three WRPs (Calumet, North Side, and Stickney), District staff collected samples (24-hour composites every day for four to seven days) and monitored the flow of industrial effluent being discharged by 43 industries in the service area of these WRPs. The samples were analyzed for total P and soluble P by the Analytical Laboratories Division. Contributions of P from other sources were determined based on estimated per capita contributions using published literature and some assumptions.

The study showed that of the combined influent P loading of 9,817 tons/year from the three WRPs, less than 29 percent was from domestic sewage and almost 23 percent was from industry. The recycle streams at these WRPs are also a major source of P, contributing about 18 percent of the influent P. Lesser contributors included stormwater, detergents, food waste, dogs, and drinking water.

Effect of Moisture and Storage on Biosolids Odor. Air-dried biosolids produced by the District's solids processing trains are utilized as a fertilizer and soil amendment under the CSD Program. These air-dried biosolids often develop odor when stockpiled (or stored) for more than one week. The potential for odor has a negative impact on the cost effectiveness of biosolids

management because odor emissions from stockpiled biosolids can be a nuisance when they are used at some sites. This limits the District's ability to store air-dried biosolids to make them available year-round. An understanding of the factors that contribute to the development of odors when air-dried biosolids are stored in stockpiles will help in identifying methods that can be used to produce air-dried biosolids to increase public acceptance, year-round availability, and the overall market value of biosolids under the CSD Program. The residual moisture (20 – 40 percent) in the District's stockpiled air-dried biosolids appears to be a cause of odor because moisture tends to facilitate increased microbial activity and results in emission of odorous organic and sulfur-containing compounds. Therefore, in this study, we hypothesized that there is a critical moisture level at which microbial activity in stockpiled biosolids is significantly reduced with minimal potential for odor emissions, and that this can be achieved with little modifications to current operations.

In July 2010, a batch of biosolids was air-dried to six different targeted solids content (55 – 80 percent solids) on the drying bed and 40 cubic yards of each of the six biosolids were stockpiled inside a garage at HASMA. The stockpiles were scheduled for sampling biweekly during the first 2 months and after 8 and 12 months of stockpiling. The samples were tested for odor emissions and chemical and physical properties to evaluate changes in biological stability over time. Odor was measured using an olfactometer in units of ED50. The data in Table III-2 show that odor (ED50) in the six stockpiles increased during the first 15 days, but the odor decreased afterwards. The wetter stockpiles tended to dry out over time, and after one year, there was a narrow range in the solids content of the stockpiles.

Biosolids Composting Using Low Rates of High Carbon Materials. The process of producing Class A air-dried biosolids at the District includes lagoon-aging followed by air-drying. When the air-dried product is stockpiled during storage, it has the potential to produce odors because it is not well stabilized. The District has begun an initiative to evaluate the potential of producing value-added biosolids products, such as composted biosolids, which has a lower potential to produce odors. As part of this initiative, a composting study was started in 2011. In this study, composting of various blends of biosolids and high carbon:nitrogen (C:N) ratio materials using minimal modifications to current District biosolids drying operations was evaluated to determine the effect on biological stability and odor potential of the final air-dried product. The study includes two types of biosolids: lagoon-aged (aged biosolids) and unaged centrifuge cake biosolids, and three types of locally available high C:N ratio materials: tree leaves, wood chips, and landscape waste mixture (LWM). Each type of biosolids was mixed with a high C:N ratio material at the ratio of 2:1 (w/w) biosolids:high C:N ratio waste. There were two additional ratios for LWM treatments at 4:1 and 1:1 biosolids:LWM. The biosolids and high C:N ratio materials were blended with a mechanical auger and spread on a paved bed at the LASMA site for two weeks, with additional mixing to increase the solid content to 35 percent. The mixtures were then piled into windrows 5 feet wide, 4 feet high and 50 feet long. During the first 15 days (composting period), the internal temperature was measured, and the windrows were turned every three days. After the composting period, the windrows were allowed to "cure" for an additional 14 weeks and were turned every three weeks during that period. Samples of the composted materials were collected at the end of the curing period.

Odor emission tests and chemical analysis were done on the samples. Odor emission tests were done by a panel of technicians. The samples collected in 1 L polyethelene bottles were randomly arranged and "sniffed" by the odor panel. The intensity of the odor was ranked on a scale from 0 to 10 that were established based on three reference materials: Kankakee County sandy soil (0), typical District air-dried biosolids (5), and centrifuge cake biosolids (10). To evaluate the effect of rewetting of the dried composted biosolids products, the original sample was wetted to achieve approximately 50 percent solids content, and the rewetted materials were left to incubate in the laboratory for two weeks. Odor emissions from the wetted samples were measured by the odor panel.

The mean temperature during the composting period, the odor rating, and concentration of nitrogen species of the composted materials are presented in Table III-3. The odor of all the composted materials was lower than the odor of typical District air-dried biosolids, and odor potential increased only slightly upon rewetting of the materials. The total Kjeldahl nitrogen and ammonia nitrogen in the composted materials generally decreased as the amount of high C:N ratio waste increased.

Fate and Transport of Biosolids-Borne Triclosan and Triclorban. Triclosan (TCS) and triclorban (TCC) are the active ingredients heavily used in the antibacterial product market, and these compounds are discharged from industries and household drains to become influent to wastewater treatment plants. In 2008, the District began a study in collaboration with the University of Florida to conduct laboratory and bench scale tests on samples of District biosolids to determine the levels of TCS and TCC in the biosolids and the fate of these compounds in biosolids-amended soil. This study was completed in 2011 and the final report is being prepared.

Plant Uptake of Perfluorinated Compounds in Biosolids-Amended Soil. The occurrence of perfluorinated compounds (PFCs) in biosolids and the potential risk of transport of these compounds through the food chain are emerging concerns that have to be addressed to ensure public acceptance and long-term sustainability of biosolids application to farmlands. The District is collaborating with the USEPA, Region 5 and Colorado School of Mines (CSM) to generate data on the uptake of PFCs by plants grown in biosolids-amended soils for an evaluation of exposure risks to humans. As a part of this collaboration, the District initiated a three-year field study and established research plots on the Main Stream Pumping Station ground in 2011. The study consists of plots amended with four rates of biosolids application including control plots that receive only the recommended dose of commercial fertilizers. All plots are planted with corn and four vegetable crops, i.e., tomatoes, zucchini, carrots, and lettuce. The soil and plant tissue samples are collected at the time of crop maturity and shipped to CSM for analysis of PFCs. Data for the samples collected in 2011 will be available in 2012.

Use of Biosolids in Ecological Restoration. As part of the District's efforts to promote the use of biosolids in the City of Chicago, this project was initiated in 2009 to address issues raised by the United States Fish and Wildlife Service and other stakeholders regarding the potential use of biosolids for the ecological restoration of degraded lands in Chicago's Calumet region.

The project was conducted in collaboration with The Ohio State University. The study consisted of field plots in which biosolids and other recyclable materials were used as a soil amendment, and the effects of these amendments on soil biology and concentration of potential contaminants in runoff water were evaluated. The data collection phase of the study was completed in 2011, and the final report is being reviewed.

TABLE III-1: PERMEABILITY OF DIFFERENT PERMEABLE SURFACES AT THE PARKING LOT OF THE STICKNEY WATER RECLAMATION PLANT

Area	Paver Stone	Concrete	Asphalt
	---------- Permeability (inches/sec) ----------		
Driving area	0.21±0.01	0.80±0.10	0.79±0.07
Parking slot	0.35±0.03	0.99±0.06	1.13±0.06

TABLE III-2: ODOR IN SIX STOCKPILES OF AIR-DRIED BIOSOLIDS AT VARIOUS SOLIDS CONTENT DURING ONE YEAR OF STORAGE

Treatment	Days after stockpiling						
	0	15	30	45	60	240	365
	----------Odor (ED50[1])----------						
Stockpile 1	36	122	81	110	63	18	20
Stockpile 2	52	559	73	94	1	24	10
Stockpile 3	27	199	71	205	93	41	98
Stockpile 4	75	321	215	292	29	48	22
Stockpile 5	24	376	125	441	129	85	55
Stockpile 6	28	205	113	113	79	21	16
	----------Solids content (%)[2] ----------						
Stockpile 1	61	64	66	67	70	68	72
Stockpile 2	63	70	67	69	73	73	72
Stockpile 3	73	77	77	77	80	73	75
Stockpile 4	75	77	74	79	81	75	76
Stockpile 5	76	77	79	80	81	73	76
Stockpile 6	77	80	80	79	82	78	79

[1]Odor measured using olfactometer in units of ED50.
[2]The range in initial (Day 0) solids content was different than planned due to moisture loss during transportation and stockpiling.

TABLE III-3: MEAN WINDROW TEMPERATURE DURING FIFTEEN DAYS OF COMPOSTING BIOSOLIDS WITH VARIOUS RATIOS OF HIGH CARBON TO NITROGEN RATIO MATERIALS AND ODOR AND TOTAL KJELDAHL AND AMMONIA NITROGEN 14 WEEKS AFTER COMPOSTING

Treatment[2]	Mean Temperature	Odor Strength[1]		TKN	NH_4-N
		Original	Rewet		
	------C°-----	-------Scale (0-10)[3]-------		------%-----	----mg kg^{-1}----
AB	32.1	6.5	6.1	2.81	637
AB + TL (2:1)	35.8	1.7	4.3	2.69	70.8
AB + WC (2:1)	34.1	1.5	3.0	2.53	56.0
AB + LWM (4:1)	34.7	1.9	2.9	2.55	91.8
AB + LWM (2:1)	38.0	2.1	2.0	2.40	13.3
AB + LWM (1:1)	41.0	2.1	1.8	2.49	28.5
UAB	34.6	3.9	2.9	2.65	32.3
UAB + TL (2:1)	41.6	1.9	1.8	2.45	22.5
UAB + WC (2:1)	44.0	1.7	2.2	2.24	4.3
UAB + LWM (4:1)	46.7	2.2	3.3	2.36	39.8
UAB + LWM (2:1)	46.2	1.8	2.0	2.08	29.8
UAB + LWM (1:1)	54.8	1.7	2.0	2.01	14.5

[1]Odor of original sample (45 – 77 percent total solids) collected 14 weeks after 15-day composting and original sample rewetted, as needed, to 50 percent total solids.
[2]AB = aged biosolids; UAB = unaged biosolids; TL = tree leaves; WC = wood chips; LWM = landscape waste mixture.
[3]Odor strength tested by odor panel and ranked based on rating for reference materials: Kankakee County sandy soil = 0, typical District air-dried biosolids = 5, centrifuge cake biosolids = 10.

ANALYTICAL MICROBIOLOGY AND BIOMONITORING SECTION

ANALYTICAL MICROBIOLOGY AND BIOMONITORING SECTION

Section Mission, Goals and Objectives

The Analytical Microbiology and Biomonitoring Section (AMBS) mission is to provide on-time, high quality, cost-effective microbiological monitoring and research services to support the EM&RD's five program goals. These five goals correspond to the EM&RD's mission to protect and improve the District's facilities, operations, environment and public health. The AMBS's role is to:

- Conduct microbiological monitoring of liquid and solids for operational control and regulatory reporting requirements and to monitor the environmental impacts of District operations to assess compliance with all regulations and properly assess the impacts of District operations.

- Address and provide monitoring support to the District's sustainable operation improvements (disinfection, nutrient, and storm water control) to fulfill the emerging regulatory development in meeting the CAWS recreational development and environment improvement.

- Promote employee self-development, education, public awareness, and acceptance of the District's operations.

The AMBS is equipped with the latest technologies and staffed with highly knowledgeable professionals and skilled technical staff, who are organized into five dedicated state-of-the-art laboratories to perform specialized monitoring and/or research activities. These specialized groups are:

I. Analytical Bacteriology Laboratory (ABL)

II. Biomonitoring/Wastewater Microbiology Laboratory (BL/WML)

III. Parasitology Laboratory (PL)

IV. Virology Laboratory (VL)

V. Molecular Microbiology Laboratory (MML)

As part of EM&RD's reorganization, the biomonitoring program was transferred from the AMBS to the Aquatic Ecology and Water Quality (AEWQ) Section in December of 2011. The BL program was replaced within the AMBS by the WML and MML programs.

Overview of Section Activities

The AMBS goals were achieved by maintaining the following core objectives:

- Illinois Department of Public Health certification of the ABL, Registry #17508 (Figure IV-1), for the examinations of: 1) Heterotrophic bacteria, heterotrophic plate count (HPC); 2) Total coliform (TC) with *Escherichia coli* (EC) broth verification examination of water from public water supplies and their sources (membrane filtration [MF] and multiple tube fermentation [MTF]); 3) Fecal coliform (FC) examination of water from public water sources (MF and MTF); 4) 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]).

- Continued establishment of a well-maintained laboratory control and analysis program. Employment of test methods with comprehensive 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.

- Ensured that staff are trained by completing the demonstration of capability which enables them to perform analyses according to the laboratory SOPs and the Quality Assurance Program (QAP).

- To reduce monitoring costs, the bacteriological test procedure for the Ambient Water Quality Monitoring (AWQM) program was amended by discontinuing the EC monitoring.

- Monitored 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.

- Updated SOPs and the QAP, and implemented QA policies and essential applicable QC procedures to assure test validity.

- Increased the number of analyses that can be performed to more efficiently support the District's research and operation(s) programs.

- Replaced obsolete equipment and upgraded facilities by finding the most cost-effective ways to meet the regulatory requirements.

- Fostered a "zero defects" commitment or course of action for all staff. This commitment seeks to produce analytical data and services of the highest quality attainable.

During 2011, the AMBS performed activities under the following five program goals:

Goal 1: Operations Monitoring

To achieve the EM&RD mission's critical goal of liquid and solids monitoring and reporting, the AMBS completed the following activities.

National Pollutant Discharge Elimination System Required Water Reclamation Plant Effluent Monitoring. Under the NPDES program (Section 402 of the Clean Water Act), the ABL conducted membrane filtration analyses of FC bacteria to monitor and evaluate the District's WRP effluents for their respective operating permit requirements. The ABL performs routine FC bacteria monitoring (one day/week/WRP) of the final treated effluent samples from each of the District's seven WRPs. The Hanover Park, Kirie and Egan WRPs have a seasonal disinfection requirement from May 1 through October 30 of each year. During the seasonal disinfection period, FC bacteria are analyzed five days/week from these three District WRPs. The ABL performed FC analyses on a total of 680 samples from the District's seven WRPs. FC analysis results of disinfected and tertiary treated final effluent samples are available to WRP managers within 24 hours of the start of analyses. These data were used as a guide in maintaining proper treatment operation/disinfection at the District WRPs and for reporting compliance with NPDES permit regulations.

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 discharge primary treated and disinfected effluent to the receiving streams. In 2011, the ABL performed analyses of FC bacteria on storm-related excess flow discharge events at District WRPs. Three storm-related excess flow samples were analyzed from the Egan WRP on April 20, May 30, and July 23, 2011.

National Pollutant Discharge Elimination System Required Effluent Biomonitoring. Under the NPDES permits' special condition, the BL conducted the following acute tests: a) Fish (Fathead minnows)-96 hour Static LC 50 Bioassay; and b) Invertebrate (*C. dubia*)-48 hour Static LC 50 Bioassay, which are know as the Whole Effluent Toxicity (WET) tests, to monitor and evaluate the District WRP's treated final effluents for any adverse effects (toxicity) to aquatic life.

Four acute WET tests on the Egan WRP's effluent and two acute WET tests on the Lemont WRP's effluent were conducted for NPDES permit compliance. No acute toxicity was observed. The acute WET test method and procedures were in accordance with the USEPA's established protocol following an approved SOP and QAP (EPA, 2002)[1]. For each test performed, ongoing laboratory quality performance was continually evaluated by performing reference toxicant tests (RTT) using sodium chloride. All RTTs were performed using the

[1]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.

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. All twenty RTTs conducted were valid. The BL participated in the Discharge Monitoring Report Quality Assurance Program, established by the USEPA, by conducting toxicity tests of unknown samples. The results were within the acceptable ranges.

Whole Effluent Toxicity Test Training. In order to facilitate the transition of the WET testing program to the AEWQ section, a comprehensive training program was developed and AEWQ staff was trained in 2011. The training consisted of hands-on demonstrations on organism culturing/maintaining, preparation of samples, WET testing, chemical analysis of samples, QA/QC, statistical analysis of WET tests and report preparation. Reference toxicant tests were carried out for Demonstration of Capabilities for both organisms by six of the AEWQ section technical staff and two supervisors.

United States Environmental Protection Agency 40 Code of Federal Regulations Part 503 Rule Compliance – Biosolids Monitoring. Part 503 regulations require that biosolids applied to land meet specific pollutant limits, site restrictions, management practices, and/or pathogen concentrations and vector attraction reduction processes. The AMBS analyzed lagoon-aged, air-dried biosolids for the detection and enumeration of FC bacteria, viable *Ascaris* ova (Helminthes), and culturable enteric viruses in accordance with the USEPA established protocol (EPA/625/R-92/013, July 2003 and EPA-821-R-06-013, July 2006[2]). These analyses were done to determine compliance with the Part 503 Class A biosolids pathogen criteria, and to meet the pathogen monitoring requirements of the site specific Process to PRFP certification of the Calumet and Stickney solids processing trains awarded by USEPA. The laboratory maintained a high standard for QA and QC. All laboratory procedures were conducted in accordance with an approved QAP and SOP. An internal audit of the laboratories was conducted on May 13, 2011. The audit report indicated that the microbiological analytical methods, chain of custody, data/record archiving and retrieval, and quality assurance protocols are in compliance with Part 503 methodology requirements for bacteria and pathogen analysis. The BU&SS section submitted all pathogen analysis data to the USEPA in semi-annual and annual reports.

Fecal Coliform Bacteria Monitoring. The ABL analyzed 41 biosolids samples and performed 44 SOP required QC analyses for site-specific PFRP equivalency monitoring and for compliance with Part 503 biosolids regulations. Samples were analyzed to determine site specific PFRP equivalency monitoring and for compliance with Part 503 biosolids bacteria limitations. The analytical results are presented in Table IV-1. The biosolids generated by the District's solids process train are monitored for FC bacteria to meet Class A criteria (<1,000 FC MPN/100 g dry wt) prior to any beneficial land-use application.

[2]Method 1681: Fecal Coliforms in Sewage Sludge (Biosolids) by Multiple-Tube Fermentation using A-1 medium, July 2006, EPA-821-R-06-013.

Viable Ascaris Ova (Helminthes) Monitoring. The PL analyzed 16 biosolids samples, performed 14 sand control and 16 QC analyses as is required for site-specific PFRP equivalency monitoring and for compliance with Part 503 biosolids regulations. The USEPA 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. Two 300g and fourteen 50g samples were analyzed.

The PL uses a state-of-the-art microscopic image analysis (MIA) system 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 a slide to the computer workstation (Figure IV-2). The video imaging allows staff to record and document images of viable *Ascaris* ova (Figure IV-3). Digital images were stored and analyzed using the MetaVue™ version 7.7 (Molecular Devices LLC, California) imaging software. 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).

Culturable Enteric Virus Monitoring. The VL analyzed 16 biosolids samples and performed 16 QC analyses as is required for site-specific PFRP equivalency monitoring and for compliance with Part 503 biosolids regulations. The VL maintained a high standard for QA & QC. All VL procedures were conducted in accordance with the USEPA established protocol and an approved QAP and SOP for determining the density of enteric viruses in biosolids (EPA/625/R-92/013, July 2003). 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 QC-required positive recovery studies were performed on all samples for quality assurance purposes. The mean recovery of spiked viruses was 34.5 percent. Recoveries ranged from 5.2 – 97.7 percent and were dependent upon the sample spiked (Table IV-1).

Groundwater Monitoring Wells. The quality of groundwater is monitored at Solids Management Areas around biosolids processing and application handling sites. The presence and density of FC in groundwater wells samples were determined. The Biosolids Utilization and Soil Section reported the analytical results to the IEPA as part of the quarterly monitoring reports.

Goal 2: Waste Monitoring

Microbiological Monitoring to Support the Pre-Treatment and User Charge Programs. The ABL conducted FC bacteria analyses of seven industrial waste survey samples to track the pollution sources and investigate the discharge quality as required for the industrial waste code compliance.

Goal 3: Environmental Monitoring

The AMBS supported a variety of programs under this goal by microbiological monitoring of the CAWS, Lake Michigan, the TARP, the Illinois waterway, and other miscellaneous samples. Bacterial indicator analyses for TC, FC and/or EC are used by the District as indicators of the sanitary quality of water. Table IV-2 shows a summary of the major programs receiving support for the year 2011 and the number of analyses for each program. Bacteriological data were reported on time to assess compliance with regulations. The indicator bacteria types and number of analyses performed in 2011 are presented in Table IV-3. Described below are the activities conducted under the environmental impact assessment goal.

Illinois Waterway Monitoring. Since 1984, the District has been involved in a comprehensive AWQM program to assess the chemical and microbiological quality along the Illinois Waterway from the Lockport Lock to the Peoria Lock. Water samples are collected from 49 sampling stations along 133 waterway miles during May, August, and October. The primary purpose of the monitoring program is to assess microbiological quality changes downstream of the District's major point source (treated final effluent) discharges. The IEPA utilizes water quality data to assess water quality in the District's service area.

Chicago Area Waterway System Monitoring. Under the AWQM program, the bacteriological quality at 59 monitoring stations in the CAWS is assessed. Water samples are collected for FC bacteria monthly at each of the 59 stations. In addition, water samples for EC are collected quarterly at each of the 59 stations. A review of the past three years (2008-2010) of data showed no significant change in FC and EC bacteria density (Table IV-4). In addition, the District Report (2004-10) has long established high EC/FC ratio in the District's treated effluent (0.97), Calumet River (0.93) and Des Plaines River (0.92). Thus, given the high EC monitoring cost and the overtime incurred for the analyses, the EC test in the AWQM was discontinued for bacteriological analysis. The AWQM plan was modified to include only monthly analyses for FC bacteria. The EC monitoring was discontinued as of September 14, 2011. This revision is in agreement with the IEPA proposed effluent standard requirement of FC bacteria monitoring.

Tunnel and Reservoir Plan. The District conducts groundwater monitoring for the TARP Systems as required by IEPA. The groundwater monitoring for the six TARP systems includes the Mainstream, Calumet, Des Plaines, and Upper Des Plaines Tunnel Systems, the Gloria Alitto Majewski Reservoir, and the Thornton Transitional Flood Control Reservoir.

The WTPR section reported the analytical results to the IEPA annually.

Lake Michigan Monitoring. Monitoring of Chicago's harbors was conducted when river reversals to Lake Michigan occurred due to heavy rainfall in the Chicagoland area. In 2011, there were two reversals to Lake Michigan as a result of an exceptionally large volume of rainfall. During these river backflow events, the ABL conducts water quality monitoring to assess

the impact of the release of CAWS water to Lake Michigan. Samples were collected and analyzed for FC and EC. The report titled, "Bacteriological Monitoring Report of River Back-flow Samples in 2011" describes the results of microbiological sampling for bacteria during storm water and combined sewage discharged to Lake Michigan (M&R Report No. 12-32).

Special Condition Monitoring in the James C. Kirie Water Reclamation Plant Service Area. At the request of the IEPA and in an effort to verify the CSO discharges in the Kirie WRP basin, the District developed the post-construction monitoring program for the Weller Creek and Feehanville Ditch. A total of eight samples, from each of four dry and wet weather events, were analyzed for FC bacteria. The FC results were provided to M&O.

Goal 4: Technical Assistance

The activities under this goal aimed to address and generate microbiological monitoring of the District's WRP treatment process operations to evaluate process control, advance sustainable operation and/or improvements to support regulatory development, and minimize its impact on the CAWS.

Wastewater Microbiology Laboratory. The WML program was developed to address the following objectives.

1. Microscopic Examination. Analysis of mixed liquor samples from the District's seven WRPs to determine the relative abundance of protozoan and metazoan species; identify and quantify filamentous bacteria; and to characterize the health of the biological floc.

2. Provide technical support and consultation to the WTPR Section and M&O Department during treatment system upsets, and/or for plant optimization research.

Microbiological Examination. In 2011, the routine microscopic examination program was transferred from the WTPR Section to the WML. The WML began a more detailed assessment of the type, relative abundance and behaviors of the microorganisms in the District's WRPs. Microscopic examinations were conducted in accordance with approved SOPs. A reference manual was developed which included handouts describing the various protozoan and metazoan types, the shape, size and color of activated sludge floc, as well as descriptions of various types of filamentous bacteria.

Samples from each WRP were examined on a rotating bi-weekly schedule. The WML laboratory performed microscopic examinations on 304 activated sludge samples. The microscopic examinations included characterizing the dominance and abundance of protozoa and metazoan types, the abundance and types of filamentous bacteria present as well as assessing floc

characteristics. The results for each sample were summarized on report that is posted in a public folder on the District intranet.

The microscopic examination data, recorded as counts per milligram of volatile suspended solids (counts/mg VSS) were compared to WRP process control test parameters. Floc color, the number of shelled protozoa and metazoan, the number of zoogleal masses and the total filament count was directly related to the sludge volume index (SVI). SVI is used as an indicator of sludge settling characteristics. Comparisons of the microscopic examination data with the SVI at the District's WRPs are shown in Figures IV-4 through IV-5. Common filamentous bacteria observed in the District's activated sludge are shown in Figure IV-6.

Technical Support. Special examinations and assessments for North Side, Calumet and Egan WRPs were performed in order to closely monitor plant performance during critical winter operations and plant upset conditions. Additional examinations and assessments were performed on Stickney WRP samples to assist with the evaluation of nitrification in the system and on samples from the Hanover Park WRP to assist with the identification and control of problematic filamentous bacteria. The microscopic assessment results provided an additional diagnostic tool to assist M&O to improve treatment operations.

Water Reclamation Plant Bacteriological Sampling Program. At the request of M&O, the AMBS reviewed the sampling programs for quality assurance. The purpose of the review was to evaluate and determine the validity of the overall procedures established for on-site sampling, including the suitability of sample preservatives, equipment and rinse water, and sample transport and storage conditions. The bacteriological sampling protocol was revised to provide standardized guidance with additional quality control and assurance assessment measures for microbiological sample collection to ensure proper handling of samples and to avoid any sampling-related errors that may cause permit violations.

An on-site training session was conducted on November 2, 2011, at the Hanover Park, Kirie, and Egan WRPs.

Disinfection Study. The AMBS provided support to the WTPR section, Engineering, and M&O Departments for the following disinfection studies.

Ultraviolet Collimated Beam Tests. The UV collimated beam tests were performed by the WTPR section to determine the effect of individual additives on irradiation dose response of EC bacteria. Stock solutions were prepared by adding EC (BioBall®, BioMérieux, Inc.) to deionized water to achieve a bacteria concentration of approximately 10,000 CFU/100 mL. A series of experiments was conducted with different additives (Kaolinite, alum, $FeCl_3$, $FePO_4$) treatments: 1) Kaolinite as suspended at 0, 5, 15, 40 mg/L (particle size = 105-250 μm); 2) alum at 0, 2, 4, 10 mg/L; 3) $FeCl_3$ at 0, 2, 4, 10 mg/L; and 4) $FePO_4$ at 0, 1, 3, 5 mg/L. All additive treatments were then subject to UV irradiation at 0, 5, 10, and 20 mJ/cm^2. During January 27 through

March 31, 2011, approximately 232 samples were analyzed for FC and/or EC. A second phase of the research continued with 161 bacteria analysis to determine the impact of high turbidity samples on UV disinfection efficiency. The final phase included bacteria analyses of 98 secondary effluent samples from the North Side and Calumet WRPs.

Peracetic Acid Disinfection System Evaluation. The ABL conducted 12 FC analyses in order to pretest and evaluate the disinfection efficiency of peracetic acid on secondary treated effluent from the North Side and Calumet WRPs.

Thornton Transitional Reservoir Bacteria Monitoring. As requested by the Engineering Department, sampling and analysis for FC bacteria were conducted on March 16, 2011. A composite of ten small grab samples was collected from different locations along the perimeter of the entire pile in the west pit of the Thornton Transitional Reservoir. An additional two control samples were collected from the dry reservoir area. A memorandum including the FC bacteria result was transmitted to the Engineering Department.

Microbiological Monitoring of Biosolids Composting Research. The AMBS provided analytical support to the BU&SS research on partially air-dried biosolids composting with various proportions of landscape wastes to produce a high quality Class A product. The sampling for the project was scheduled for the first quarter of 2012, which required final composted biosolids to be tested for FC and enteric bacteria. The density of pathogenic enteric bacteria (*Salmonella* spp.) in Class A biosolids for unrestricted use must be less than three most probable numbers per four grams of total solids (dry weight basis) at the time the biosolids are used utilized.

The analytical support request for this research highlighted the need to update the method for *Salmonella* spp. monitoring in Sewage Sludge (Biosolids) by Modified Semisolid Rappaport-Vassiliadis medium[3]. The QC requirements for the analysis of samples using this method included an initial demonstration of laboratory capability through performance of the initial precision and recovery (IPR) and the ongoing demonstration of laboratory capability through performance of the ongoing precision and recovery (OPR) analysis and matrix spike (MS) analysis. For the IPR, OPR and MS analyses, it was necessary to conduct testing prior to method implementation. Four biosolids control samples were analyzed for *Salmonella* spp. in December 2011 for updated method validation in preparation for the analyses of samples due in the first quarter of 2012. FC analyses were also performed on eight composted biosolids samples.

Drinking Water Monitoring. The ABL continued to respond immediately to all requests to analyze drinking water at District facilities on an as-needed basis. The ABL collected samples upon request from the Lemont WRP facility that is not serviced by the public drinking water system. In addition, the ABL continued the sampling of the drinking water at the Lockport Powerhouse. A total of 13 samples were collected from Lockport Powerhouse and three samples

[3]EPA Method 1682: *Salmonella* in Sewage Sludge (Biosolids) by Modified Semisolid Rappaport-Vassiliadis (MSRV) Medium. July 2006.EPA-821-R-06-14.

from the Lemont WRP facility. All samples were examined for the presence of TC and EC, which are indicators of fecal contamination. The heterotrophic plate count was also conducted, which is an indicator of the general bacteriological content of the water. Final test results with safety instructions and recommendations were distributed to Lockport Powerhouse and Lemont WRP managers.

Regulatory Monitoring, Reviews, and Response. The AMBS provided data and review of the national water quality criteria for bacteria and prepared comprehensive response documents in support of the IPCB Rulemaking concerning the CAWS Water Quality Standards and Effluent Limits.

Outreach Activities. The AMBS continued outreach support activities to promote public awareness and acceptance of District operations. On a regular basis, the AMBS staff attended meetings and provided support to the following activities.

- Science Fair Participation. Staff participated and judged middle school and high school science fairs. Staff offered encouragement to students and provided insight on research, report writing and the scientific process.

- Wastewater Microbiology Hands-On Workshop. As a member of the Water Environment Federation program, staff presented at the Water Environment Federation Technical Exhibition and Conference, 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.

- Laboratory Tours. Laboratory tours are encouraged and conducted upon request to any person or group wishing to learn about the District's microbiology laboratory. Individual and group tours were provided in 2011.

Goal 5: Operations and Applied Research

To support the District's strategic business plan, the AMBS continued its efforts to achieve the following applied research and outreach activities.

Use Attainability Analysis Research Project. The AMBS completed Use Attainability Analysis 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. The epidemiological study titled, "Chicago Health, Environmental Exposure, and Recreation Study (CHEERS)," was conducted in collaboration with a multidisciplinary team at the University of Illinois at Chicago

School of Public Health and was completed in 2011. The CHEERS final report is posted on the District website (M&R Report No. 11-43).

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 EC via receptors on the cell wall. There are two main groups of coliphages: F^+ specific phages (FP) and somatic phages (SP). The USEPA coliphage method 1602: Male-specific (F^+) and Somatic Coliphage in Water by a Single Agar Layer (SAL) method was modified and adapted in the PL to determine coliphage concentrations in Class A and B biosolids.

The SP concentrations ranged between less than 0.13 to 5,600 plaque forming units (PFUs) per gram dry weight biosolid samples from the Calumet and Stickney WRPs. Lower FP concentrations (<0.13-270 PFU per gram dry weight) were recovered from the Calumet and Stickney WRPs biosolids samples. Results of these analyses are shown in Table IV-5. Higher coliphage concentrations in the biosolids generated at the Stickney and Calumet WRPs may be due to low percent total solids (<60 percent) content. These Stickney and Calumet WRP biosolids were not PRFP-compliant with the digester holding time criteria specified in the codified operating parameters.

The data generated from this research will provide information on the occurrence and levels of enteric viruses and coliphages in biosolids. Direct testing of biosolids for viral pathogens is technically challenging and costly; it would be in the District's interest to continue research on coliphage and request regulators to support the coliphage as a surrogate indicator for use in biosolids land application management.

Research Collaboration. The AMBS continued collaboration with other agencies and research organizations by providing support to their research request proposals as follows:

- Development of a microbial sampling strategy for wastewater, storm water, and combined sewer overflows and the local receiving waters.
- Microbial analyses of samples from the District's wastewater treatment processes.
- Participation in and providing technical support to pilot and full-scale wastewater/biosolids operation studies.

Water Environment Research Foundation Research Projects. The AMBS was involved in the Water Environment Research Foundation (WERF) Issue Area Team (IAT) for its research program in the fields related to micro constituents; biosolids risk assessment, and critical research and scientific needs for the development of recreational water quality criteria. As a member of WERF's Science and Regulatory Advisory Panel and pathogen IAT, staff provided

technical review of the research projects and regulatory documents, attended project-related meetings and teleconference calls, and evaluated WERF project proposals and the final report.

National Association of Clean Water Agencies. The AMBS staff participated as an advisory member of the National Association of Clean Water Agencies' Recreational Criteria Workgroup by providing feedback to the USEPA on the Agency's efforts to develop new recreational water quality criteria. Participation on this issue focused on three items: 1) review of the underlying epidemiological studies; 2) the broader policy implications for POTWs, and 3) provide comments to the USEPA.

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

- Lake Michigan Total Maximum Daily Load for Illinois Beaches, USEPA Region 5 and IEPA.

- Michigan State University, Great Lake Research on Forecasting Beach and Near Shore Health Effects Using Quantitative Microbial Risk Assessment.

TABLE IV-1: SUMMARY OF VIROLOGICAL ANALYSIS OF CLASS A BIOSOLIDS IN COMPLIANCE WITH THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY 40 CODE OF FEDERAL REGULATIONS PART 503 PROCESS TO FURTHER REDUCE PATHOGENS[1] DURING 2011

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 (East and West)	9	9	<0.8000	5.2 – 97.7
Marathon	1	1	<0.8000	46.5
LASMA[6]	3	3	<0.8000	18.7 - 31.0
Vulcan	2	2	<0.8000	47.8 - 61.0
HASMA[7]	1	1	<0.8000	6.4

[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 4g (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.

TABLE IV-2: BACTERIOLOGICAL ANALYSES AND SUPPORT PROVIDED TO VARIOUS METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO PROGRAMS IN 2011

Program	Total Coliform	Fecal Coliform	*Escherichia coli*
District Waterway Surveys	-[a]	674	159
Industrial Waste Surveys	-	7	-
Lake Michigan Monitoring[1]	40	36	60
Treatment Facility Monitoring[2]	-	8	-
Illinois Waterway[3]	-	157	157
TARP	-	528	-
Other[4,5]	35	12	35
Total	75	1,422	411

[a]No Samples Analyzed.
[1] Includes District bypasses to Lake Michigan.
[2] Includes support to plant operations.
[3]Analyses conducted by contract laboratory. Data review and LIMS entry by ABL.
[4]Includes drinking water.
[5]Includes annual performance evaluation sample testing required by EPA and IDPH certification.

TABLE IV-3: ANALYTICAL BACTERIOLOGY LABORATORY SAMPLES ANALYSES IN 2011

		Analysis or Test Performed[1]						
Year	Samples	TC	FC	HPC	EC	IQC	SAL	Total
2011	2,608	54	2,611	18	264	10,757	4	13,708

[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); SAL = *Salmonella* spp.

TABLE IV-4: 2008 THROUGH 2010 REPORT OF THE CHICAGO AREA WATERWAY SYSTEM ANALYSES FOR *ESCHERICHIA COLI* AND FECAL COLIFORM

Monitoring Location Cross Street/Waterway	Location Code (WW)	Geometric Mean CFU/100 ML	
		E.coli	Fecal Coliform
Dundee Road/West Fork North Branch	106	1,316	1,827
Golf Road/West Fork North Branch	103	720	837
Lake-Cook Road/Middle Fork North Branch	31	580	895
Lake-Cook Road/Skokie River	32	409	668
Frontage Road/Skokie River	105	157	142
Central Street/North Shore Channel	35	100	92
Oakton Street/North Shore Channel	102	1,286	700
Touhy Avenue/North Shore Channel	36	6,098	6,684
Foster Avenue/North Shore Channel	101	5,253	6,009
Glenview Road/North Branch Chicago River	104	263	359
Dempster Street/North Branch Chicago River	34	633	997
Albany Avenue/North Branch Chicago River	96	409	518
Wilson Avenue/North Branch Chicago River	37	4,886	5,038
Diversey Pkwy/North Branch Chicago River	73	3,450	3,894
Grand Avenue/North Branch Chicago River	46	1,441	1,782
Lake Shore Drive/Chicago River	74	33	76
Wells Street/Chicago River	100	109	324
Madison Street/South Branch Chicago River	39	643	1,035
Loomis Street/South Branch Chicago River	108	226	491
Archer Avenue/South Fork South Branch	99	345	555
Ewing Street/Calumet River	49	13	13
130th Street/Calumet River	55	25	21
Burnham Avenue/Wolf Lake	50	26	27
Burnham Avenue/Grand Calumet River	86	7,102	1,374
Ashland Avenue/Calumet-Sag Channel	58	894	1,602
Cicero Avenue/Calumet-Sag Channel	59	320	729
Route 83/Calumet-Sag Channel	43	47	117
Damen Avenue/Chicago Sanitary & Ship Canal	40	336	414
Cicero Avenue/Chicago Sanitary & Ship Canal	75	165	282

TABLE IV-4 (Continued): 2008 THROUGH 2010 REPORT OF THE CHICAGO AREA WATERWAY SYSTEM ANALYSES FOR *ESCHERICHIA COLI* AND FECAL COLIFORM

Monitoring Location Cross Street/Waterway	Location Code (WW)	Geometric Mean CFU/100 ML	
		E.coli	Fecal Coliform
Harlem Avenue/Chicago Sanitary & Ship Canal	41	1,818	2,958
Route 83/Chicago Sanitary & Ship Canal	42	645	735
Stephen Street/Chicago Sanitary & Ship Canal	48	381	446
Wentworth Avenue/Little Calumet River	52	1,433	2,401
Indiana Avenue/Little Calumet River	56	125	93
Halsted Street/Little Calumet River	76	2,651	2,484
Ashland Avenue/Little Calumet River	57	578	852
Joe Orr Road/Thorn Creek	54	1,138	1,549
170th Street/Thorn Creek	97	628	869

TABLE IV-5: COLIPHAGE (SOMATIC AND F^+ SPECIFIC) ANALYSIS OF BIOSOLIDS IN 2011[1]

WRP/Sample Location	Total Solids (TS)[2]	Coliphage MPN/Gram Dry Weight[3,4]	
		Somatic	Male Specific (F^+)
Calumet[5]	61.51 – 77.79	<0.1286 – 3	<0.1344 - 14
Calumet[6]	27.40 – 71.45	<0.1400 – 120	<0.1400 - <0.3650
Stickney[6]			
HASMA[7]	16.54	5,600	270
LASMA[8]	15.68 - 33.75	<0.2963 – 2,500	<0.2963 - 120
Vulcan	16.03 - 51.48	4 - 710	4 - 110
Marathon	35.35	390	13

[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 1gram of as-received biosolids.
[4]Failure to detect coliphages in biosolids is recorded as less than (<) the limit of test sensitivity.
[5]PFRP compliant as specified in the codified operating parameters.
[6]PFRP non-compliant as specified in the codified operating parameters.
[7]Harlem Avenue Solids Management Area.
[8]Lawndale Avenue Solids Management Area.

FIGURE IV-1: ILLINOIS DEPARTMENT OF PUBLIC HEALTH CERTIFICATE OF APPROVAL FOR PUBLIC HEALTH LABORATORY SERVICE

ILLINOIS DEPARTMENT OF PUBLIC HEALTH

Awards this certificate of approval
for public health laboratory service to

Metropolitan Water Reclamation District

6001 West Pershing Road
Cicero, Illinois 60804

for the following laboratory examinations:

Heterotrophic Plate Count for Water (9215B)
Total Coliform Examination of Water from Public Water Supplies and their Sources (9222B, 9221B)
Fecal Coliform Verification with EC Broth (9221E)
Fecal Coliform Examination of Water from Public Water Supply Sources (9222D)
Total Coliform and E. Coli Examination of Water from Public Water Supplies and their Sources (9223B,Colilert P/A,Quantitray)

Rick Gore, Kathleen Jackowski, Andrea Maka, David Roberts, and Geeta Rijal are approved for the procedures listed above.

SEAL OF THE STATE OF ILLINOIS AUG. 26TH 1818

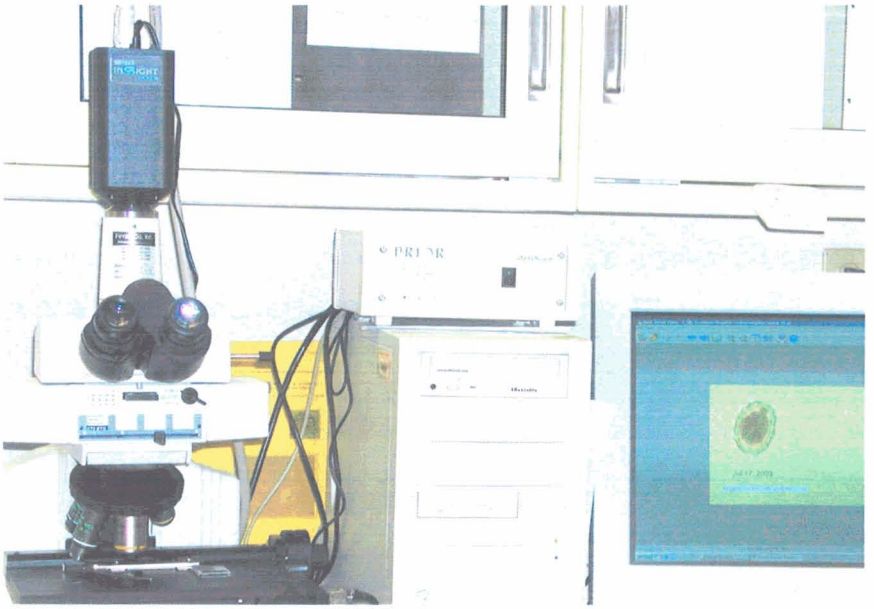
Registry no. 17508

Date October 27, 2010

For the period ending October 27, 2012

Damon T. Arnold, M.D., M.P.H., Director
Illinois Department of Public Health

FIGURE IV-2: 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-3: DIGITAL IMAGES OF *ASCARIS LUMBRICOIDES*

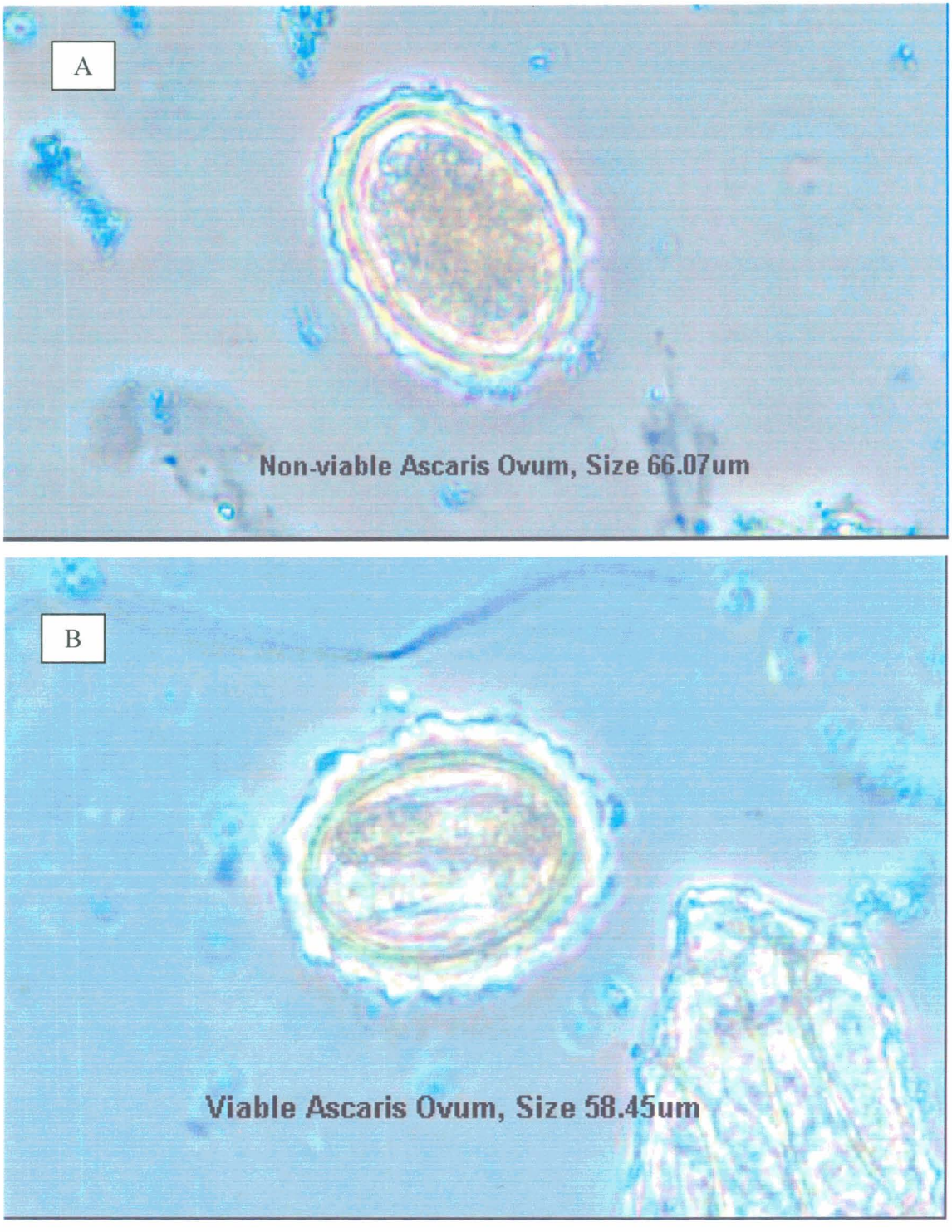


Image captured with the Nikon E600 Research microscope at 20X magnification:
A. Non-viable ovum; 66.07 μm long B. Viable, fertile ovum; 58.45 μm long

FIGURE IV-4: COMPARISON OF AVERAGE SLUDGE VOLUME INDEX (SVI-mL/g) WITH THE AVERAGE COUNTS OF ZOOGLEAL MASSES, SHELLED PROTOZOA/METAZOA AND FILAMENTOUS BACTERIA (Count/mgVSS) AT THE LEMONT AND JAMES C. KIRIE WATER RECLAMATION PLANTS, AUGUST – DECEMBER 2011

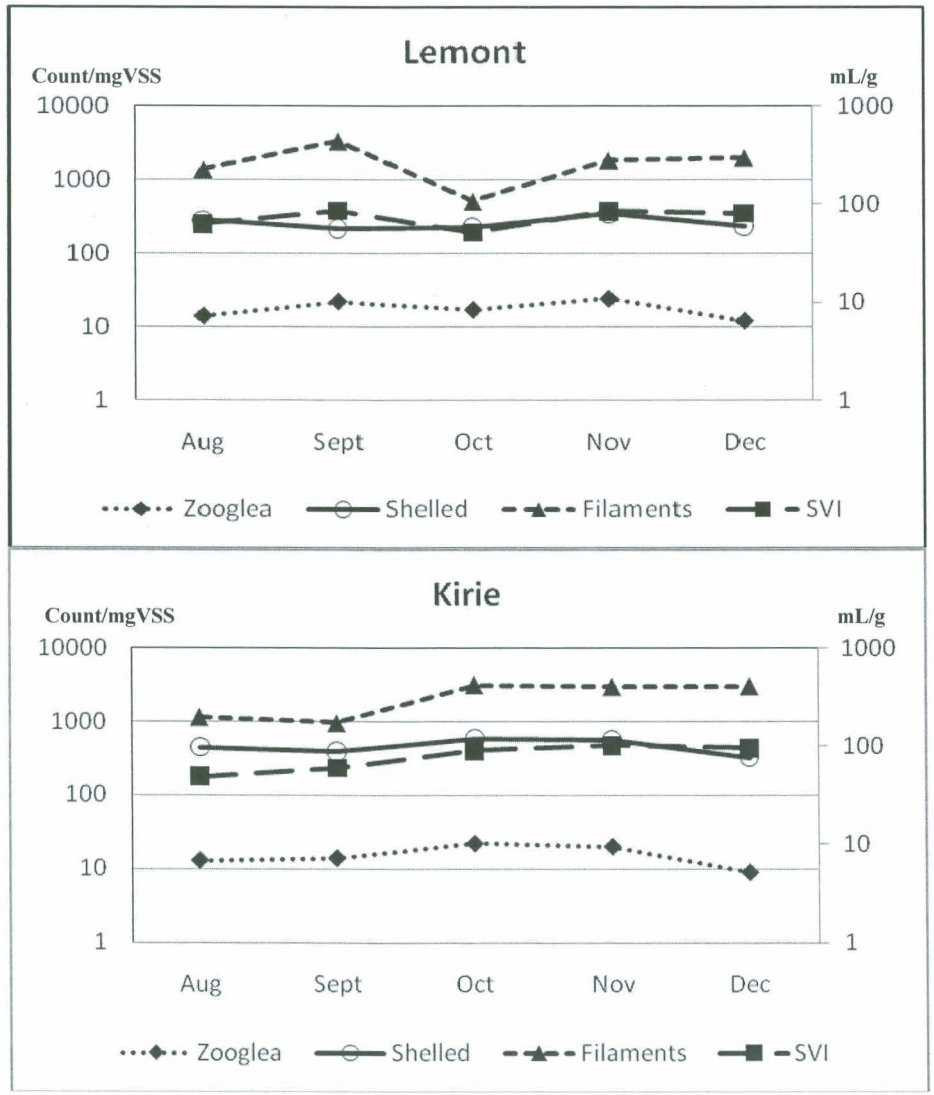


FIGURE IV-5: COMPARISON OF MONTHLY AVERAGE SLUDGE VOLUME INDEX (SVI-mL/g) WITH THE MONTHLY AVERAGE COUNTS OF ZOOGLEAL MASSES, SHELLED PROTOZOA/METAZOA AND FILAMENTOUS BACTERIA (Count/mgVSS) AT THE HANOVER PARK AND CALUMET WATER RECLAMATION PLANTS, AUGUST – DECEMBER 2011

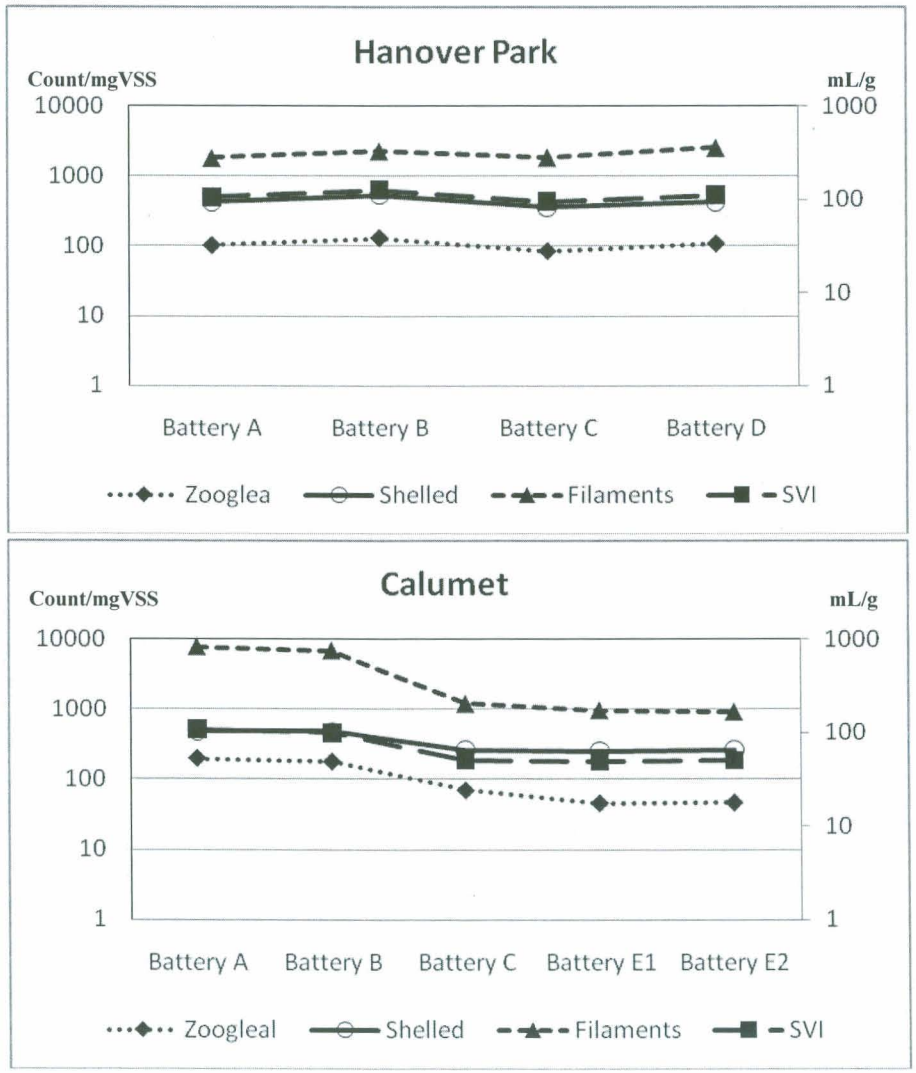
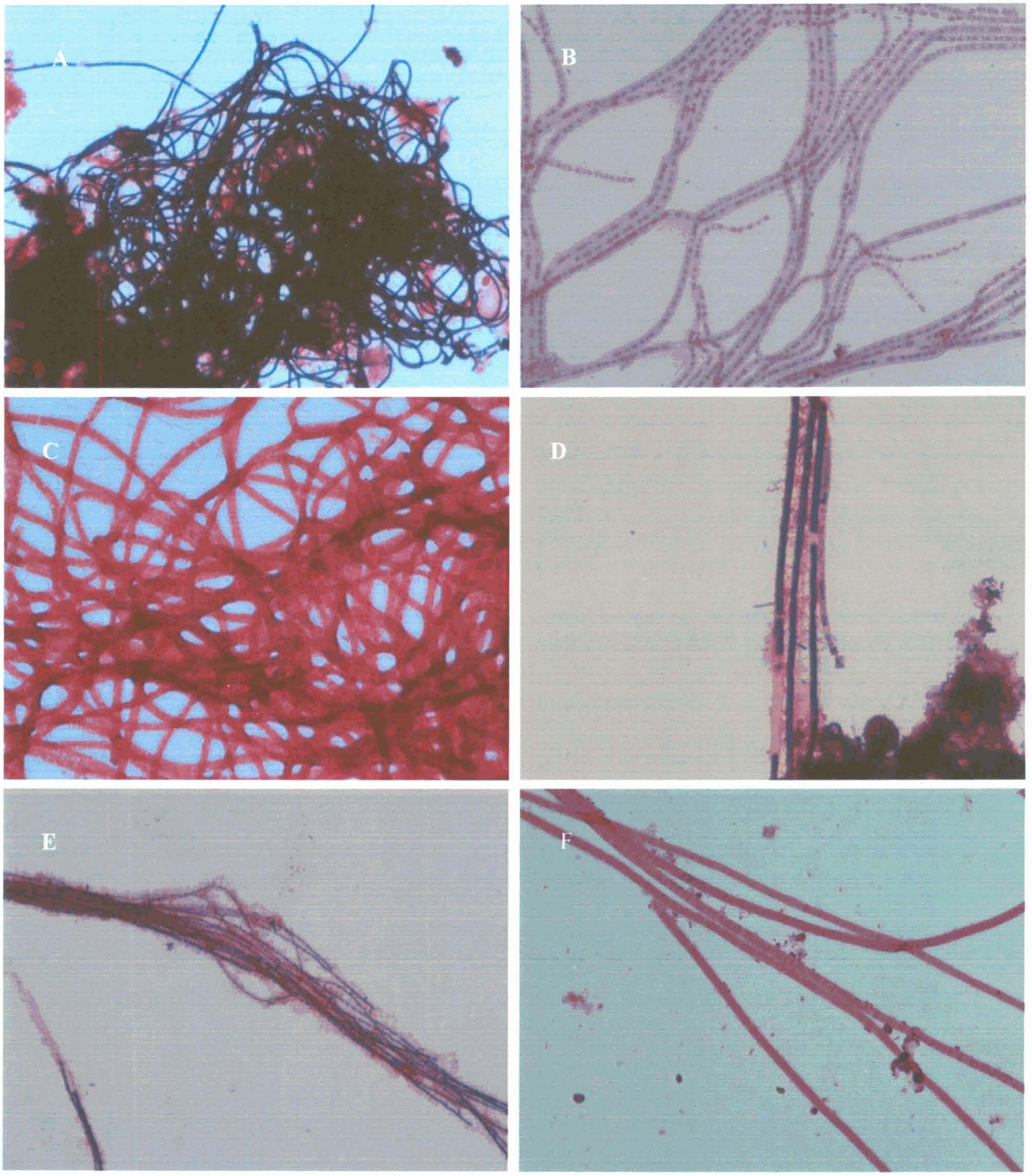


FIGURE IV-6: MICROSCOPIC OBSERVATIONS – RESULTS FROM THE METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO WATER RECLAMATION PLANTS' ACTIVATED SLUDGE



Filamentous bacteria types commonly observed in the District's activated sludge (All slides were Gram stained and observed at 100x oil immersion using Brightfield): (A) *Microthrix parvicella,* (B) *Sphaerotilus natans,* (C) Type 021N, (D) Type 0041, (E) Type 1851, (F) *Thiothrix.*

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 the District's wastewater treatment operations. The goals of the Aquatic Ecology and Water Quality (AEWQ) 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 biological and physical habitat monitoring in order to evaluate the health of waterways and assess changes in waterway conditions over time, especially those associated with District operations.

3. Perform laboratory analysis of chlorophyll for the samples colleted at Ambient Water Quality Monitoring stations in accordance with the SOP.

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

5. Design and conduct research projects to explore emerging issues in water quality and treatment.

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. Review plans for stormwater improvement construction projects on small streams and recommend biologically sound implementations. Monitor before and after construction events to document biological effects.

During 2011, the AEWQ Section preformed activities under the following three program goals:

Goal 3: Environmental Monitoring

Ambient Water Quality Monitoring Program. The AEWQ Section manages the AWQM program to assess water quality at 59 sampling stations on 21 waterways reaches within the District's service area (Figure V-1). Samples are collected monthly and analyzed for a diverse array of water-quality constituents. Analytical results are compared to applicable water-quality standards in an annual summary report.

The biological monitoring program, which runs in conjunction with the AWQM program, includes chlorophyll monitoring, the study of the benthic invertebrate and fish communities, characterization of the physical habitat, and, periodically, the assessment of sediment toxicity and sediment chemistry. The primary objective of the monitoring program is to provide scientific data to the District and the IEPA regarding the biological condition of the CAWS and Chicago Area General Use waterways. The IEPA uses the data to assess waterways in the District's service area for attainment of Clean Water Act goals.

The AEWQ Section performs biological monitoring at 15 of the 59 sampling stations annually and the remaining 44 stations once every four years. During June through September 2011, fish were collected by electrofishing and seining at 23 biological monitoring stations in Chicago area waterways. In 2011, a total of 3,911 fish, comprised of 39 species and 1 hybrid, 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. Benthic invertebrates were also collected from side and center locations using a petite ponar grab and Hester Dendy larval plate samplers at 25 AWQM stations. Invertebrates other than worms were isolated for later identification.

In cooperation with the IEPA, as part of the Illinois Fish Contaminant Monitoring Program, a total of 24 composite fish fillet samples from 102 fish collected from nine sampling stations were sent to the IEPA for contaminant analyses.

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 high algae concentrations may indicate nutrient impairment of a water body. The IEPA is cooperating with other state and local agencies to promulgate regional water quality criteria for nutrients, and possibly chlorophyll. Therefore, the District began monitoring chlorophyll on a monthly basis in August 2001 as part of the AWQM Program. Results from 2011 are shown in Table V-3.

Continuous Dissolved Oxygen Monitoring. In order to gain a better understanding of the oxygen dynamics in deep-draft sections of the CAWS, the AEWQ Section developed a comprehensive Continuous Dissolved Oxygen Monitoring program beginning in August 1998 in the Chicago River System and July 2001 in the Calumet River System. The DO monitoring in wadeable Chicago area waterways, particularly in the Des Plaines River System, began in July 2005. Figure V-1 shows a map of the continuous DO monitoring locations.

The DO results for 2011 can be found in the reports entitled, "Continuous Dissolved Oxygen Monitoring in the Deep-Draft Chicago Waterway System During 2011" (M&R Report No. 12-33) and "Continuous Dissolved Oxygen Monitoring in Chicago Area Wadeable Streams During 2011" (M&R Report No. 12-31).

Illinois Waterway Monitoring. In 1984, the 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 2011, 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. 12-35 entitled, "Water and Sediment Quality Along the Illinois Waterway from the Lockport Lock to the Peoria Lock During 2011."

Goal 4: Technical Assistance

Freshwater Mussel Monitoring. In order to better assess the implications of the 2009 USEPA proposed ammonia criteria, which were based on the protection of freshwater Unionid mussels, the AEWQ Section began performing mussel surveys in some wadeable streams in the Chicago area. In September and October of 2011, mussel surveys were conducted at seven of the wadeable AWQM stations (Table V-4). Sampling events consisted of one-hour long searches for living and relic specimens when feasible. A total of 335 native live specimens, consisting of three species, were found.

Goal 5: Operations and Applied Research

Investigation of Endocrine Disruption in the Chicago Area Waterway System. In collaboration with St. Cloud University, Minnesota, a three-year study began in March 2009 to conduct a comprehensive assessment of the potential for endocrine disrupting compounds (EDCs) to impact the reproductive potential of fish populations in the CAWS. The objectives of this study were to determine (1) the spatial and temporal occurrence of EDCs, (2) the occurrence

of endocrine disruption in wild fish populations, and (3) the likely sources contributing to any occurrence of endocrine disruption. During 2011, the study included analysis of waterway and WRP effluent samples, deployment of caged fish, collection of wild fish, and deployment of a mobile exposure laboratory. Final results will be published at the conclusion of this study in August 2012.

Wet Weather Fish Movement Study. A collaborative study with LimnoTech Inc. and the Illinois Natural History Survey, funded by the WERF, began in 2010 and concluded in 2011. The purpose of this pilot study was to assess the effect of wet weather driven DO sags on CAWS fish. The 2011 results confirmed the initial 2010 findings that following wet weather discharges that resulted in hypoxia, there was a general trend of fish movement away from hypoxic areas. However, not all fish avoided hypoxic areas, suggesting that fish may tolerate the hypoxic conditions for a short time or that the fish are able to find refuge in local areas of higher DO that may not be observed by the study design. The final WERF Report Number U3R09 entitled "The Effect of Wet Weather Driven Dissolved Oxygen Sags on Fishes in Urban Systems" was published in April 2012.

TABLE V-1: FISH COLLECTED FROM DEEP-DRAFT WATERWAYS DURING 2011

Station No.	Location	Number of Fish Collected	Weight (kg) of Total Catch	Number of Fish Species	Number of Game Fish Species	Most Abundant Fish Species
			NORTH SHORE CHANNEL			
36	Touhy Avenue	174	75.8	13	6	Gizzard shad
			NORTH BRANCH CHICAGO RIVER			
46	Grand Avenue	95	11.1	10	5	Gizzard shad
			CHICAGO SANITARY AND SHIP CANAL			
75	Cicero Avenue	401	32.8	13	6	Western mosquitofish
41	Harlem Avenue	137	89.5	9	4	Bluntnose minnow
92	16th St., Lockport	47	0.6	7	5	Green sunfish
			CALUMET RIVER			
49	Ewing Avenue	146	4.9	7	4	Smallmouth bass
55	130th Street	223	23.3	16	7	Gizzard shad
			LITTLE CALUMET RIVER			
56	Indiana Avenue	507	145.0	18	10	Gizzard shad
76	Halsted Street	589	61.9	11	5	Gizzard shad
			CALUMET-SAG CHANNEL			
58	Ashland Avenue	101	135.1	8	4	Common carp
59	Cicero Avenue	124	40.2	11	5	Gizzard shad
43	Route 83	73	43.7	6	2	Bluntnose minnow

TABLE V-2: FISH COLLECTED FROM WADEABLE WATERWAYS DURING 2011

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			
96	Albany Avenue	68	189	6	3	Green sunfish
			HIGGINS CREEK			
78	Wille Road	3	8	1	0	Fathead minnow
			DES PLAINES RIVER			
13	Lake-Cook Road	75	1,182	12	7	Bluntnose minnow
22	Ogden Avenue	32	178	5	2	Green sunfish
91	Material Services Rd.	17	124	6	1	Blackstripe topminnow, Oriental weather fish
			SALT CREEK			
18	Devon Avenue	60	409	8	5	Bluegill
			WEST BRANCH DUPAGE RIVER			
64	Lake Street	25	940	7	4	Green sunfish
			THORN CREEK			
54	Joe Orr Road	3	63	3	2	Bluegill, Johnny darter, Yellow Bullhead
97	170th Street	11	1,280	8	5	Common carp
			LITTLE CALUMET RIVER			
52	Wentworth Avenue	25	7,356	8	4	Goldfish
57	Ashland Avenue	158	67,486	15	9	Gizzard shad
			WOLF LAKE OUTLET			
50	Burnham Avenue	817	660	13	6	Bluntnose minnow

TABLE V-3: MEAN AND RANGE OF CHLOROPHYLL *a* VALUES FROM THE CHICAGO AREA WATERWAY SYSTEM AND CHICAGO AREA GENERAL USE WATERWAYS DURING 2011

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	10	15	4	55	15
103	Golf Road	11	15	4	34	10
	MIDDLE FORK NORTH BRANCH CHICAGO RIVER					
31	Lake-Cook Road	9	8	2	20	5
	SKOKIE RIVER					
32	Lake-Cook Road	10	8	1	15	5
105	Frontage Road	12	11	2	31	9
	NORTH BRANCH CHICAGO RIVER (Wadeable Portion)					
104	Glenview Road	12	9	1	18	6
34	Dempster Street	11	12	2	48	13
96	Albany Avenue	11	10	2	23	6
	NORTH SHORE CHANNEL					
35	Central Street	8	15	1	98	34
102	Oakton Street	12	5	1	12	4
36	Touhy Avenue	12	1	<1	4	1
101	Foster Avenue	12	5	<1	25	9
	NORTH BRANCH CHICAGO RIVER (Deep-Draft Portion)					
37	Wilson Avenue	12	3	1	9	2
73	Diversey Avenue	12	4	1	7	2
46	Grand Avenue	12	4	1	13	5
	CHICAGO RIVER					
74	Lake Shore Drive	12	1	1	5	1
100	Wells Street	12	2	1	8	2

TABLE V-3 (Continued): MEAN AND RANGE OF CHLOROPHYLL *a* VALUES FROM THE CHICAGO AREA WATERWAY SYSTEM AND CHICAGO AREA GENERAL USE WATERWAYS DURING 2011

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	5	4	2	7	2
108	Loomis Street	12	4	1	15	4
	BUBBLY CREEK (South Fork South Branch Chicago River)					
99	Archer Avenue	12	29	2	250	70
	CHICAGO SANITARY AND SHIP CANAL					
40	Damen Avenue	12	4	2	9	2
75	Cicero Avenue	12	4	1	14	4
41	Harlem Avenue	12	3	1	7	2
42	Route 83	12	3	1	16	4
48	Stephen Street	12	4	1	13	3
92	Lockport	49	4	<1	15	4
	CALUMET RIVER					
49	Ewing Avenue	6	1	1	2	1
55	130th Street	10	3	1	8	2
	WOLF LAKE					
50	Burnham Avenue	11	6	1	20	6
	GRAND CALUMET RIVER					
86	Burnham Avenue	10	17	2	52	20
	LITTLE CALUMET RIVER					
56	Indiana Avenue	10	4	1	11	3
76	Halsted Street	11	3	<1	11	3
52	Wentworth Avenue	10	8	4	18	4
57	Ashland Avenue	10	5	5	17	4

TABLE V-3 (Continued): MEAN AND RANGE OF CHLOROPHYLL *a* VALUES FROM THE CHICAGO AREA WATERWAY SYSTEM AND CHICAGO AREA GENERAL USE WATERWAYS DURING 2011

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	10	4	2	7	2
97	170th Street	9	8	3	21	5
		CALUMET-SAG CHANNEL				
58	Ashland Avenue	11	5	1	11	3
59	Cicero Avenue	11	4	1	7	2
43	Route 83	11	4	<1	9	3
		BUFFALO CREEK				
12	Lake-Cook Road	9	17	3	38	10
		HIGGINS CREEK				
77	Elmhurst Road	5	9	4	14	4
78	Wille Road	11	2	<1	8	2
		DES PLAINES RIVER				
13	Lake-Cook Road	11	14	7	42	10
17	Oakton Street	11	27	4	176	50
19	Belmont Avenue	11	20	2	108	30
20	Roosevelt Road	11	24	2	125	35
22	Ogden Avenue	11	20	4	126	35
23	Willow Springs Road	11	16	4	58	15
29	Stephen Street	11	15	2	28	9
91	Material Service Road	11	16	6	33	9
		SALT CREEK				
79	Higgins Road	10	23	2	52	16
80	Arlington Heights Road	11	15	4	33	10
18	Devon Avenue	11	12	3	22	7
24	Wolf Road	11	5	1	14	5
109	Brookfield Avenue	11	7	1	17	6

TABLE V-3 (Continued): MEAN AND RANGE OF CHLOROPHYLL *a* VALUES FROM THE CHICAGO AREA WATERWAY SYSTEM AND CHICAGO AREA GENERAL USE WATERWAYS DURING 2011

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	10	14	1	40	12
89	Walnut Lane	12	7	1	32	9
111	Arlington Drive	12	14	3	39	13
		POPLAR CREEK				
90	Route 19	11	8	2	15	5

TABLE V-4: MUSSELS COLLECTED FROM WADEABLE WATERWAYS DURING 2011

Station No.	Location	Number of Live Mussel Species Observed	Number of Relic Mussel Species Observed	Total Number of Mussel Species Observed	Most Abundant Live Mussel Species[1]
		SALT CREEK			
18	Devon Avenue	1	4	4	None
		DES PLAINES RIVER			
91	Material Service Road	3	4	5	*Pyganodon grandis*
		BUFFALO CREEK			
12	Lake-Cook Road	3	3	4	*Lasmigona complanata*
		WEST FORK NORTH BRANCH CHICAGO RIVER			
106	Dundee Road	3	3	3	*Pyganodon grandis* *Lasmigona complanata*
		SKOKIE RIVER			
32	Lake-Cook Road	2	2	2	*Pyganodon grandis*
105	Frontage Road	3	4	4	*Pyganodon grandis*
		NORTH BRANCH CHICAGO RIVER			
34	Dempster Street	2	3	3	*Pyganodon grandis*

[1]Native species.

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

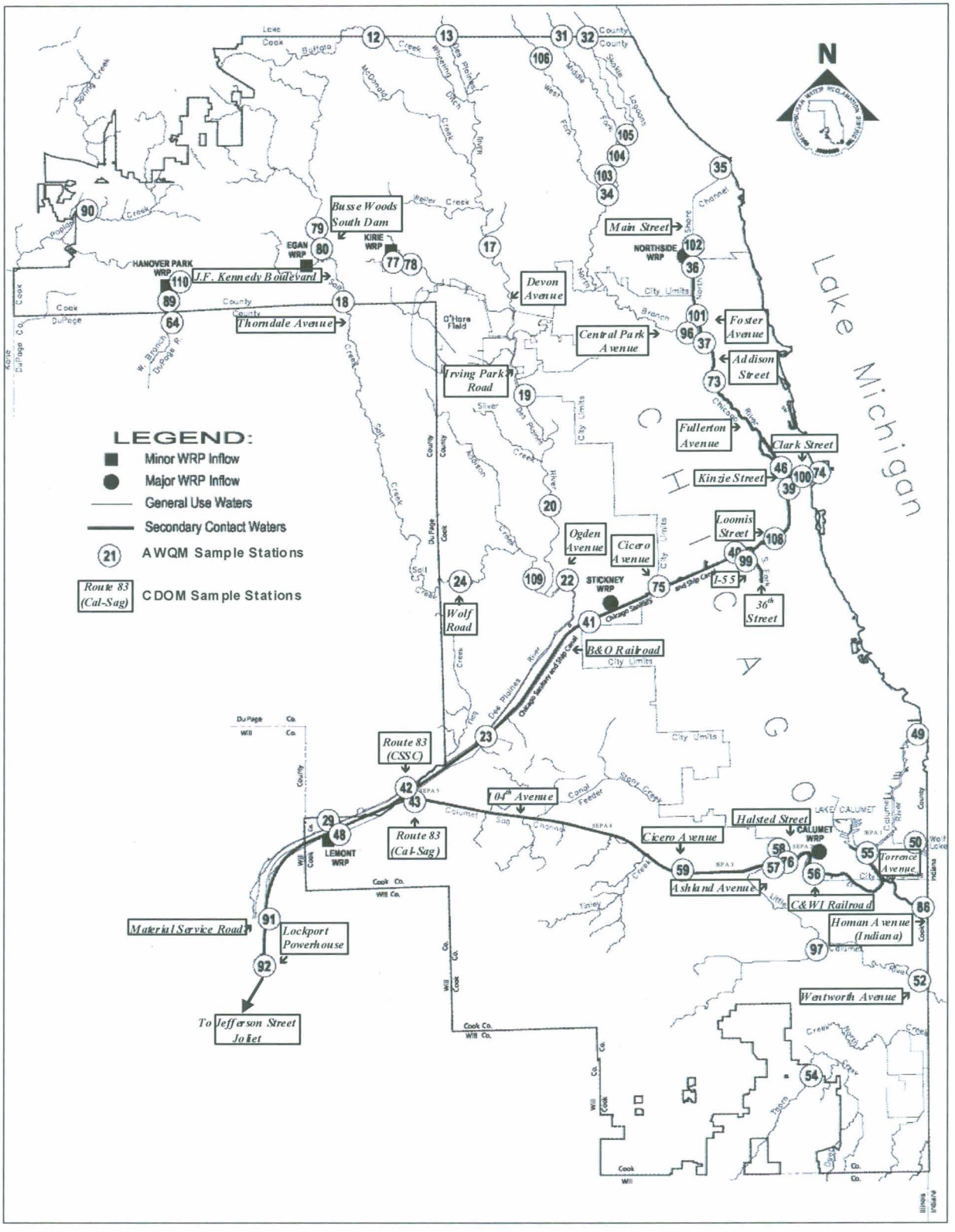


FIGURE V-2: MAP OF THE ILLINOIS WATERWAY FROM LOCKPORT TO MARSEILLES SHOWING SAMPLING STATIONS 1 TO 21

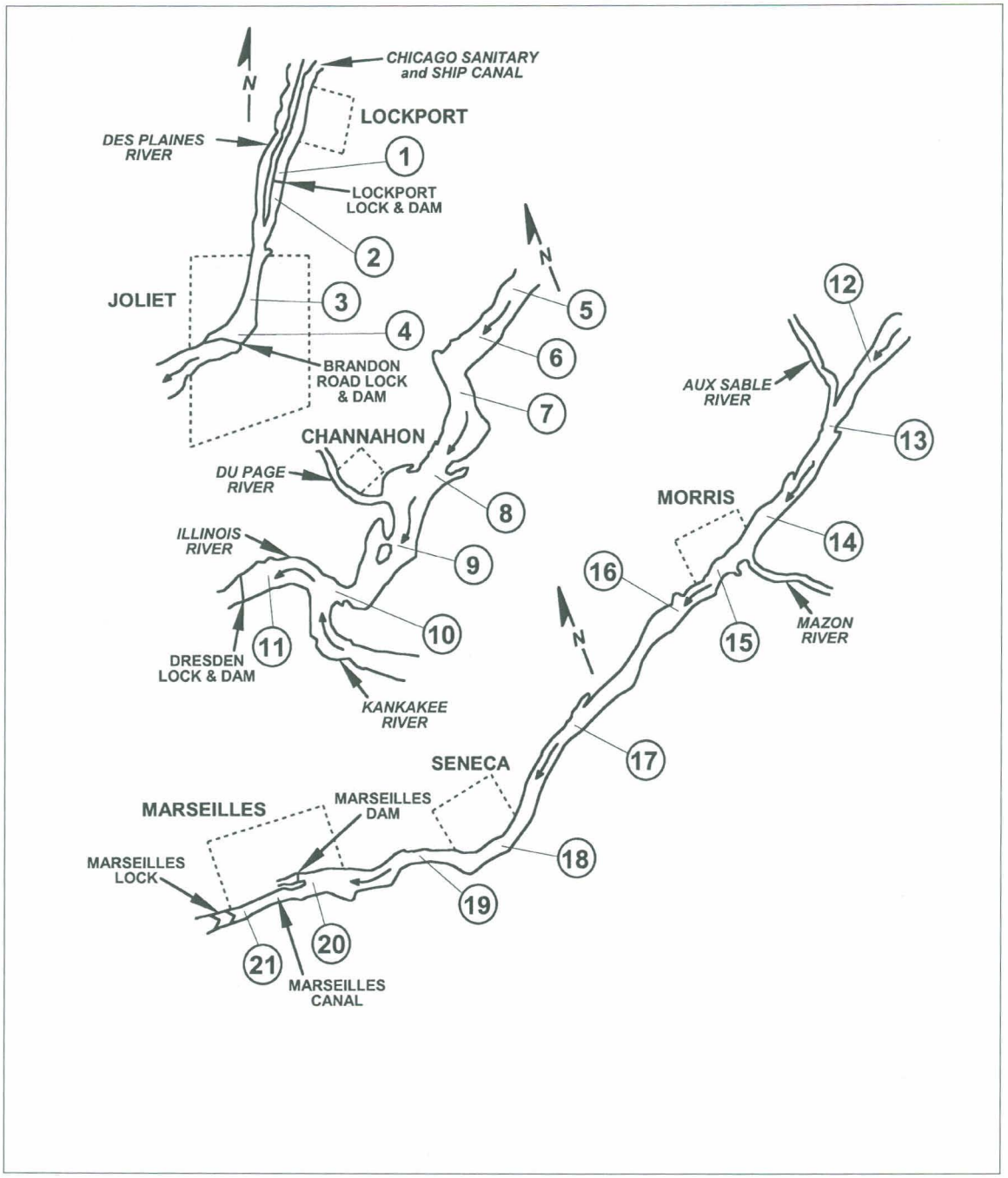
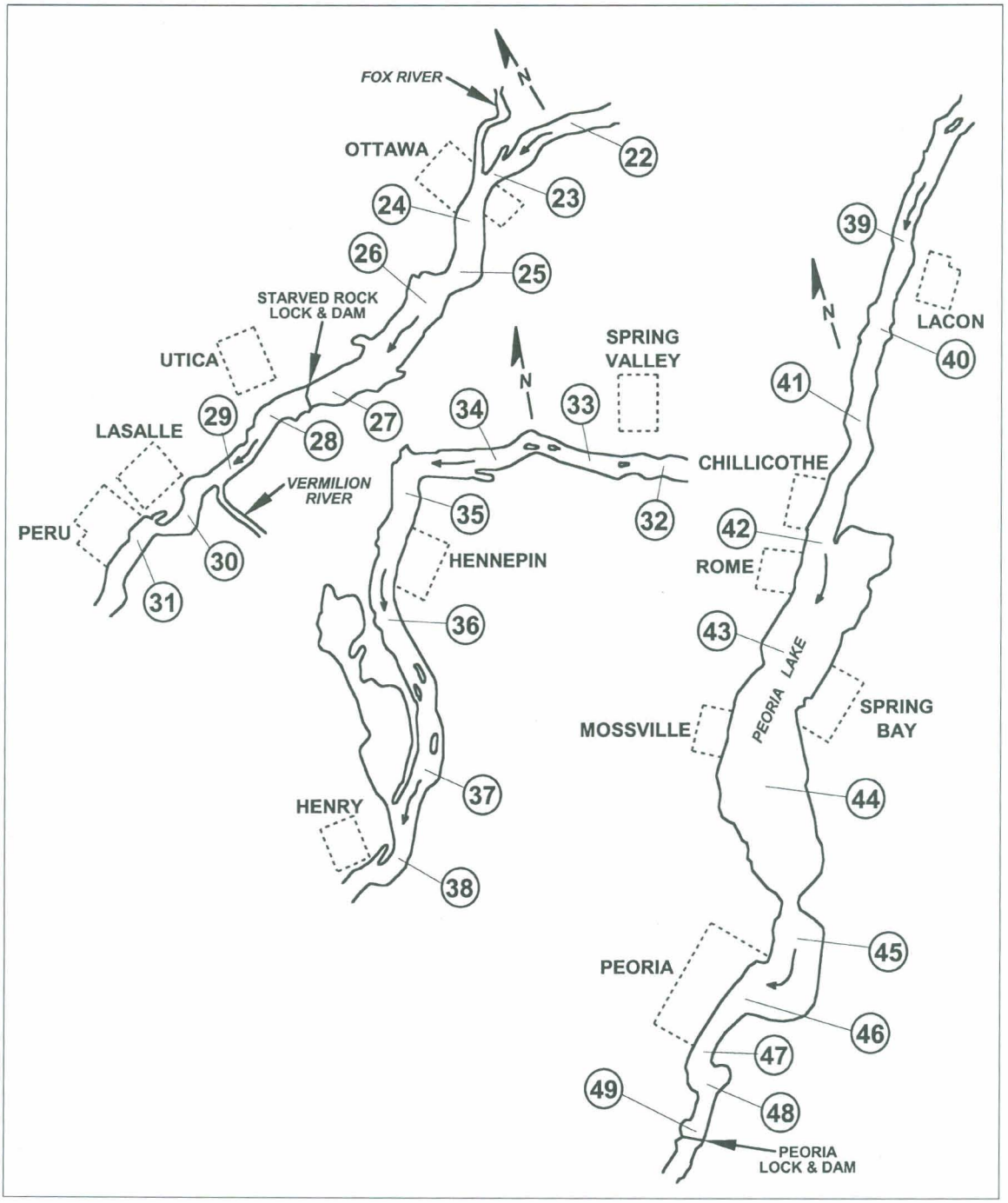


FIGURE V-3: MAP OF THE ILLINOIS WATERWAY FROM OTTAWA TO PEORIA SHOWING SAMPLING STATIONS 22 TO 49



APPENDIX I

APPENDIX I

MEETINGS AND SEMINARS 2011
ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

1. Illinois Environmental Protection Agency, Nutrient Stakeholders Workgroup Meeting (and follow-up meetings throughout the year), Springfield, Illinois, *January 2011.*

2. Midwest Water Analysts Association, Winter Expo 2011 (and follow-up committee meetings throughout the year), Kenosha, Wisconsin, *January 2011.*

3. Water Environment Federation, Impaired Water Symposium 2011, Miami, Florida, *January, 2011.*

4. Asian Carp Regional Coordinating Committee, Technical and Policy Workgroup Meeting, Chicago, Illinois, *February 2011.*

5. Asian Carp Science Meeting, Control Strategy Projects, Chicago, Illinois, *February 2011.*

6. Dupage River Salt Creek Workgroup, Annual Meeting, Lombard, Illinois, *February 2011.*

7. Illinois Chapter of the American Fisheries Society Annual Meeting, Peoria, Illinois, *March 2011.*

8. Illinois Pollution Control Board, Use Attainability Analysis Hearings (and follow-up meetings and hearing throughout the year), Chicago, Illinois, *March 2011.*

9. Illinois Section American Water Works Association and Illinois Water Environment Association, WaterCon 2011, Joint Conference and Expo, Springfield, Illinois, *March 2011.*

10. Society of Environmental Toxicology and Chemistry, Meeting, Lake Geneva, Wisconsin, *March 2011.*

11. United States Environmental Protection Agency, National Beach Conference, Miami, Florida, *March 2011.*

12. United States Fish and Wildlife Service, Stream Habitat Measurement Techniques, Shepherdstown, Washington, *March 2011.*

13. Midwest Water Analysts Association, 2011 Spring Meeting, Glenwood, Illinois, *April 2011.*

14. Lower Des Plaines Ecosystem Partnership, Meeting, Homer Glen, Illinois, *May 2011.*

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MEETINGS AND SEMINARS 2011
ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

15. North American Benthological Society, 2011 Annual Meeting, Providence, Rhode Island, *May 2011.*

16. Soil Ecology Society, 2011 Meeting, Kelowna, British Columbia Canada, *May 2011.*

17. Dupage River Salt Creek Workgroup, Bimonthly Meeting, (and follow-up meetings throughout the year) Lombard, Illinois, *June 2011.*

18. Dupage River Salt Creek Workgroup Projects Committee, Integrated priority System Workshop, Itasca, Illinois, *June 2011.*

19. Illinois Water Environment Association, Government Affairs Conference, Chicago, Illinois, *June 2011.*

20. United States Department of Agriculture, Cooperative Research W-2170 Committee Meeting, University Park, Pennsylvania, *June 2011.*

21. United States Environmental Protection Agency, Stakeholder's Meeting, New Orleans, Louisiana, *June 2011.*

22. Endocrine Disruptor Study, Data Review and Manuscript Writing Workshop, Minneapolis, Minnesota, *July 2011.*

23. Water Environment Federation, Energy and Water Conference, Chicago, Illinois, *July 2011.*

24. Asian Carp Regional Coordinating Committee, Technical and Policy Workgroup Meeting, Chicago, Illinois, *August 2011.*

25. Paul's Turf and Tree Nursery, 2011 Biosolids for Sod Production Workshop and Field Day, Marshall, Wisconsin, *August 2011.*

26. Water Environment Research Foundation, Nutrient Water Quality Criteria Modeling Meeting, Alexandria, Virginia, *August 2011.*

27. International Ultraviolet Association, 2nd North American Conference, Toronto, Ontario, Canada, *September 2011.*

28. Barnes and Thornburg, Clean Water Workshop, Chicago, Illinois, *October 2011.*

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MEETINGS AND SEMINARS 2011
ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

29. Chicago Council on Science and Technology, Chicago's Water, Luncheon Meeting, Chicago, Illinois, *October 2011.*

30. North Branch Dam Removal Task Force (and follow-up meetings throughout the year), Chicago, Illinois, *October 2011.*

31. Water Environment Federation Technical Exhibition and Conference, 2011 Pre-Conference Workshop, Los Angeles, California, *October 2011.*

32. Air Quality Management Conference (Lake Michigan Section), Glen Ellyn, Illinois, *November 2011.*

33. Asian Carp Regional Coordinating Committee, eDNA Workshop, Chicago, Illinois, *November 2011.*

34. Chicago Area Waterway System Use Attainability Analysis Dissolved Oxygen Workgroup (throughout end of the year), Chicago, Illinois, *November 2011.*

35. Chicago Area Waterway System Use Attainability Physical Habitat Projects Workgroup (throughout end of the year), Chicago, Illinois, *November 2011.*

36. United States Army Corp of Engineers, Bubbly Creek Feasibility Study, Chicago, Illinois, *November 2011.*

37. Water Environment Research Foundation, Teleconference (and follow-up meetings throughout the year), *November 2011.*

38. Midwest Association of Fish and Wildlife Agency, Midwest Fish and Wildlife 72nd Conference, Des Moines, Iowa, *December 2011.*

APPENDIX II

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PRESENTATIONS 2011
ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

1. "Characterization of Recycle Streams at the Water Reclamation Plants of the Metropolitan Water Reclamation District of Greater Chicago and Potential for Resource Recovery." Presented at the Midwest Water Analysts Association Winter Expo, Kenosha, Wisconsin, by K. Patel. *January 2011.* PP

2. "Dissolved Oxygen Water Quality Standards for the Chicago Area Waterway System: Costs and Environmental Impacts of Compliance." Presented at the Water Environment Federation Impaired Waters Symposium, Miami, Florida, by C. O'Connor, T. Granato, T. Minarik, J. Moran, J. Wasik, and H. Zhang. *January 2011.* PP

3. "Evaluation of Aeration Efficiency through Profile Sampling." Presented at the Midwest Water Analysts Association Winter Expo, Kenosha, Wisconsin, by J. Moran. *January 2011.* PP

4. "Improving Soil Quality for Sustained Productivity and Human Health." Presented at the Metropolitan Water Reclamation District of Greater Chicago Monitoring and Research Seminar Series, by K. Kumar. *January 2011.* PP

5. "A Simple Approach to Identifying and Controlling Filamentous Bacteria." Presented at WATERCON 2011, Illinois Section of the American Water Works Association and Illinois Water Environment Association Joint Conference and Expo, Springfield, Illinois, by T. Glymph. *March 2011.* PP

6. "Algae, Habitat, and Dissolved Oxygen Monitoring in the Chicago Area Waterway System." Presented at the Illinois Environmental Protection Agency Nutrient Stakeholders Workgroup Meeting, Springfield, Illinois, by J. Wasik. *March 2011.* PP

7. "Assessing the Potential for Endocrine Disruption in Chicago Area Waterways: Study Design and Preliminary Results." Presented at the Illinois American Fisheries Society Annual Meeting, Peoria, Illinois, by D. Gallagher and T. Minarik. *March 2011.* PS

8. "Controlling Dissolved Oxygen in Aeration Tanks to Meet Dissolved Oxygen Permit Limits." Presented at WATERCON 2011, Illinois Section of the American Water Works Association and Illinois Water Environment Association Joint Conference and Expo, Springfield, Illinois, by J. Moran. *March 2011.* PP

9. "Heat Recovery at a Water Reclamation Plant in Greater Chicago (Biothermal System)." Presented at WATERCON 2011, Illinois Section of the American Water Works Association and Illinois Water Environment Association Joint Conference and Expo, Springfield, Illinois, by A. Oskouie, C. O'Connor, J. Kozak, D.T. Lordi, T. C. Granato, and L. Kollias. *March 2011.* PP

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PRESENTATIONS 2011
ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

10. "Improving Soil Quality for Sustained Productivity and Human Health." Presented at the Water Environment Association, Annual Meeting, Springfield, Illinois, by K. Kumar. *March 2011.* PP

11. "Protecting Lake Michigan Water Quality: Addressing Reversals and Beach Use Restrictions." Presented at the United States Environmental Protection Agency's National Beach Conference, Miami, Florida, by G. Rijal. *March 2011.* PS

12. "Safety of Chicago Waterway Determined by Public Health Studies." Presented at WATERCON 2011, Illinois Section of the American Water Works Association and Illinois Water Environment Association Joint Conference and Expo, Springfield, Illinois, by G. Rijal. *March 2011.* PP

13. "The Dose Response Relationships of Chemical Additives for the Suppression of Hydrogen Sulfide Generation in Wastewater." Presented at WATERCON 2011, Illinois Section of the American Water Works Association and Illinois Water Environment Association Joint Conference and Expo, Springfield, Illinois, by J. Kozak. *March 2011.* PP

14. "Update on the Development of a Biosolids Land Application Network." Presented at the Water Environment Association, Annual Meeting, Springfield, Illinois, by A. Cox, D. Collins, and O. Oladeji. *March 2011.* PP

15. "Utilization of Exceptional Quality Biosolids for Turfgrass Management in the Chicago Area." Presented at the Water Environment Association, Annual Meeting, Springfield, Illinois, by O. Oladeji, A. Cox, and D. Collins. *March 2011.* PP

16. "Current Challenges at the Metropolitan Water Reclamation District of Greater Chicago." Presented at the University of Notre Dame, Department of Civil Engineering and Geological Sciences Weekly Seminar, Notre Dame, Indiana, by J. Kozak. *April 2011.* PP

17. "Protozoa as Indicators of Activated Sludge Treatment System Conditions." Presented at the Illinois Association of Water Pollution Control Operators 76th Annual Conference, Springfield, Illinois, by T. Glymph. *April 2011.* PP

18. "Water Quality in the Chicago Area Waterway, 1970-Present: Cost, Environmental Impact and Expected Biological Response to Further Water Quality Improvement." Presented at the Second Annual Center for Global Management and Responsible Leadership Conference, Chicago Illinois, by C. O'Connor. *April 2011.* PP

19. "Energy and Carbon Footprint and Sustainability at the Metropolitan Water Reclamation District of Greater Chicago." Presented at the DePaul University Sustainable Cities Class, Chicago, Illinois, by J. Kozak. *May 2011.* PP

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PRESENTATIONS 2011
ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

20. "The Role of Biosolids in Replenishing Organic Matter in Cultivated Soils." Presented at the Meeting of the Soil Ecology Society, Kelowna, British Columbia, Canada, by G. Tian, A. Cox, T. C. Granato, C. Chiu and A. Franzluebbers. *May 2011.* PP

21. "CSI Chicago: Tracking the Sources and Fate of Phosphorus in Chicago Area Waterways." Presented at the Government Affairs Conference, Chicago, Illinois, by K. Kumar. *June 2011.* PP

22. "Status of the Chicago Area Waterway System Use Attainability Analysis Hearings before the Illinois Pollution Control Board." Presented at the Chemical Industry Council of Illinois, Chicago, Illinois, by C. O'Connor. *June 2011.* PP

23. "Status of Chicago Area Waterway System Use Attainability Analysis Hearings before the Illinois Pollution Control Board, Plans for Disinfection and Potential Impact on Taxpayers." Presented at the Chicagoland Chamber of Commerce, Chicago, Illinois, by C. O'Connor. *June 2011.* PP

24. "Greening the City of Chicago." Presented at the National Association of Clean Water Agencies Annual Meeting, Chicago, Illinois, by J. Attarian and J. Kozak. *July 2011.* PP

25. "Water Utility Response to Climate Change and Engagement with the Environmental Protection Agency Climate Ready Water Utility Initiative." Presented at the Water Environment Federation Energy and Water 2011: Efficiency, Generation, Management, and Climate Impacts Conference, Chicago, Illinois, by A. Quintanilla, J. Kozak, S. O'Connell, C. O'Connor, J. Whitler, and M. Ampleman. *July 2011.* PP

26. "Assessing the Potential for Endocrine Disruption in Chicago Area Waterways: Study Design and Preliminary Results." Presented at the American Fisheries Society Annual Meeting, Seattle, Washington, by D. Gallagher and T. Minarik. *September 2011.* PS

27. "Wastewater Treatment, Process Control at the Stickney Water Reclamation Plant." Presented at the Institute of Technology Cyber Physical Systems Research Team, Chicago, Illinois, by C. O'Connor. *September 2011.* PP

28. "Activated Sludge and Biological Nutrient Removal Process Control: Hands-on in the Real World." Pre-Conference Workshop. Co-presented at the WEFTEC 2011 Conference, Los Angeles, California, by T. Glymph. *October 2011.* PP

29. "Evaluating the Potential for Endocrine Disruption in Urbanized Aquatic Environments." Presented at the Midwest Fish and Wildlife Annual Meeting, Des Moines, Iowa, by J. Vick and T. Minarik. *December 2011.* PS

APPENDIX II

PRESENTATIONS 2011
ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

30. "Stable Isotope and Isotopomeric Constraints on N_2O Production in Wastewater Treatment Plants." Presented at the American Geophysical Union Fall Meeting 2011, San Francisco, California, by F. Bellucci, M. Gonzalez-Meler, N.C. Sturchio, J.K. Bohlke, N.E. Ostrom, and J. Kozak. *December 2011.* 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 2011
ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

1. Hundal, L. S., K. Kumar, N. Basta, and A. Cox. "Evaluating Exposure Risk to Trace Organic Chemicals in Biosolids." *Biocycle*, 52:31-36. *2011*

2. Kar, G., L. S. Hundal, J. J. Schoenau, and D. Peak. "Direct Chemical Speciation of P in Sequential Chemical Extraction Residues Using Phosphorus K-edge XANES Spectroscopy." *Soil Science,* 176:589-595. *2011.*

3. Kelly, J. J., K. Policht, T. Grancharova, and L. S. Hundal. 2011. "Addition of Biosolids to an Agricultural Soil Increases Nitrification and Produces Distinct Responses in Ammonia Oxidizing Archaea and Bacteria." *Applied Environmental Microbiol*ogy, 77:6551-6558. *2011.*

4. Kozak, J., K. Patel, Z. Abedin, D. Lordi, C. O'Connor, T. C. Granato, and L. Kollias. 2011. "Effect of Ferric Chloride Addition and Holding Time on Gravity Belt Thickening of Waste Activated Sludge." *Water Environment Research*, 83, 2, 140-146, *2011.*

5. Quintanilla, A., J. Kozak, S. O'Connell, C. O'Connor, J. Whitler, and M. Ampleman. "Water Utility Response to Climate Change and Engagement with the Environmental Protection Agency Climate Ready Water Utility Initiative." Proceedings of the Water Environment Federation Energy and Water 2011 Conference, Chicago, Illinois. *2011.*

6. Rijal, G., T. Glymph, and R. Gore. "Protecting Lake Michigan and Water Quality: Addressing Reversals and Beach Use." Proceedings of the United States Environmental Protection Agency's National Beach Conference, Miami, Florida. *2011.* http://water.epa.gov/type/oceb/beaches/2011proceedings.cfm.

7. Sepulvado, J., A. Blaine, L. S. Hundal, and C. Higgins. "Occurrence and Fate of Perfluorochemicals in Soil Following the Land Application of Municipal Biosolids." *Environmental Science and Technology,* 45:8106-8112. *2011.*

APPENDIX IV

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO
MONITORING AND RESEARCH DEPARTMENT 2011 SEMINAR SERIES

January 28, 2011
Improving Soil Quality for Sustained Productivity and Human Health
Dr. Kuldip Kumar, Associate Environmental Soil Scientist, Monitoring and Research Department, Metropolitan Water Reclamation District of Greater Chicago (District), Chicago, IL

February 25, 2011
Need and Challenge of Alternative Water Sources for use in Electric Power Production
Professor David A. Dzombak, Carnegie Mellon University, Pittsburg, PA

March 25, 2011
Vancouver, British Columbia's Sewage-to-Heat Neighborhood Energy Center
Mr. Chris Baber, Neighborhood Energy Utility Manager, City of Vancouver, Vancouver, British Columbia, CAN

April 29, 2011
A Comprehensive Survey of Endocrine Active Compounds and Fish Effects In the Chicago Area Waterway System
Professor Heiko Schoenfuss, St. Cloud State University, St. Cloud, MN

May 20, 2011
Nitrogen Removal Technology: Past, Present and Future – Including Blue Plains Advanced Wastewater Treatment Plant's Current Nutrient Regulation and Recovery Processes
Dr. Sudhir Murthy, Manager, Process Development and Optimization, District of Columbia Water and Sewer Authority, Washington D.C.

June 17, 2011
Status of the Hearing Before the Illinois Pollution Control Board: Water Quality Standards and Effluent Limitations for the Chicago Area Waterway System
Dr. Thomas C. Granato, Acting Director of Monitoring and Research Department, District, Chicago, IL

July 29, 2011
Wastewater Treatment and Climate Change
Professor Kartik Chandran, Columbia University, New York, NY

August 26, 2011
Airborne Laser Scanning for Riverbank Erosion Assessment
Professor Satish Gupta, University of Minnesota, Minneapolis, MN

September 30, 2011
East Bay Municipal Utility District's Renewable Energy Initiatives
Mr. David Williams, Director of Wastewater, East Bay Municipal Utility District, Oakland, CA

October 28, 2011
Digester Gas Modeling and Utilization at the District's Stickney Water Reclamation Plant
Mr. Steve McGowan, Vice President, Malcolm Pirnie, Inc., Schaumburg, IL

November 18, 2011
Computer Modeling to Support Process Design at the District
Mr. Edward Podczerwinski, Principal Civil Engineer, Engineering Department, Cicero, IL

December 16, 2011
The Maintenance and Operations of the Stickney Water Reclamation Plant
Mr. Stephen Carmody, Engineer of Treatment Plant Operations and Reed Dring, Engineer of Treatment Plant Operations, Maintenance and Operations Department, District, Cicero, IL

RESERVATIONS REQUIRED (at least 24 hours in advance); PICTURE ID REQUIRED FOR PLANT ENTRY
CONTACT: Dr. Catherine O'Connor, 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 Monitoring and Research
Zhang, Heng, Environmental Monitoring and Research Manager
Abedin, Zainul, Biostatistician
Khalique, Abdul, Radiation Chemist
Gregor, Bettina, Secretary
Quinlan, Kathleen, Administrative Assistant

Section 122 - Wastewater Treatment Process Research

Joseph Kozak, Supv. Env. Research Scientist
Vacant, Supv. Env. Research Scientist
Franklin, Laura, Prin. Office Support Spec.
Oskouie, Ali, Senior Env. Research Scientist
Patel, Kamlesh, Senior Env. Research Scientist
Bernstein, Doris, Assoc. Env. Research Scientist
Vacant, Assoc. Env. Research Scientist
MacDonald, Dale, Assoc. Env. Research Scientist
Moran, Judith, Assoc. Env. Research Scientist
Haizel, Anthony, Lab Technician 2
Reddy, Thota, Lab Technician 2
Bodnar, Robert, Lab Technician 1
Byrnes, Marc, Lab Technician 1
Iu, Kim, Lab Technician 1
Kowalski, Shawn, Lab Technician 1
Robinson, Harold, Lab Technician 1

Section 123 - Biosolids Utilization and Soil Science

Cox, Albert, Supv. Env. Soil Scientist
Vacant, Prin. Office Support Spec.
Hundal, Lakhwinder, Senior Env. Soil Scientist
Tian, Guanglong, Senior Env. Soil Scientist
Kumar, Kuldip, Assoc. Env. Soil Scientist
Lindo, Pauline, Assoc. Env. Soil Scientist
Oladeji, Olawale, Assoc. Env. Soil Scientist
Patel, Minaxi, Assist. Env. Chemist
Mackoff, Ilyse, Lab Technician 2
Tate, Tiffany, Lab Technician 2
Adams, Richard, Lab Technician 1
Vacant, Lab Technician 1
Vacant, Lab Assistant
Horvath, Beverly, Lab Assistant

Section 124-Analytical Microbiology and Biomonitoring

Rijal, Geeta, Supv. Env. Microbiologist
Slaby, Pamela, Prin. Office Support Spec.
Glymph, Auralene, Senior Env. Microbiologist
Gore, Richard, Assoc. Env. Microbiologist
Shukla, Hemangini, Assist. Env. Microbiologist
Vacant, Lab Technician 2
Jackowski, Kathleen, Lab Technician 2
Kaehn, James, Lab Technician 2
Maka, Andrea, Lab Technician 2
Rahman, Shafiq, Lab Technician 2
DeGutes, Mathew, Lab Technician 1
Hussaini, Syed, Lab Technician 1
Mehta, Atulkumar, Lab Technician 1
Vacant, Lab Technician 1
Roberts, David, Lab Technician 1
Qureshi, Farhan, Lab Assistant
Saverson, Amanda, Lab Assistant

Section 126 - Aquatic Ecology and Water Quality

Wasik, Jennifer, Supv. Aquatic Biologist
Maurovich, Coleen, Prin. Office Support Spec.
Minarik, Thomas, Senior Aquatic Biologist
Gallagher, Dustin, Assoc. Aquatic Biologist
Vick, Justin, Assoc. Aquatic Biologist
Kollias, Nick, Assist. Aquatic Biologist
Burke, Michael, Lab Technician 2
Joyce, Colleen, Lab Technician 2
Schackart, Richard, Lab Technician 2
Whitington, Angel, Lab Technician 2
Lansiri, Panu, Lab Technician 1
Schipma, Jane, Lab Technician 1