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ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

2013

ANNUAL REPORT

Monitoring and Research Department
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This 2013 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 Bettina Gregor for her immaculate typing, zealous adherence to the Monitoring and Research Department formatting guidelines, 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 80 employees, and is comprised of six Sections. These are illustrated in Figure 1 and Appendix V. The six Sections are:

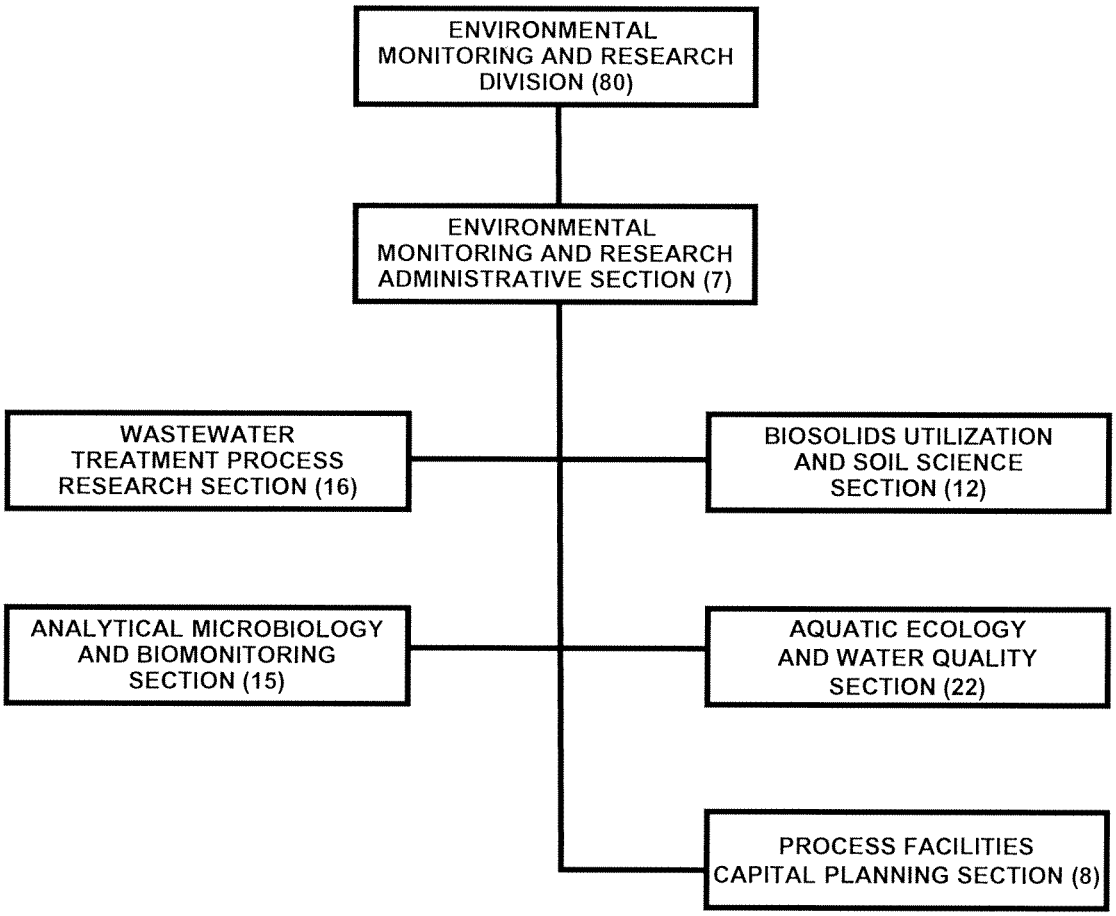
1. Administrative
2. Wastewater Treatment Process Research
3. Biosolids Utilization and Soil Science
4. Analytical Microbiology and Biomonitoring
5. Aquatic Ecology and Water Quality
6. Process Facilities Capital Planning

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

- Monitoring the environmental quality of Lake Michigan, and area rivers and canals 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.
- Generating and submitting environmental monitoring reports to regulatory agencies to ensure compliance with requirements of Tunnel and Reservoir Plan (TARP), water reclamation plant (WRP) National Pollutant Discharge Elimination System (NPDES), and biosolids processing and utilization permits.

FIGURE 1

ENVIRONMENTAL MONITORING AND RESEARCH DIVISION ORGANIZATION CHART



- Identify the District's capital infrastructure needs, ensure their alignment with the District's Strategic Plan and develop a long term process facilities capital plan.

During 2013, EM&RD participated in numerous Meetings and Seminars (Appendix I), presented several papers, PowerPoint presentations, and poster presentations (Appendix II), and also published several papers (Appendix III).

OVERVIEW OF SECTIONS OF THE ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

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 the interested public through prior registration, which presents information on areas of interest to the District operations. In 2013, 1,956 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 (EDSEG), provided support to the rest of the EM&RD. The Radiochemistry Group, which was part of the Administrative Section, was discontinued in May 2013 following the retirement of the Radiation Chemist. Therefore, activities performed in the group were transferred between the Analytical Laboratories Division and the Aquatic Ecology and Water Quality Section (AEWQ).

Experimental Design and Statistical Evaluation Group. The 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:

During 2013, the EDSEG provided statistical and computing support to various projects. The following is a description of some of the activities.

1. Summarized results of the District's Ambient Water Quality Monitoring program (AWQMP) for the Chicago Area Waterways System (CAWS). Surface water quality data for 2013 were evaluated with respect to compliance with state water quality standards; and summarized version of the waterways report was produced.

2. Provided support to the AEWQ Section on the production of the annual Continuous Dissolved Oxygen (DO) Monitoring Reports (Deep-Draft, and Wadeable).

3. The EDSEG provided data management support to the Biosolids Utilization and Soil Science (BU&SS) Section to produce quarterly reports on the District's solids management areas and the Hanover Park Fischer Farm in accordance with Illinois Environmental Protection Agency (IEPA) permit requirements.

4. Provided support to the AEWQ Section on legal issues such as the CAWS Use Attainability Analysis and lawsuit regarding nutrients and algae in waterways.

5. Provided support to the BU&SS Section on the evaluation of ground water sampling frequency to support request to IEPA for reduction in monitoring requirements.

6. Provided support to Process Facilities Capital Planning Section (PFCP) on cost forecasting analysis.

7. Provided support to the Wastewater Treatment Process Research (WTPR) Section for the project on evaluation of potential reduction of polymer consumption strategies at the Stickney WRP.

8. Prepared numerous statistical analyses and data summaries to respond to IEPA regulatory issues.

Radiochemistry Group. The Radiochemistry Group is responsible for the radiological monitoring of waterways and wastewaters, and the maintenance of radiation safety at the District. It also performs any special tasks involving the use of ionizing radiation and radioisotopes. Activities in this group were done until the retirement of the Radiation Chemist in April 2013. This group was then discontinued and the administration of the radiation safety program was transferred to the Analytical Laboratories Division while the radiological monitoring of waterways and wastewaters was transferred to the AEWQ.

Radiation Safety. The Radiochemistry Group maintains a radiation safety program for the District. The District possesses a radioactive material license from the Illinois Emergency Management Agency, Division of Nuclear Safety (IEMA-DNS). The radiation protection program is conducted in accordance with the license conditions and regulatory requirements of IEMA-DMS. 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 2013, the survey was completed and submitted to the IEMA-DNS.

In 2012, all radioactive chemicals previously used in the radiochemistry laboratory were surrendered to IEMA-DNS. Therefore, the District is now in possession of only sealed sources of radioactivity which are associated with the following instruments:

- Four Troxler surface moisture/density gauges used by the Construction Division of the Engineering Department.

- Six Ni-63 detectors on three gas chromatographs at the Organic Compounds Analytical Laboratory.

- Chemical Warfare Detector (APD 2000) and an X-ray fluorescence paint analyzer owned by the Safety Section of the Human Resources Department.

Routine activities conducted in accordance with the license and applicable regulations through June 2013 include the following:

- Monitoring of District staff for radiation exposure using badges and finger ring dosimeters. These are the Engineering Department (Engineering) staff who use the Troxler moisture/density gauges.

- Quarterly operational checks of radiation survey meters.

- Leak test of the radioactive sealed sources at intervals not to exceed six months.

- A physical inventory of the radioactive sealed sources possessed by the District was carried out twice in 2013. A record of this inventory was maintained as per license requirements.

Wastewater Treatment Process Research Section

The WTPR Section's mission is to provide technical support to the Maintenance and Operations Department (M&O) and Engineering Department also to Planning, to conduct applied research on 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 be done to address WRP problems or to generate new information on wastewater treatment processes. Plans and specifications are also reviewed at the request of Engineering to optimize process design criteria. The Section is responsible for conducting research aimed to solve problems and evaluate 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 operation and cost efficiencies of existing processes or the development of new processes. Investigations are performed through surveys, literature reviews, laboratory bench-scale testing, pilot-plant studies, full-scale testing, or special analyses.

Biosolids Utilization and Soil Science Section

The role of the BU&SS Section is the application of science for continuous improvement in the cost effectiveness of the District's biosolids management, TARP groundwater monitoring, and environmental stewardship through:

1. Research, technical assistance, and public outreach.

2. Contribution to formulation of and compliance with relevant regulations.

3. National leadership in biosolids management.

4. Assistance on the District's green initiatives.

5. Technical assistance on the District's initiative to produce a value-added product by co-composting woodchips with biosolids.

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 and the TARP.

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

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

4. To 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.

6. To promote local use of biosolids by producing value-added biosolids products

Analytical Microbiology and Biomonitoring Section

The Analytical Microbiology and Biomonitoring (AMB) Section mission is to provide on-time, high quality, cost-effective microbiological monitoring and research services to support the M&R Department's five program goals. The AMB Section's role is to:

- Conduct microbiological monitoring of liquid and solids for operational control and regulatory reporting requirements and to assess the environmental impacts of District operations.

- Address and provide monitoring support to the District's sustainable operation improvements (disinfection, nutrient removal, biosolids and storm water control) to fulfill the emerging regulatory developments, in meeting the CAWS recreational use attainment, and other environment improvements.

- Promote employee self-development, education, public awareness, and participation in the District's outreach activities.

The AMB Section has been certified by the Illinois Department of Public Health (IDPH) for the bacterial analysis of water since 1979 and is equipped with the latest technologies and highly knowledgeable professionals and technical staff. The Section is organized into the following five separate laboratories:

1. Analytical Bacteriology Laboratory (ABL)

2. Wastewater Microbiology Laboratory (WML)

3. Parasitology Laboratory (PL)

4. Virology Laboratory (VL)

5. Molecular Microbiology Laboratory (MML)

During 2013, the AMB Section performed the following activities to improve its operations and achieve its goals:

- Maintained its Illinois Department of Public Health (IDPH) certification of the ABL, Registry No. 17508, 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]).

- Ensured laboratory personnel training by completing the demonstration of capability, which enables them to perform analyses according to the laboratory Standard Operating Procedures (SOPs) and Quality Assurance Plan (QAP).

- Amended the bacteriological test procedure for the AWQMP by discontinuing the EC monitoring in order to reduce monitoring costs.

- Proposed reduced backflow and CSO monitoring frequency to reduce the cost of monitoring and the overtime incurred for the bacteriological analyses.

- 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 QAP, and implemented Quality Assurance policies and essential applicable Quality Control procedures to assure test validity.

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

- 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.

During 2013, the AMB Section laboratories provided microbiological, analytical and technical support to various projects under all EM&RD program goals. Table 1 shows a summary of the number of analyses provided under each program.

Aquatic Ecology and Water Quality Section

The mission of the AEWQ Section is to provide scientific and technical support to assess the waterways impacted by the District's wastewater treatment operations. The goals of the 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.

TABLE 1: TOTAL NUMBER OF ANALYSES PERFORMED BY THE ANALYTICAL MICROBIOLOGY LABORATORY IN 2013

Program	Total Coliform, Fecal Coliform, HPC[1], *E. coli*	Pathogens[2]	Microscopic Assessments[3]
4652 Liquid Monitoring	701	--[4]	--
4653 Solids Monitoring	85	76	--
4666 Sewage and Waste Control	8	--	--
4671 Lake Michigan (Backflow)	158	--	--
4672 Waterways	347	--	6
4674 Groundwater	489	--	--
4681 Assistance to Engineering and Maintenance and Operations	9	--	1,389
4682 Assistance to Others	394	61	60
4690 Operations and Applied Research	396	--	112
Total	2,587	137	1,567

[1]HPC-Heterotrophic Plate Count.
[2]Includes *Salmonella* spp., enteric virus and *Ascaris ova* (Helminth Ova).
[3]Includes filament, ammonia oxidizing bacteria (AOB), nitrite oxidizing bacteria (NOB), and phosphorus accumulating organisms (PAO).
[4]No Analyses.

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. Conduct Whole Effluent Toxicity (WET) tests on District effluents in accordance with NPDES permits to monitor and evaluate the final effluents for any adverse effects to aquatic life.

4. Perform laboratory analysis of chlorophyll for the samples collected at AWQMP stations.

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

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

7. Participate in regulatory review of water-quality related standards and documents, including attendance at regulatory hearings and stakeholder meetings relevant to District operations.

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

9. Review plans for stormwater improvement construction projects on small streams and recommend biologically sound implementations.

Process Facilities Capital Planning Section

The PFCP Section was added to the Division in 2013. The mission of the PFCP Section is to facilitate and document a long-term capital plan for the District and to ensure alignment with the District's Strategic Plan. The goals of the section are to:

1. Identify long-term infrastructure needs.

2. Identify and prioritize areas for research to obtain data for evaluating infrastructure needs and capital projects.

3. Utilize data to define and justify capital projects and programs.

SUMMARY OF ENVIRONMENTAL MONITORING AND RESEARCH DIVISION ACTIVITIES DURING 2013

During 2013, 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 (4660) - 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.

Goal 1: Operations Monitoring

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 2013. 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.

The analysis of gross alpha and beta concentrations was conducted on 24-hour composite samples of raw sewage and final effluent collected monthly at all WRPs. The samples were analyzed by Environmental, Inc. Midwest Laboratory, Northbrook, Illinois (EIML). The data will be presented in the 2013 Radiological Annual Report.

Monitoring and Reporting for the Biosolids Management Program. The Division conducted the following activities under the District's biosolids management program:

- Biosolids Monitoring Under Process to Further Reduce Pathogens Certification – The District maintains certification of a site-specific 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 annual reporting to the USEPA. The PFRP certification was renewed in 2012, and the certification period increased from two years to five years.

- Pathogen monitoring – The District utilizes its exceptional quality (EQ) lagoon-aged, air-dried biosolids in the Chicago metro area under a Controlled Solids Distribution (CSD) program under a permit issued by IEPA. The AMBS laboratories conducted analyses of biosolids for FC bacteria, viable *Ascaris* ova (Helminth Ova-HO), and culturable enteric viruses (EV) as required to demonstrate compliance with the 40 CFR Part 503 regulations for Class A pathogen criteria of the EQ standard. During 2013, biosolids analysis under the program included 61 samples for FC and 14 samples for HO and culturable EV analyses.

In 2013, EM&RD prepared the following regulatory reports under the biosolids management program:

1. The 2011 Biosolids Management Report to the USEPA - This report (Report No.13-02) was prepared to satisfy the reporting requirements of the Part 503 regulation. Based on the five-year PFRP certification issued in 2012, pathogen analysis data is reported in the Annual Biosolids Management Report to the USEPA.

2. Four quarterly reports for the CSD permit were submitted to the IEPA (Report Nos.13-01, 13-10, 13-26, and 13-48. The reports document the biosolids users, project descriptions and locations, and biosolids analyses.

National Pollutant Discharge Elimination System Effluent Monitoring. The AMB Section conducted the following monitoring to satisfy the requirements of the NPDES permits issued to the District WRPs.

- Fecal coliform monitoring – Membrane filtration analyses of FC bacteria was conducted to monitor the District's WRP effluents as required by their respective NPDES permits and to guide treatment operations. This included FC bacteria monitoring (one day/week/WRP) of the final treated effluent samples from each of the District's seven WRPs. The ABL performed FC

analyses on a total of 701 samples from the District's seven WRPs (Table 1). The FC analysis results were reported to M&O. As required in the NPDES permits, additional monitoring is done when rain storm events cause excess flow above the treatment capacities of the WRPs which result in discharge of untreated effluent to the receiving streams.

Goal 2: Waste Monitoring

The ABL analyzed eight industrial waste survey samples for FC bacteria to track the pollution sources and investigate the compliance of discharge quality of industrial users with the Industrial Waste Control Ordinance.

Goal 3: Environmental Monitoring

Fulton County Environmental Monitoring. The Fulton County Land Reclamation Site consists of 5,568 hectares (13,758 acres) of land the District owns in Fulton County, Illinois. The site was used to recycle biosolids for the purpose of reclaiming mine soil and fertilizing agricultural crops. To satisfy the IEPA permit requirements for operation of the site, the District established an environmental monitoring program to ensure that the land application of biosolids would not adversely affect surface water, groundwater, soils, and crops. The last application of biosolids at the site was done in 2004. As of 2007, all monitoring and reporting for soil, crop, and surface and groundwater at the site was terminated as approved by the IEPA until 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 M&O staff located at the Fulton County site assists EM&RD staff with the sampling. 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. 2012-SC-2255) 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 2013 groundwater monitoring data were submitted to the IEPA in the quarterly monitoring reports (Report Nos. 13-09, 13-11, 13-33, and 13-47).

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. The SMAs include the following six sites.

- John E. Egan Water Reclamation Plant Solids Management Area – This SMA is no longer used. The IEPA operating permit (No. 2010-AO-0266) does not require groundwater monitoring or reporting unless drying resumes at the site.

- Calumet Water Reclamation Plant Solids Management Area – This SMA consist of the Calumet West and Calumet East SMAs. The IEPA operating permit (No. 2010-AO-0265) requires sampling of lysimeters for groundwater monitoring. The 2013 groundwater monitoring data were submitted to the IEPA in the quarterly reports for the Calumet West SMA (Report Nos. 13-05, 13-14, 13-29, and 13-43) and the Calumet East SMA (Report Nos. 13-04, 13-13, 13-28, and 13-42).

- Lawndale Avenue Solids Management Area – The IEPA operating permit for this site (No. 2010-AO-0267) requires sampling of groundwater monitoring wells and lysimeters. The 2013 groundwater monitoring data were submitted to the IEPA in quarterly reports (Report Nos. 13-07, 13-16, 13-31, and 13-45).

- Ridgeland Avenue Solids Management Area – Currently, biosolids drying is not done on this site. Under the IEPA operating permit for this site (No. 2010-AO-0267) sampling of groundwater monitoring lysimeters has been terminated, except for lysimeter L-2N. The 2013 groundwater monitoring data were submitted to the IEPA in quarterly reports (Report Nos. 13-08, 13-17, 13-32, and 13-46).

- Harlem Avenue Solids Management Area – The IEPA operating permit for this site (No. 2009-AO-2715-1) requires sampling of monitoring lysimeters. The 2013 groundwater monitoring data were submitted in quarterly reports to the IEPA (Report Nos.13-06, 13-15, 13-30, and 13-44).

- 122nd and Stony Island Solids Management Area – Currently, biosolids drying is not done on this site. Under the IEPA operating permit for this site (No. 2010-AO-0267) sampling of groundwater monitoring lysimeters has been terminated, except for lysimeter L-1. The 2013 groundwater monitoring data were submitted to the IEPA in quarterly reports (Report Nos.13-03, 13-12, 13-27, and 13-4).

Estimation of Emission of Hazardous Air Pollutants. Part A, Title I, of the Clean Air Act, states that a publicly owned treatment works (POTW) is considered a major source of

hazardous air pollutants (HAPs) if it emits or has the potential to emit 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 per year and analyzed for 65 of the HAP compounds of concern to POTWs. Emissions of these HAPs from the wastewater treatment process units (grit chamber, primary settling tanks, aeration tanks, and secondary settling tanks) are estimated 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 2013, influent samples were collected in January and July 2013. The average influent concentrations and estimated emissions of the HAPs are presented in Table 2 for the three largest District WRPs (Calumet, Terrance J. O'Brien [O'Brien], and Stickney).

According to the BASTE model, all the individual HAP emissions were less than the ten tons/year criterion. The predominant compound emitted from the wastewater treatment processes were acetaldehyde at the Stickney WRP, toluene and cumene at the Calumet WRP, tetrachloroethene at the O'Brien WRP. The total measured HAP emissions were substantially less than the 25 tons/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, the annual HAPs report was filed as part of the IEPA's Environmental Emissions Reduction Market System.

John E. Egan Water Reclamation Plant Air Quality Permit. As part of the Egan WRP's Federally Enforceable State Operating Permit, monthly hydrogen sulfide (H_2S) monitoring was performed at the facility's compressor room. The monthly permit limit for the digester H_2S is 1,000 parts per million by volume (ppmv). In 2013, there was no permit violation with respect to H_2S concentration in the Egan WRP digester gas.

Tunnel and Reservoir Plan Groundwater Monitoring. The IEPA requires groundwater monitoring for the District's six TARP systems, which includes the Mainstream, Calumet, Des Plaines, and Upper Des Plaines (UDP) Tunnel Systems, the Gloria Alitto Majewski Reservoir, and the Thornton Transitional Flood Control Reservoir (Report Nos. 13-20, 13-18, 13-19, 13-23, 13-20, and 13-22, respectively). After each reservoir fill event resulting from storm events, the reservoirs are sampled, and weekly thereafter, during the period that the storm water remains in the reservoir. The groundwater monitoring program includes over 150 groundwater wells adjacent to the tunnel and reservoirs to monitor potential for groundwater contamination through extrusion of combined sewage. The wells are monitored three to six times per year and all samples for general chemistry are analyzed by the Analytical Laboratories Division, and FC by the AML.

TABLE 2: INFLUENT CONCENTRATIONS AND ESTIMATED EMISSIONS OF HAZARDOUS AIR POLLUTANTS AT THE CALUMET, STICKNEY AND TERRENCE J. O'BRIEN WATER RECLAMATION PLANTS IN 2013

Hazardous Air Pollutant Organic Compound	Influent Concentrations (µg/L)[1]			Emissions (tons/yr)[2]		
	Stickney	Calumet	O'Brien	Stickney	Calumet	O'Brien
Acetophenone	0.0	29.9	0.0	0.00	0.05	0.00
Chloroform	1.6	1.1	1.7	0.22	0.14	0.22
Cresol	7.3	16.5	6.9	0.00	0.03	0.01
1,4 Dioxane	3.6	0.0	0.0	0.00	0.00	0.00
Styrene	2.2	2.7	2.5	0.26	0.29	0.26
Tetrachloroethene	0.5	0.0	57.0	0.08	0.00	7.66
Trichloroethene	0.0	0.0	2.1	0.00	0.00	0.43
Xylene	0.4	0.0	0.0	0.02	0.00	0.00
Toluene	6.7	29.2	1.5	0.17	5.07	0.27
Acetaldehyde	57.1	0.0	0.0	0.95	0.00	0.00
Carbon disulfide	0.2	2.5	0.5	0.01	0.60	0.33
Methyl ethyl ketone	4.4	0.0	1.8	0.03	0.00	0.10
Proprionaldehyde	17.9	0.0	0.0	0.15	0.00	0.00
Lindane	0.0	0.0	3.6	0.00	0.00	0.00
Dichloromethane	0.0	15.3	0.0	0.00	0.00	0.08
Cumene	0.0	2.1	0.0	0.00	3.29	0.00

[1]Average of the two influent samples collected in January and July 2013.
[2]Emissions estimated using the Bay Area Sewage Toxics Emissions (BASTE) model.

Lake Michigan Monitoring. Monitoring of the Chicago harbors is conducted when river backflow to Lake Michigan occurs due to heavy rainfall in the Chicagoland area. During the river backflow events, water quality monitoring is conducted to assess the impact of the release of CAWS water to Lake Michigan. In 2013, there was one backflow event to Lake Michigan. During the river backflow, 128 water samples collected by the Industrial Waste Division were analyzed for EC and FC.

Drinking Water Monitoring. The Division analyzes drinking water at District facilities on an as-needed basis. During 2013, a total of 48 samples were analyzed for bacteria in response to requests from other departments to assess water quality following new pipe construction at the Stickney and O'Brien WRPs and Lockport Powerhouse facility, and mold contamination in drinking water pipe at the O'Brien WRP. 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. The results were reported together with safety instructions and recommendations where applicable.

Ambient Water Quality Monitoring Program. The AWQM program includes monthly sampling for water quality analysis, including FC analysis, at 28 stations on 13 waterways within the District's service area (Figure 2). Analytical results were summarized in M&R Report No. 14-47.

The biological monitoring program, which runs in conjunction with the AWQM program, includes chlorophyll monitoring and the study of fish communities. The primary objective of the monitoring program is to generate scientific data to be used by the District and provided to the IEPA for assessing 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.

Between June and September 2013, the AEWQ Section collected fish by electrofishing, mini fyke netting and seining at ten biological monitoring stations in the Chicago River System. In 2013, a total of 5,730 fishes comprised of 25 species and one hybrid species (Table 3), were identified, weighed, and measured for length. The fishes were also examined for parasites and disease. Data from these collections are shown in Table 3.

As a photosynthetic component of all algae cells, chlorophyll *a* analysis is used to quantify algal biomass in lakes and streams. The District began monitoring chlorophyll on a monthly basis in August 2001 as part of the AWQMP. Chlorophyll *a* results for 2013 were reported in M&R Report No. 14-47, "Annual Summary Report on Water Quality Within the Waterway System of Metropolitan Water Reclamation District of Greater Chicago."

FIGURE 2: AMBIENT WATER QUALITY MONITORING SAMPLE STATIONS

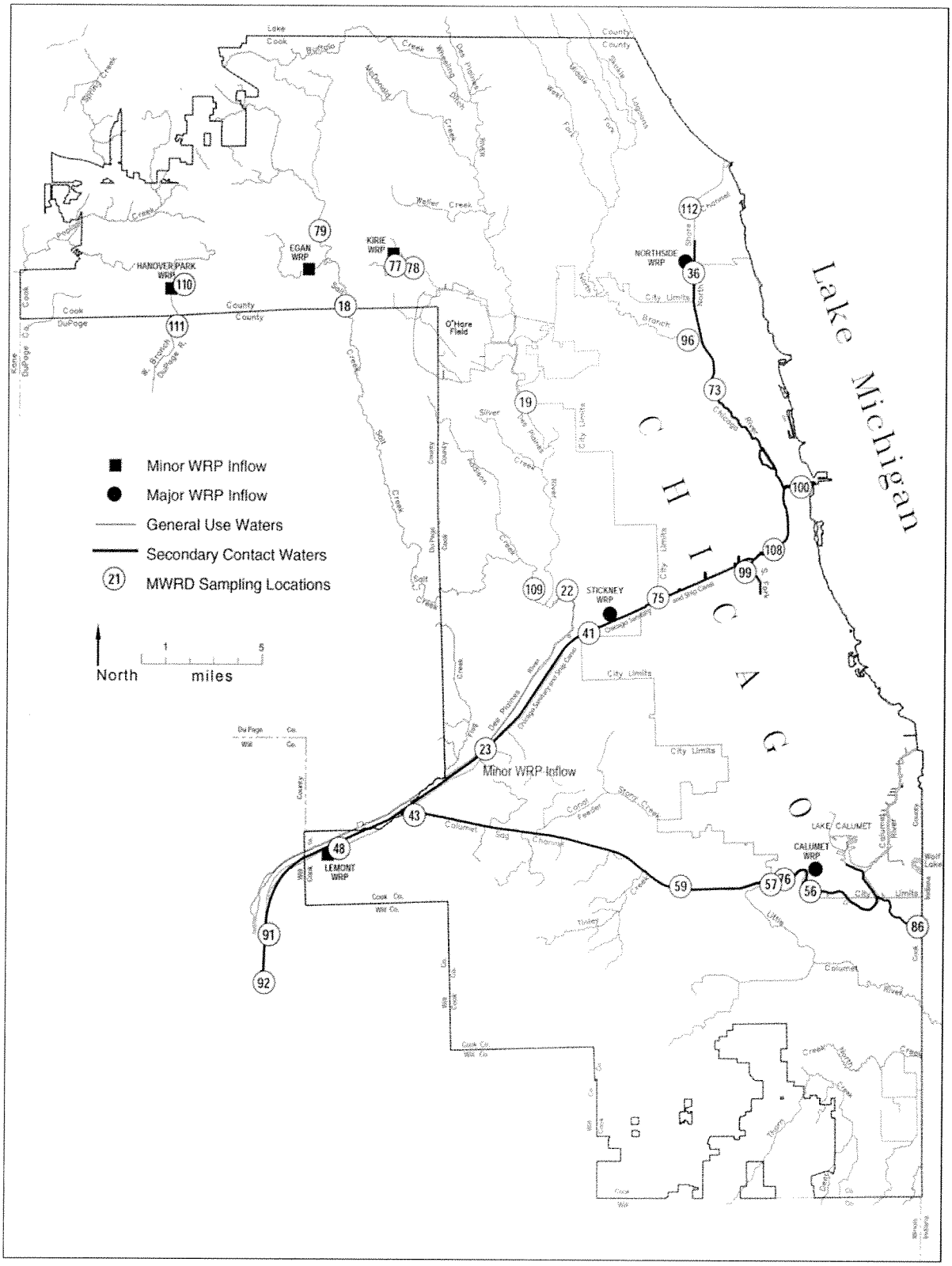


TABLE 3: FISH COLLECTED FROM THE CHICAGO RIVER SYSTEM DURING 2013

Waterway	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	2,374	128	21	8	Bluntnose minnow
North Branch Chicago River	101	0.4	6	3	Blackstripe topminnow
Deep-Draft North Branch Chicago River	97	85.7	11	5	Bluegill
Chicago Sanitary and Ship Canal	1,478	179.8	15	7	Gizzard shad

Continuous Dissolved Oxygen Monitoring. The AEWQ Section developed a comprehensive Continuous DO Monitoring program beginning in August 1998 in the Chicago River System and July 2001 in the Calumet River System to evaluate the dissolved oxygen dynamics in deep-draft sections of the CAWS. The DO monitoring in wadeable Chicago area waterways, particularly in the Des Plaines River System, began in July 2005. Figure 3 shows current continuous DO monitoring locations.

The DO results for 2013 are included in the reports entitled, "Continuous Dissolved Oxygen Monitoring in Chicago Area Wadeable Streams During 2013" (M&R Report No. 14-19) and "Continuous Dissolved Oxygen Monitoring in the Deep-Draft Chicago Waterway System During 2013"(M&R Report No. 14-21).

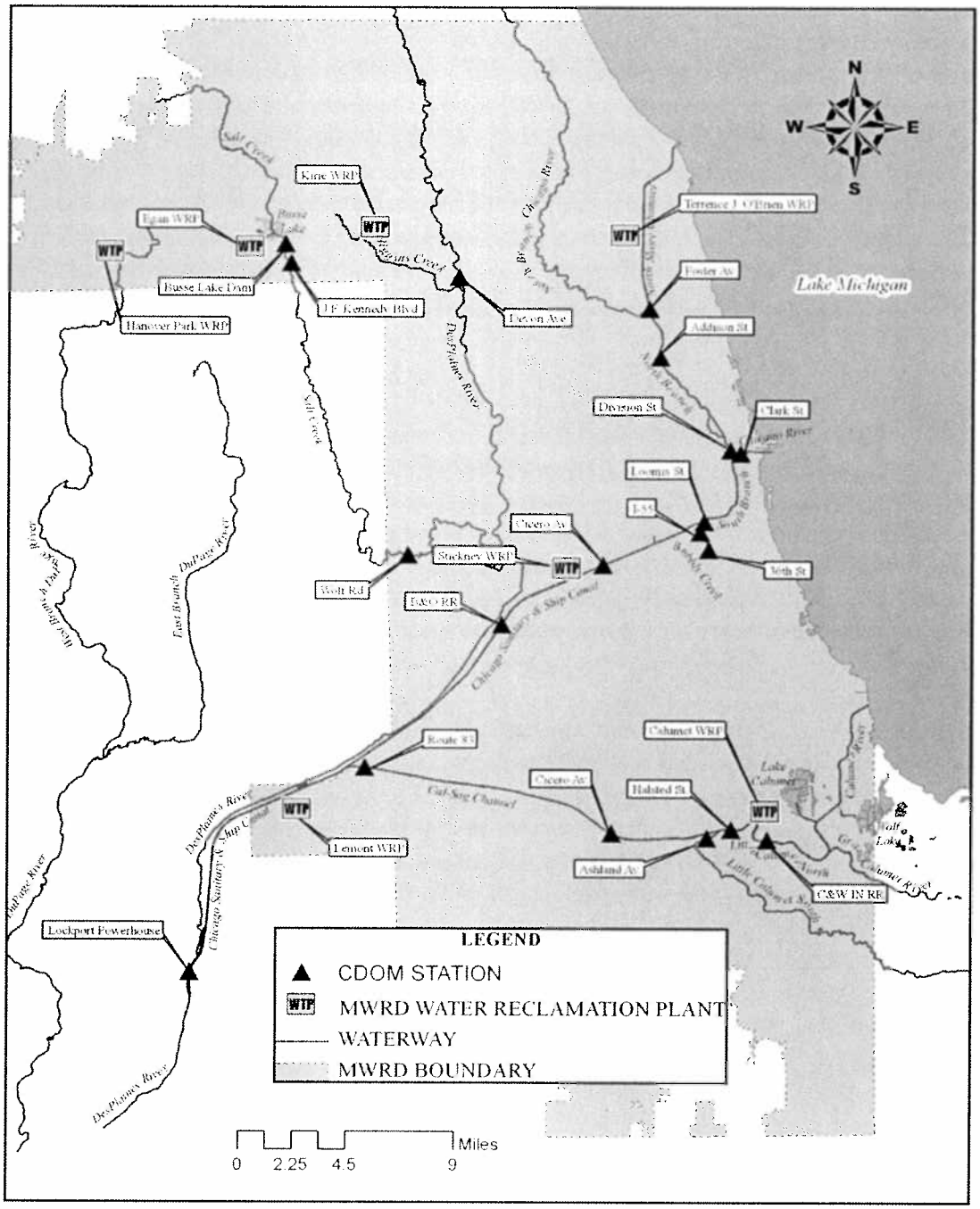
Goal 4: Technical Assistance

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, in spring 2012, it was determined that NH_3-N was completely removed by mid-tank length for both the North and South Batteries. Overall, based on the results of the quarterly sampling and analysis during 2013, the plant was operated adequately.

John E. Egan Water Reclamation Plant Chlorine Disinfection Process Control Evaluation. A study of the Egan WRP 001 Outfall disinfection process was initiated when FC in the outfall on May 31, 2011, exceeded the NPDES permit limit. Another exceedance occurred on August 20, 2013. Though conditions for both violations were different, it was considered that the chlorine demand may have increased along with the suspended solids (SS) concentration resulting in inadequate chlorine available for disinfection. The full-scale study, conducted from September 2012 through June 2013, addressed the following: (1) Verify the total residual chlorine (TRC) set point range at the end of the contact tank (clear well after the sand filter) that ensures consistent compliance with the NPDES FC permit (400 CFU/100 mL), under various operating conditions, particularly under transient conditions; (2) Investigate a potential correlation between secondary effluent turbidity with SS concentrations to determine whether turbidity can be used as an additional parameter for disinfection process control decisions; and (3) Evaluate the relationship between the TRC before the filter and after the filter in order to implement cascade control at the Egan WRP in the future.

For the first objective we attempted to simulate transient conditions with significant changes in TRC and chlorine demands. Unfortunately, since this process was controlled manually it was difficult to achieve simulation. Therefore, we could not collect sufficient FC data in the range of 100 to 10,000 coliform forming units (CFU)/100mL to establish a direct correlation between clear well total residual chlorine and FC concentration for different operational conditions.

FIGURE 3: CONTINUOUS DISSOLVED OXYGEN MONITORING SAMPLE STATIONS



The results of the study to address the second objective indicated that a relationship between the secondary effluent suspended solids concentration and turbidity exists in the lower turbidity range of 2 through 6 Nephelometric Turbidity Units (NTUs), as shown in Figure 4.

For the third objective, average delayed chlorine demand was determined under different flow regimes: 0.87 mg/L (10-23 MGD), 0.88 mg/L (24-49 MGD), and 0.23 mg/L (>50 MGD). The results indicate that at flows less than 50 MGD, the demands were similar. At flows higher than 50 MGD, the demand was much less. Based on the consistency of the target TRC (~1.0 mg/L) in the clear well during different operating conditions and under current control practices, cascade control was recommended. However, flow-paced manual control and use of pre-filter TRC and turbidity measurements for chlorine dose conditions were recommended.

Technical Support during Stickney Water Reclamation Plant Upset in October 2013. A major nitrification upset occurred at the Stickney WRP during October 25 through 30, 2013. Nitrification ceased in all four aeration batteries probably due to toxicity. The M&O Department requested M&R staff to run lab and field oxygen uptake rate (OUR) tests and lab nitrification tests during the upset and recovery. Based on the results obtained, M&R recommended to seed Stickney Battery A with O'Brien WRP waste activated sludge (WAS). Once Battery A completely recovered, Batteries C and D were cross-reseeded with Battery A WAS; Battery D was also partially seeded with Egan WAS. Battery B self-recovered without reseeding. Figure 5 illustrates the nitrification rates calculated from the lab OUR tests with spiked NH_3-N solution during the upset period. The nitrification rates for the three seeded batteries increased significantly after reseeding. These results indicated that seeding with a healthy nitrifying activated sludge is a practical solution to a nitrification upset.

John E. Egan Water Reclamation Plant Diffuser Plate Evaluation. During September and October 2013, a series of oxygen transfer efficiency (OTE) and specific oxygen uptake rate (SOUR) tests were performed to evaluate the new diffuser plates installed in the Egan WRP South Aeration Battery. Testing was performed at seven locations along the profile test battery. The results were compared to similar testing performed in 2011 on the diffuser plates that were installed in 1975 and replaced during summer 2012. Average OTE, Specific OTE (SOTE), DO, OUR, SOUR, off-gas air flow through the hood, air flow per diffuser, mixed liquour volatile suspended solids (MLVSS), and temperature at each location during the 2011 and 2013 study periods are summarized in Table 4. Dissolved oxygen was generally higher at all locations in 2013, except for Location 1. Air flow per diffuser was higher at all locations in 2011, except for Locations 6 and 7. The results of the statistical analysis is not shown in Table 4, but the SOTEs only showed a statistically significant difference of average values for Location 2 (higher in 2013). The data showed that the replacement of diffuser plates did not improve SOTEs in general.

FIGURE 4: TURBIDITY VERSUS SUSPENDED SOLIDS CONCENTRATION FOR THE JOHN E. EGAN WATER RECLAMATION PLANT CHLORINATED SECONDARY EFFLUENT (SEPTEMBER 18, 2012, THROUGH JUNE 26, 2013)

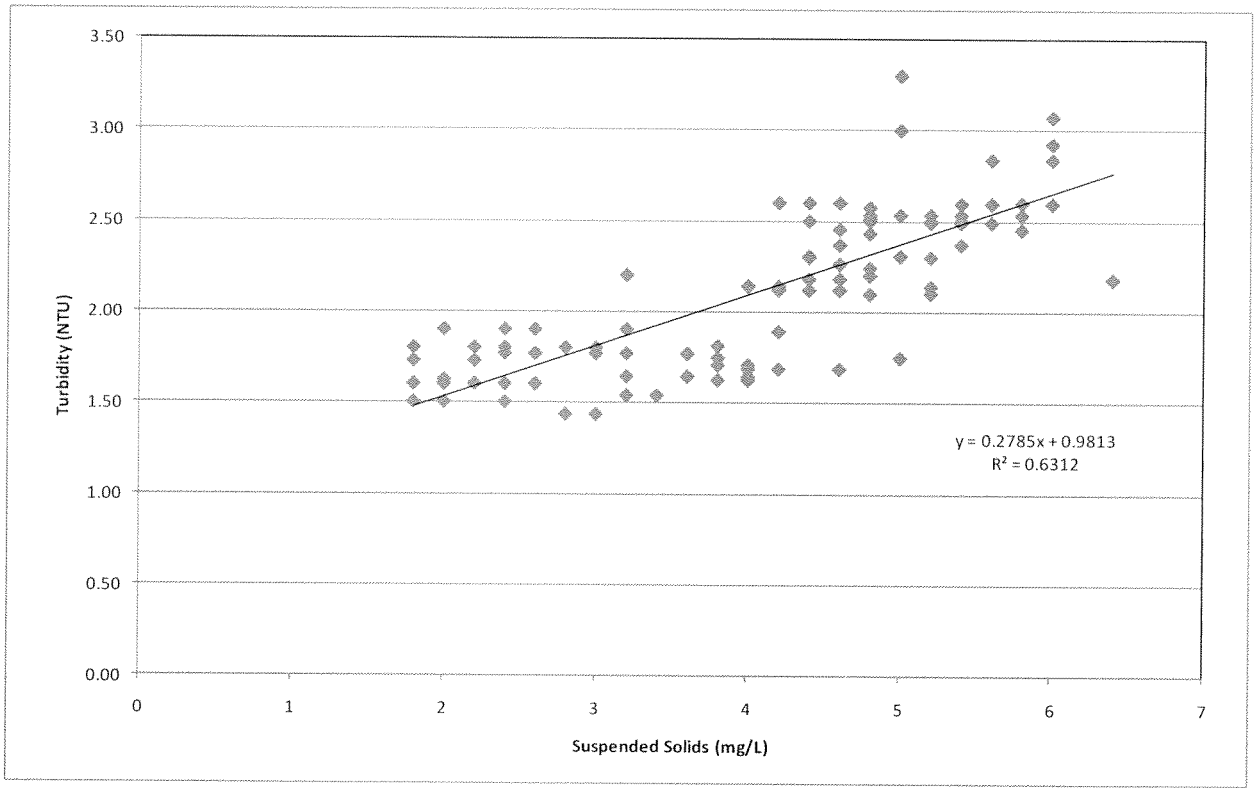
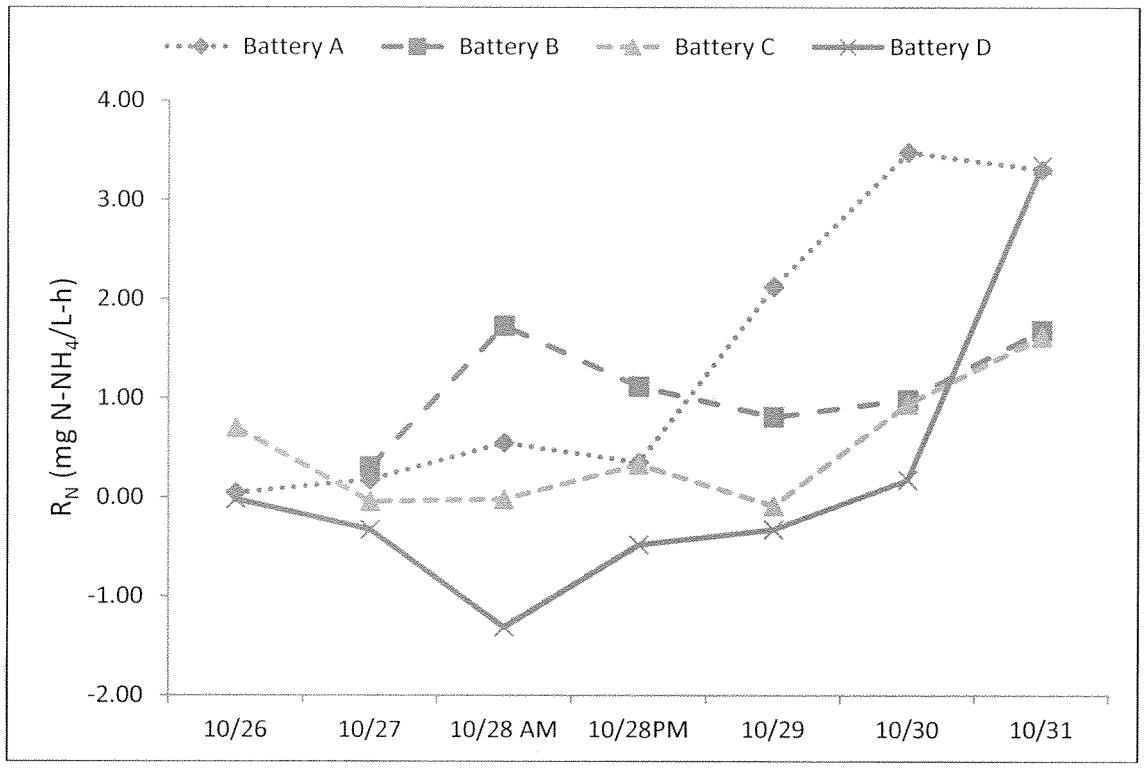


FIGURE 5: NITRIFICATION RATES (R_N) CALCULATED FROM LABORATORY OXYGEN UPTAKE RATE TESTING DURING THE STICKNEY WATER RECLAMATION PLANT OCTOBER 2013 NITRIFICATION UPSET AND RECOVERY



Note: Battery A was seeded on 10/27 at 5:00 p.m.; Battery D was seeded with Battery A WAS on 10/29 at 12:50 p.m.; Battery C was seeded with Battery A WAS on 10/30 at 9:25 a.m.; Battery D was seeded with Egan thickened WAS on 10/31.

TABLE 4: SUMMARY OF THE JOHN E. EGAN WATER RECLAMATION PLANT 2011 AND 2013 OFF-GAS TESTING RESULTS

Station	OTE	SOTE	DO (mg/L)	OUR (mg/L-hr)	SOUR (mg/L-hr-g MLVSS)	Off-Gas Flow (scfm)	Battery Air Flow/ Diffuser (scfm)	MLVSS (mg/L)	Temperature °C
					2011				
1	0.0586	0.0532	0.30	64.73	41.26	11.63	6.84	1,580	21.6
2	0.0867	0.0741	0.55	52.47	39.18	12.15	6.84	1,330	21.6
3	0.0982	0.0909	1.27	48.88	35.55	11.25	6.84	1,377	21.5
4	0.1107	0.1087	1.82	73.67	47.22	10.34	5.60	1,577	21.9
5	0.1016	0.1022	1.83	41.87	25.75	7.87	5.99	1,464	22.1
6	0.0909	0.1152	3.78	18.76	11.28	7.72	1.93	1,653	22.2
7	0.0959	0.1249	3.96	10.94	6.71	5.03	1.99	1,643	22.1
					2013				
1	0.0589	0.0497	0.41	42.63	38.41	12.08	5.99	1,120	21.4
2	0.0892	0.0905	2.03	39.16	25.97	9.71	5.99	1,523	21.6
3	0.0998	0.1070	3.78	43.56	29.60	11.08	5.99	1,467	21.6
4	0.0891	0.1114	3.64	20.14	13.07	7.87	3.27	1,572	21.6
5	0.0637	0.1401	6.81	14.24	8.78	8.75	3.27	1,640	21.6
6	0.0498	0.1248	7.28	10.36	6.61	7.51	1.99	1,567	21.6
7	0.0481	0.1227	7.32	10.31	6.61	6.52	1.99	1,567	21.6

John E. Egan Water Reclamation Plant Process Building Odor Characterization. During 2013, a series of studies were initiated to evaluate the indoor air quality in the dewatering, gravity belt thickener, and pretreatment buildings at the Egan WRP. Air quality parameters such as hydrogen sulfide (H_2S) carbon dioxide (CO_2), ammonia (NH_3), effective dosage at 50% percentile (ED50), and reduced sulfides were measured. The study in the Dewatering Building was performed to confirm the results obtained and the Odor Control recommendations of an Illinois Institute of Technology (IIT) study completed in 2008. The WTPR Section study was performed from December 11, 2012, through January 16, 2013, with monitoring at nineteen locations in areas of odor concern within the building. The data from this study were compared to the IIT results of similarly parameters as summarized in Tables 5 and 6.

The studies for the pretreatment and gravity belt thickener buildings were conducted again during fall 2013, and information on similar air quality parameters were obtained. The preliminary evaluation of the data from these two buildings showed that the NH_3 concentrations are not a concern in these two buildings, but there is potential concern with the H_2S levels in the pretreatment building. Although the concentrations of CO_2 in the pretreatment and the gravity belt thickener buildings were not considered to be at hazardous levels, they were twice as high as normal ambient CO_2 levels for both buildings. A full analysis of the data will be completed in the summer of 2014.

The conclusions based on the results from the dewatering building are: (1) The NH_3 and H_2S results of the study by the WTPR Section were higher than those of the IIT study for all areas studied; (2) The CO_2 concentrations in all areas are relatively high, and design of an adequate ventilation system for the dewatering building should be considered; (3) The elevated organic sulfides concentrations observed during the IIT study were not observed during the M&R monitoring study; and (4) Based on the ED50 results, the truck loading areas are considered slightly odorous, while the solids drop chutes areas have strong odors. However, the IIT study identified strong odor conditions in all areas.

Stickney Water Reclamation Plant Post-Centrifuge Building Polymer Bid Evaluation. Full-scale tests were conducted at the Stickney WRP post-centrifuge dewatering complex during July 2013 for the selection and purchase of summer polymer used in the post-digestion centrifuge dewatering process. During 2013, a total of four polymers from two manufacturers were submitted and tested at full scale followed by bench-scale tests. All four polymers met the District's criteria of a minimum of 95 percent solids capture during full-scale testing to be eligible for bidding on the Stickney dewatering polymer contract. The sludge cake solids and dosages determined from the testing of these polymers are shown in Table 7. The selection of polymer is based on the test performance criteria as described in the bid documents and the cost for conditioning per unit mass of sludge. The test results were transmitted to M&O via memorandum.

Ultraviolet Dose Response Study for the Terrence J. O'Brien Water Reclamation Plant. Since the O'Brien WRP is being designed for an effluent Ultraviolet (UV) radiation

TABLE 5: RESULTS OF THE ODOR (ED50) AND GAS ANALYSIS OF ODOROUS COMPOUNDS (AVERAGE VALUES) FOR SPECIFIC PARAMETERS BY THE MONITORING AND RESEARCH DEPARTMENT STUDY AND THE ILLINOIS INSTITUTE OF TECHNOLOGY STUDY IN THE JOHN E. EGAN WATER RECLAMATION PLANT DEWATERING BUILDING

Location	ED_{50} (D/T)		NH_3 (ppmv)		H_2S (ppmv)		Dimethyl Sulfide (ppmv)		Dimethyl Disulfide (ppmv)	
	MWRD	IIT	MWRD	IIT	MWRD	IIT	MWRD	IIT	MWRD	IIT
Centrifuge Area Near Office	27	195	3.1	13	0.079	1.50	<0.05	<0.05	<0.05	<0.05
Biosolids Conveyor	27	190	3.1	22	0.076	1.30	<0.05	127	<0.05	12
Truck Loading Area	11	61	1.4	7	0.044	0.27	<0.05	0	<0.05	<0.05
Solids Drop Chutes from Centrifuge	45	1,005	4.5	75	0.188	14.0	<0.05	140	<0.05	12
Polymer Room	15	ND	6.4	ND	0.098	ND	ND	ND	ND	ND

ND = No data collected.

TABLE 6: SUMMARY OF CARBON DIOXIDE CONCENTRATIONS AT VARIOUS LOCATIONS IN THE JOHN E. EGAN WATER RECLAMATION PLANT DEWATERING BUILDING

Carbon Dioxide	Ground Level	Truck Loading Area	Solids Drop Chute	Polymer Room
Mean (ppmv)	1,572	898	2,756	1,900
Median (ppmv)	1,447	928	2,781	1,695
95^{th} Percentile (ppmv)	3,507	1,391	6,907	3,597
Max (ppmv)	3,848	1,435	9,087	3,712

TABLE 7: RESULTS OF POLYMER TEST DONE AT THE STICKNEY WATER RECLAMATION PLANT CENTRIFUGE COMPLEX IN JULY 2013

Polymer Manufacturer	Polymer Identification	Sludge Cake Solids (%)	Polymer Dose (lbs/Dry Ton)
Polydyne	CE 1520	30.6	226
Polydyne	CE 1640	29.1	219.7
Ashland Specialty Chemical Company[1]	K260FL	27.6	48
Ashland Specialty Chemical Company[1]	K136L	29.5	44.1

[1]These are emulsion polymer products.

disinfection process, the WTPR Section performed a UV dose response study in 2012 to determine an appropriate UV design dose for future UV disinfection. These collimated beam tests were conducted using un-disinfected final effluent from the O'Brien WRP and FC as the target microorganism. In 2013, two collimated beam tests were completed using E. coli (EC) as the target microorganism in order to determine what impact a future change in permit limits (from FC to EC) would have on the dose requirement. Figure 6 shows the results from 2012 in which FC was the target microorganism. Figure 7 shows the results from the 2013 tests in which EC was the target microorganism. The 2012 and 2013 collimated beam tests were completed over a dose range of 0 to 33 mJ/cm^2. All tests were conducted according to the Ultraviolet Disinfection Guidance Manual by the USEPA and the Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse by the National Water Research Institute.

Technical Support to Biosolids Management Program. Technical support is provided to projects under the CSD Program, in which EQ, air-dried biosolids and composted biosolids are used in the Chicago metropolitan area, and to the Class B Biosolids Farmland Application Program. The technical support is provided 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 Division also conducts extensive marketing activities to promote the use of biosolids and composted biosolids under the CSD Program.

- CSD Program – The activities conducted in 2013 to promote and support the CSD Program include:

    1. Marketing activities and technical support on projects where 6,231 dry tons of EQ air-dried biosolids were used as a soil conditioner or fertilizer topdressing by five schools, 55 parks and suburban villages, five golf courses, three landscaping companies, and two District properties. The 2013 biosolids distribution season was very short due to relatively wet summer and fall seasons, which resulted in a shortage of dried biosolids to fulfill demand of the CSD customers.

    2. Collaboration with the City of Chicago, especially the Chicago Park District, to promote the use of biosolids for development of parks and recreational areas in Chicago.

    3. Preparation of biosolids information pamphlets.

    4. Collaboration with the Public Affairs Section to organize and conduct the District's first Sustainability Summit at Midlothian Park District, where attendees learned about the District's green initiatives, regulations pertaining to land application of biosolids, benefits of using biosolids for topdressing turf, and observed biosolids topdressing demonstration.

FIGURE 6: ULTRAVIOLET DOSE VERSUS FECAL COLIFORM COUNTS FOR THE TERRENCE J. O'BRIEN WATER RECLAMATION PLANT EFFLUENT SAMPLES USED FOR DISINFECTION DESIGN

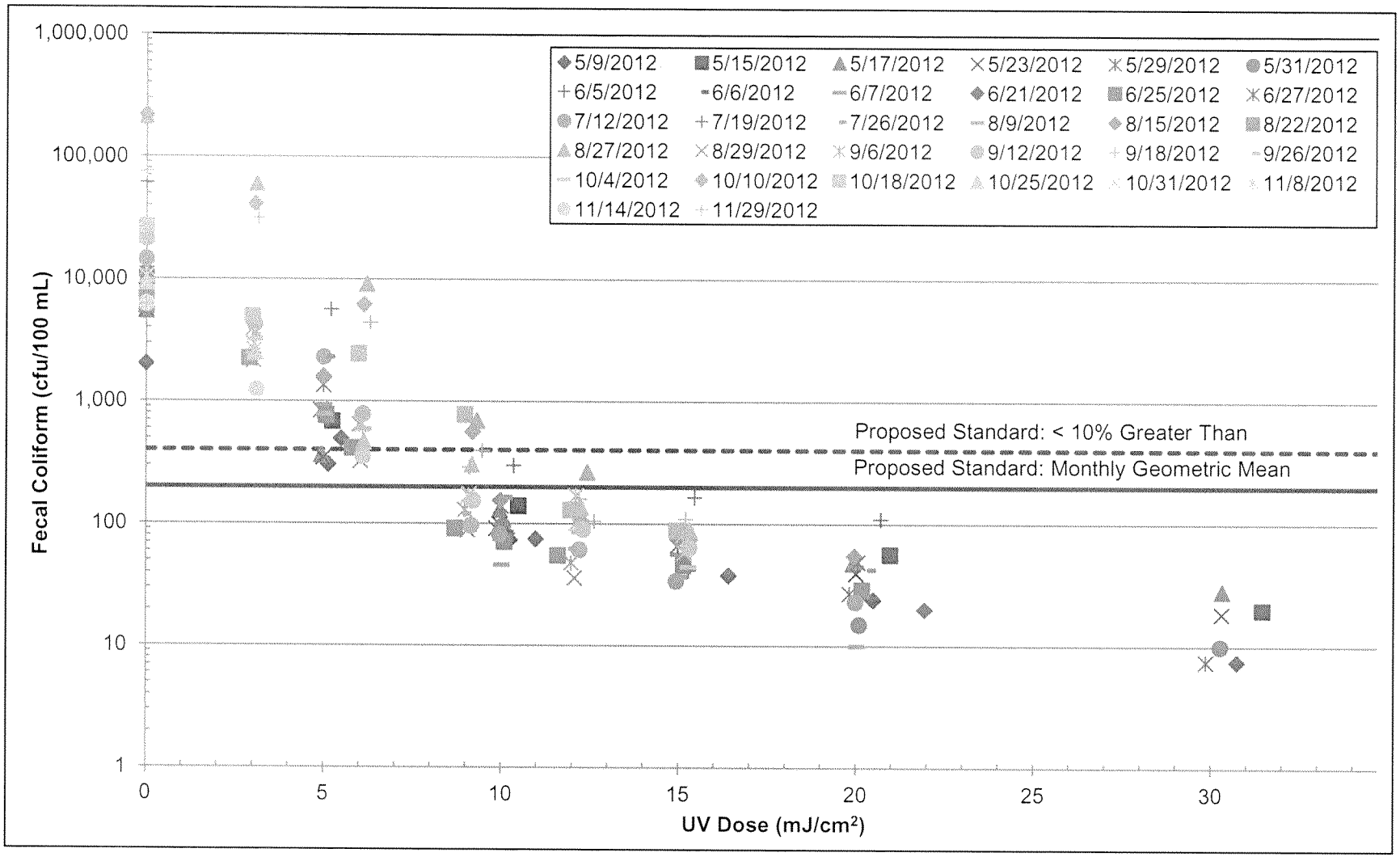
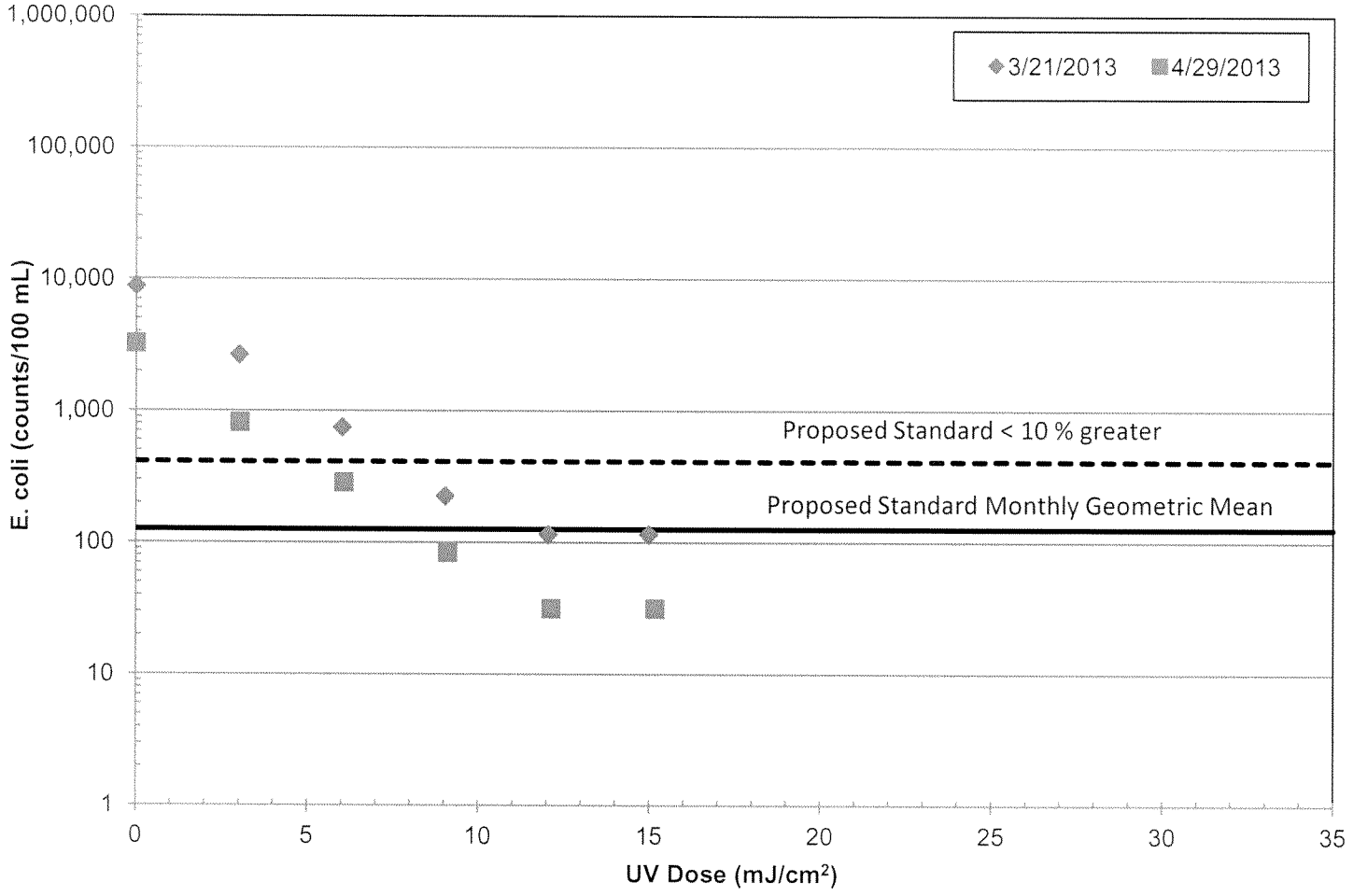


FIGURE 7: ULTRAVIOLET DOSE VERSUS E. COLI COUNTS FOR THE TERRENCE J. O'BRIEN WATER RECLAMATION PLANT EFFLUENT SAMPLES USED FOR DISINFECTION DESIGN



- Class B Biosolids Farmland Application Program – The activities the BU&SS Section conducted in 2013 to support the program include:

    1. Reviewed 330 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 submitted to M&O.

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

    3. Proactively recruited two farmers to use biosolids under the program to minimize public relations issues associated with field selection by the contractor.

Biosolids Master Plan. During 2013, the PFCP Section began to develop a Biosolids Master Plan with assistance from the M&O and Engineering Departments. The Biosolids Master Plan aims to identify the past and present and define the future path of the District's biosolids management program. The plan will cover:

1. Existing facilities, processes, and associated costs.

2. Legal structure.

3. Production forecasts.

4. Changes to raw materials/products.

5. Changes to facilities/facility optimization.

6. Market assessment.

7. New technologies.

The completion of the Biosolids Master Plan is anticipated for the summer of 2015. Approved recommendations in the Biosolids Master Plan will feed in to the overall District Capital Plan.

Lake Michigan Discretionary Diversion Monitoring. During the 2013 discretionary diversion season, the AEWQ Section worked with M&O to implement three-phased test operation scenarios focusing on the Wilmette Pumping Station (Wilmette). Each scenario tested different trigger points for activating diversion, as well as various diversion flows. The goals of the investigations were to further characterize how the North Shore Channel and the North Branch Chicago River responded to various operational strategies at Wilmette, determine which strategies were most efficient and successful in achieving IEPA proposed DO water quality standards, and counteract stagnant conditions in the upper North Shore Channel. In 2014, M&O will automate discretionary diversion at Wilmette in an effort to optimize use of discretionary flows from Lake Michigan.

Biological Monitoring of Tinley Creek. Contract 10-882-AF is a plan designed to stabilize eroding banks in Tinley Creek. Four sites were selected to conduct biomonitoring pre- and post-project completion to evaluate the ecological effects of this work. The data collected in 2013 was pre-stream bank stabilization and will serve as baseline data. Fish were collected three times from the four stations between July and September 2013. A total of 758 fishes, comprising 16 species, six of which were game species, were collected. The most abundant species collected was green sunfish. In August 2013, benthic organisms were collected and preserved once at each of the four stations using the IEPA method to collect aquatic macroinvertebrates from wadeable streams for biotic integrity assessments.

Evaluation of Permeable Pavement at the Stickney Water Reclamation Plant. 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. The permeability of the pavements measured in 2013 is shown in Table 8. Permeability of different surfaces varied and was in the order of asphalt > concrete > paver stone and was generally lower in the driving area than in the parking area. Periodic site visits during periods of rainfall indicated no visible standing water or runoff on any of the permeable lots during all monitoring seasons. Standing water, and thus runoff, was observed in the impermeable control lot. Detailed results are included in the final project report, "Performance of Permeable Pavements Installed at the Employee Parking Lot at the Stickney Water Reclamation Plant" (M&R Report No. 13-49).

Streetscape and Sustainable Design Program. The District is conducting a collaborative project with the Chicago Department of Transportation and the United States Geological Survey for evaluating various green infrastructure best management practices (BMPs) to reduce stormwater and pollutant loads to the collection systems. Construction of the BMPs was completed in fall 2012, which consisted of permeable pavers, planter boxes, and bioswales. Immediately after construction of BMPs, the permeability of pavers and soil in the planter boxes and bioswales was measured. Permeability of permeable pavers at different sites measured during 2012 and 2013 is shown in Table 9. Permeability declined with time; however, when pavers were cleaned, the permeability of pavers increased significantly.

TABLE 8: PERMEABILITY OF PERMEABLE SURFACES AT THE PARKING LOT OF THE STICKNEY WATER RECLAMATION PLANT IN 2013, FIVE YEARS AFTER INSTALLATION

Area	Paver Stone	Concrete	Asphalt
	---------- Permeability (inch/sec) ----------		
Driving area	0.07±0.02	0.13±0.07	0.15±0.13
Parking slot	0.15±0.04	0.27±0.09	0.31±0.09

TABLE 9: CHANGES IN PERMEABILITY OF PERMEABLE PAVERS AT DIFFERENT LOCATIONS OF THE STREETSCAPE SITE

Date	Juarez Academy	Blue Island-North	Blue Island-South
	----------Permeability (inch/sec)----------		
10/31/12	0.15 ± 0.02	0.30 ± 0.06	0.34 ± 0.04
06/11/13	0.07 ± 0.02	0.07 ± 0.03	0.14 ± 0.03
07/26/13	No Cleaning	Pavers Cleaned	Pavers Cleaned
08/05/13	0.05 ± 0.01	0.75 ± 0.12	2.83 ± 0.37

Permeability of bioswales is presented in Table 10. Permeability in the center of bioswales was higher as compared to near curb cut, probably due to higher sediment deposition close to the curb cut. Permeability of bioswales at both locations declined with time.

Native Prairie Landscaping. During 2013, the Division provided technical support for maintenance of the conventional and native prairie landscaping at the District's facilities.

Wastewater Microbiology Monitoring. Under this program, the WML conducts microscopic examination 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. The results are used to guide research projects and to provide technical guidance to M&O to optimize plant operations and to address treatment system upsets.

In 2013, detailed microscopic examinations were performed on 355 mixed liquor samples from the District's seven WRPs. Samples were collected on a rotating bi-weekly and/or monthly schedule. The data, recorded as counts per milligram of volatile suspended solids (counts/mg VSS), were compared to the WRP process control test parameters sludge volume index (SVI) and food to mass (F/M) ratio. Comparisons of the microscopic examination data with the sludge SVI at the Calumet WRP are shown in Figure 8. Three key microbiological parameters: zoogleal mass index, shelled metazoa-protozoa count and total filamentous bacteria count, were associated with higher SVI values. The microscopic assessment results were summarized and transmitted to M&O and posted on the District's intranet. Select protozoa and metazoan, indicators of adverse conditions, observed in the District's WRPs are shown in Figure 9.

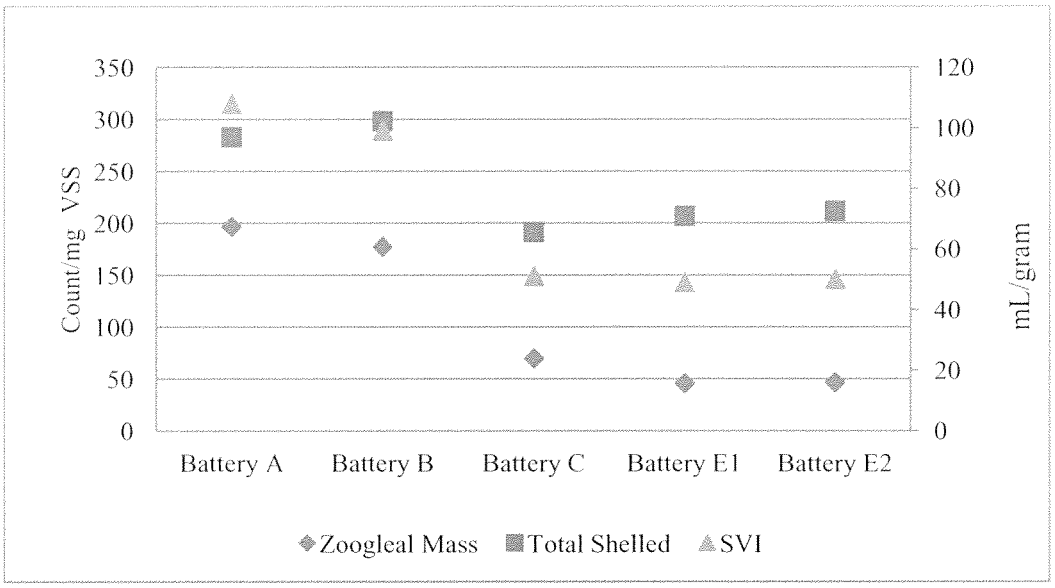
Annual average microbiological data were generated for each of the District's WRPs based on observations and data collected in 2013 (Table 11). One of the goals of the routine microscopic assessment program is to establish "Operation Action Levels" values that can be used as a proactive operational tool. Action levels are set based on data and observations collected during plant upset conditions. Action levels are set to alert the operator of potential upset conditions. Operation action levels for Egan and O'Brien WRPs are shown in Table 12.

Stickney Water Reclamation Plant West Side Primary Treatment and Grit Facility Evaluation. The PFCP Section, in conjunction with the Engineering and M&O Departments, formed a task force to re-evaluate a 98 percent consultant design for new aerated grit tanks (AGTs) and new circular primary settling tanks (PSTs) at the West Side portion of the Stickney WRP. The existing skimming tanks and Imhoff tanks are slated for removal. The 98 percent design includes replacement of the existing 16 skimming tanks with eight new AGTs with traveling bridges and a building to house the tanks. In addition, the 98 percent design includes replacement of the Battery A Imhoff tanks with nine new circular PSTs with the option of replacing Imhoff Battery B with an additional nine circular PSTs if needed. The specific objectives of the re-evaluation were to: (1) verify that the size of the new AGTs, as designed, were appropriate for the grit removal needs at West Side, (2) evaluate the need for a building to

TABLE 10: CHANGES IN PERMEABILITY OF BIOSWALE WITH TIME

Date	Near Curb Cut	Center
	----------Permeability (inch/sec)----------	
10/31/12	0.19 $\pm$ 0.06	1.02 $\pm$ 0.31
06/11/13	0.15 $\pm$ 0.05	0.92 $\pm$ 0.26
08/05/13	0.13 $\pm$ 0.06	0.84 $\pm$ 0.20

FIGURE 8: COMPARISON OF THREE KEY MICROBIOLOGICAL PARAMETERS (AVERAGE ZOOGLEAL MASS INDEX, SHELLED PROTOZOA-METAZOA AND FILAMENT COUNT) WITH SVI VALUES AT THE CALUMET WATER RECLAMATION PLANT



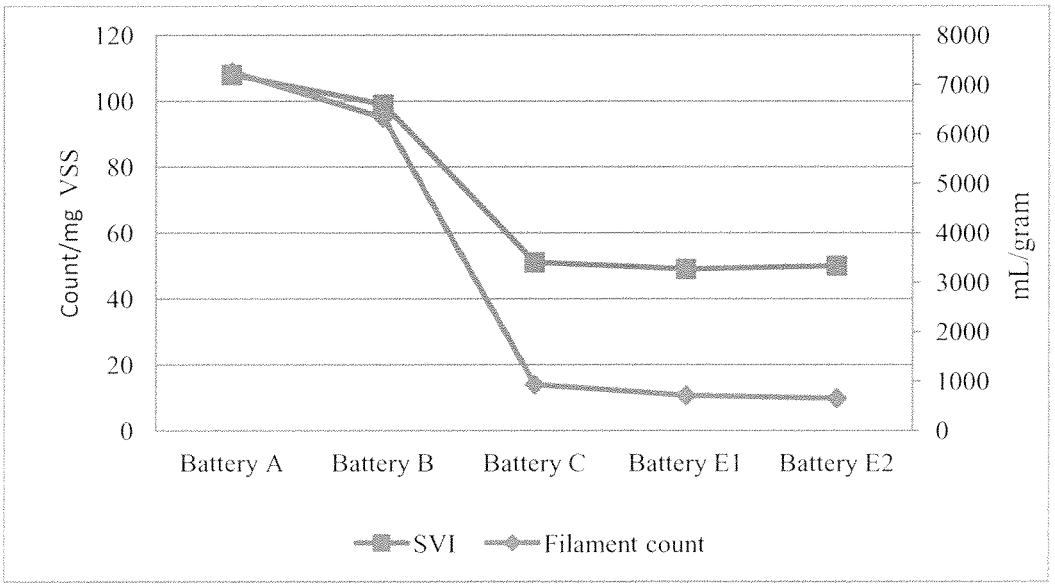
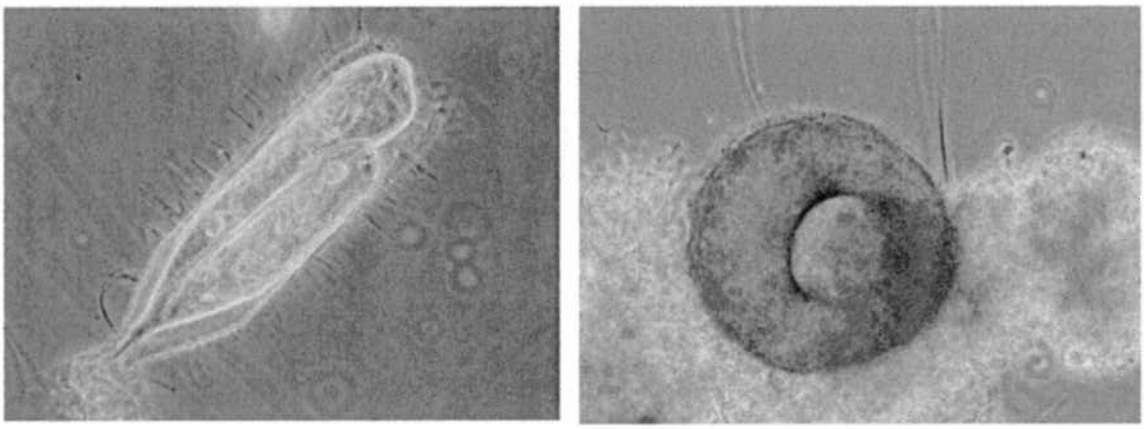


FIGURE 9: MICROSCOPIC OBSERVATIONS OF ACTIVATED SLUDGE AT THE METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO WATER RECLAMATION PLANTS



A B

(A) A tube-dwelling ciliated (*Vaginicola*) used as an indicator of adverse conditions (Lemont WRP Tank 1), 40x phase.
(B) A shelled amoeba (*Arcella*), also used as an indicator of adverse conditions (Lemont WRP Tank 3), 40x phase.

TABLE 11: ANNUAL AVERAGE VALUES FOR KEY MICROBIOLOGICAL PARAMETERS AT THE METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO'S WATER RECLAMATION PLANTS IN 2013

WRP Name	Total Shelled – Metazoa-Protozoa Count/mg VSS	Zoogleal Mass index Count/mg VSS	Filament Bacteria Count/mg VSS
Kirie	373	61	1,155[1]
Egan (2 Batteries)			--[2]
North	272	103	1,317
South	279	97	1,010
Stickney (4 Batteries)			--[2]
A	271	114	984
B	230	130	480
C	237	102	847
D	308	160	770
O'Brien (4 Batteries)			--[2]
A	464	150	2,069
B	415	157	2,444
C	436	156	1,846
D	385	84	1,800
Hanover Park (4 Batteries)			--[3]
A	300	109	1,726
B	346	101	1,779
C	361	101	1,745
D	314	111	1,782
Lemont (3 Batteries)			--[4]
1	226	69	2,394
2	251	71	2,328
3	280	61	2,322
Calumet (5 Batteries)			--[2]
A	538	234	2,690
B	544	245	2,553
C	387	107	701
E1	277	105	704
E2	216	90	585

[1] Filament bacteria (type 0041, type 0675 and type 1851).
[2] Filament bacteria (*Microthrix*, type 0041 and type 0675).
[3] Filament. bacteria (*Microthrix*, type 021N, type 0041 and type 0675).
[4] Filament bacteria (Type 021N).

TABLE 12: LEVELS OF CONCERN AND OPERATION ACTION LEVELS[1] OF MICROBIOLOGICAL PARAMETERS AT THE JOHN E. EGAN AND TERRENCE J. O'BRIEN WATER RECLAMATION PLANTS

Parameter	Egan	O'Brien
	count/mg VSS	
Total Shelled Protozoa-Metazoa[2]	400-600[3]	600-800[3]
Zoogleal Mass Index (ZMI)[4]	300-400	400-600
Filament Bacteria Count	6,000-8,000	4,000-5,000

[1]Action levels are set based on data collected and observation during plant upset conditions.

[2]Increases in the total shelled protozoa-metazoa count alone may not require process changes at the action level; however, when in conjunction with a ZMI at or above the ranges listed above, corrective action may be warranted.

[3]Values greater than the range are considered as Action Levels.

[4]ZMI at or above 400/mgVSS at Egan and 600/mg VSS at O'Brien should trigger corrective action if this occurs in conjunction with SVI values (not associated with filamentous bacteria) exceeding 100 and/or noticeable increases in effluent turbidity.

house the AGTs, and (3) consider all available primary treatment technologies and determine the most appropriate technology for use at the West Side portion of the Stickney WRP.

The task force reviewed aerated grit tank design criteria, grit settling concepts, and flow data to determine how the tank size would impact grit capture. Based on this work, the decision was made to build six new AGTs instead of the originally designed eight. To evaluate the need for a building, the task force considered different types of grit removal technologies since the use of traveling bridges exposed to the elements was considered as ideal for the District. Therefore, the task force evaluated different removal technologies, considering economics, pros, and cons, and combined this information with the economics of housing the AGTs in a building. Based on this work, the decision was made to use shaftless screw conveyors for grit removal from the tanks and with no building to house the AGTs. Finally, the task force determined the most appropriate technology for primary treatment at West Side by completing an evaluation matrix that considered economic, environmental, social, and technology criteria, including effects the alternatives would have on downstream processes. Based on this work, it was decided that nine new circular PSTs should be built with an option to bypass flow around primary treatment directly to secondary treatment. The PFCP Section drafted a technical memorandum detailing these evaluations and results.

Stickney Water Reclamation Plant D799 Substation Technical Evaluation. The PFCP Section, in conjunction with the Engineering and M&O Departments, formed a task force to evaluate the available alternatives to address concerns associated with the D799 Substation (D799) at the Stickney WRP. D799 was built in 1981, under District Contract No. 78-184-2E, and it is the only substation that provides primary electrical power to the Stickney WRP. D799 is configured with four main buses (A, B, C, and D). Due to the current configuration, complete isolation of a bus for maintenance is not possible without a complete plant shutdown. The M&O and Engineering Departments have expressed concern about the reliability and safety of the substation. The data shows a significant increase in maintenance costs of the switchgear after 2004, including costs associated with repairing the switchgear equipment due to catastrophic failures in 2009 and 2011. The M&O and Engineering Departments have also recognized that the lack of expansion capacity in the facility as well as the potential for health and safety hazards inside the plant are critical issues if life safety equipment throughout the plant becomes inoperable.

The task force considered five alternatives to address the issues at D799:

1. Do Nothing - Maintain switchgear at current levels until complete failure.

2. Refurbish - Fully restore existing switchgear to "like new" condition using existing technology.

3. Retrofit - Targeted replacement of switchgear components with modern equivalents.

4. Complete Replacement - Complete redesign of the entire switchgear system that achieves the highest level of reliability, safety, and functionality.

5. Retrofit/Replacement Hybrid - Combination of targeted replacement of some switchgear components with modern equivalents and a complete redesign of some of the switchgear equipment.

The task force determined early in the process that doing nothing (Option 1) was not an acceptable solution due to increasing trends in operating and maintenance costs. Additionally, a retrofit/replacement hybrid solution (Option 2) was eliminated due to limited physical space, extreme difficulty in modifying the current bus configuration, and minimal probability of successful implementation. The evaluation of the last three options was completed using a modified triple bottom line approach in which financial, technical, and social factors are weighted according to importance. The decision was made to completely replace the switchgear system using construction funds. A technical memorandum detailing the evaluation, data and results is available on the District portal website under M&R Data and Reports.

Stickney Water Reclamation Plant Boiler Evaluation. In 2013, the Engineering Department requested the PFCP Section to evaluate Contract 11-193-3M based on two proposed options. Option one involved providing a new 80,000 lbs/hr co-firing boiler at the Stickney Boiler Facility (SBF), and option two required transporting one 70,000 lbs/hr co-firing boiler from the Calumet Boiler Facility (CBF) to Stickney. The PFCP established a tentative evaluation schedule and held a kick-off meeting for the evaluation on December 12, 2013. Further work on this evaluation will continue in 2014.

Regulatory Review. The Division 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. The following reviews were conducted in 2012:

- Conducted a review of the NPDES permits for the O'Brien, Calumet, and Stickney WRPs.

- Provided data and review of the national water quality criteria for bacteria and ammonia nitrogen.

- Reviewed documents and provided data in support of the IPCB Rulemaking concerning the CAWS Use Attainability Analysis.

- Conducted a review of the District-wide collection system operation and maintenance manual as a reference and guidance for future updates and revisions with changes in NPDES permit requirement.

Goal 5: Operations and Applied Research

John E. Egan Water Reclamation Plant Centrate Sidestream Deammonification Pilot. The Egan WRP ammonia-rich centrate, which is conveyed to the O'Brien WRP for treatment, is believed to be creating odors along the way to the O'Brien WRP with sewages mixed with the centrate. A Deammonification (Demon®) sequencing batch reactor (SBR) suspended growth process pilot was tested for five months from September 2012 to February 2013 at the Egan WRP. The pilot study demonstrated the effectiveness of the Demon® process for removing ammonia nitrogen (NH_3-N) from the centrate. If applied at the full-scale, this would allow the treated centrate to be recycled to the plant head works without compromising the plant's mainstream nitrification capacity. Figure 10 illustrates the volumetric loading rate and average NH_3-N removal efficiency during the study period. With external alkalinity addition, the pilot achieved a loading rate of 0.55 kg/m^3-day with an average NH_3-N removal efficiency of 90 percent; without alkalinity addition, the pilot test reached a volumetric loading rate of 0.7 to 0.9 kg NH_3-N/m^3-day with an average NH_3-N removal of 44 percent. The Demon® process also demonstrated robust performance with respect to the stress of low temperatures, low alkalinity, and elevated polymer concentrations in the centrate.

The WTPR Section is currently providing support in the design of a full-scale facility with a similar approach using a moving bed biological reactor (Anita^{TM} Mox) for implementation in late 2014, instead of the sequencing batch suspended growth approach of the Demon® process. The Anita^{TM} Mox process will remove only up to 80 percent of the NH_3-N centrate load. As such, 20 percent of this load will be recycled to the head of the plant. Therefore, in early 2014, a monitoring study will begin to test if increasing NH_3-N centrate load to the head of the plant will affect the nitrifying capacity of the plant.

Enhanced Biological Phosphorus Removal Demonstration Testing. During 2012, the WTPR Section, in conjunction with the Engineering and M&O Departments, formed a Phosphorus Task Force to assess and implement biological P removal and P recovery at the Calumet, Stickney, O'Brien and Kirie WRPs. As an initial step, the WTPR Section performed a demonstration of enhanced biological phosphorus removal (EBPR) in one battery at the Stickney WRP and one battery at the Calumet WRP using current plant infrastructure. The process was implemented by creating anoxic, anaerobic, and aerobic zones in the test batteries to facilitate the growth and luxury P uptake of phosphate accumulating organisms (PAOs).

For the Stickney WRP, process optimization of the test (demonstration) in Battery D continued in 2013. This work included holding primary sludge in the preliminary tanks longer to generate more volatile fatty acids (VFAs) from sludge and further air adjustments in the battery to lower the DO at the end of the anaerobic zone. Starting in August 2013, Batteries B, C and A were subsequently converted to a similar EBPR configuration using different methods, i.e. Battery B by full conversion in one day; Battery C by step conversion over a one-month period; and Battery A by seeding with PAO enriched sludge. Figure 11 shows the monthly average total P (TP) in the Battery D effluent and plant outfall relative to the primary effluent (PE) TP entering the EBPR process during 2013. Up through September 2013, Battery D TP

FIGURE 10: DAILY AVERAGE AMMONIA NITROGEN LOADING RATE AND REMOVAL EFFICIENCY OF THE DEMON® PILOT AT JOHN E. EGAN WATER RECLAMATION PLANT SEPTEMBER 2012 THROUGH FEBRUARY 2013

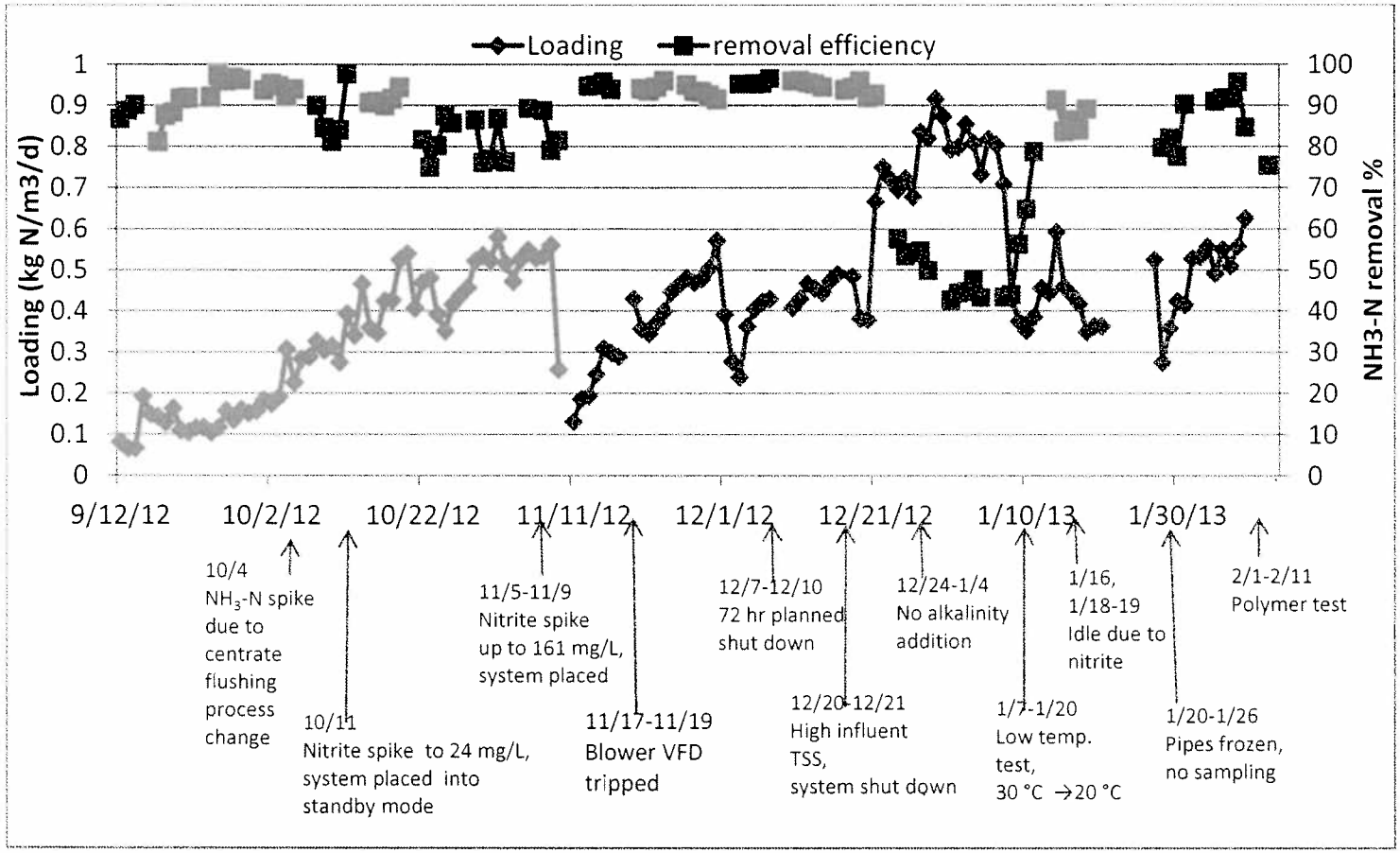
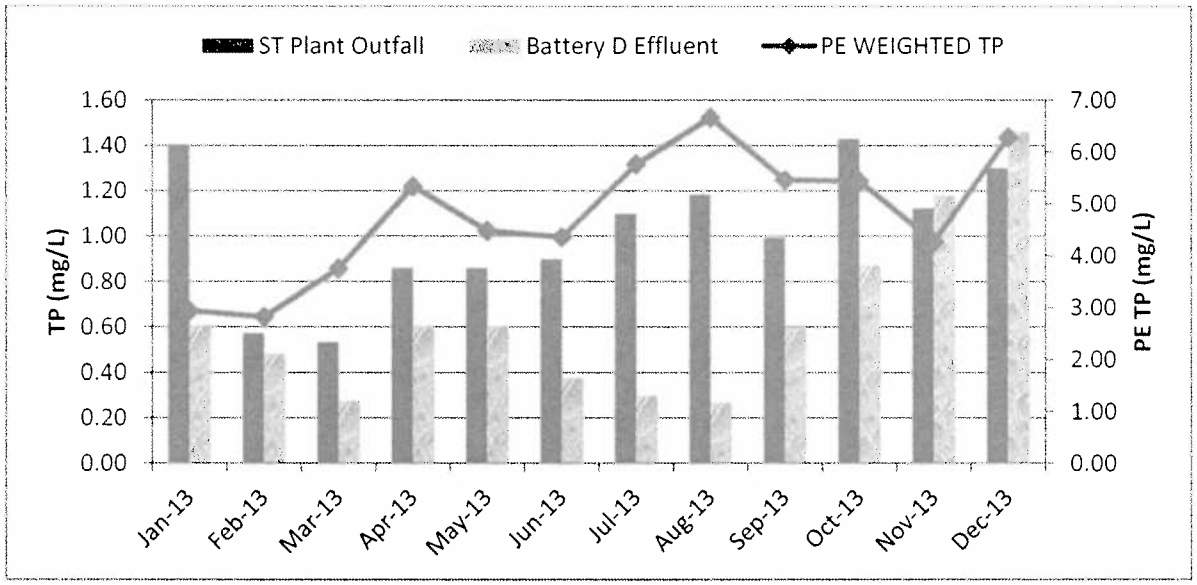


FIGURE 11: MONTHLY AVERAGE TOTAL PHOSPHORUS CONCENTRATIONS IN THE STICKNEY WATER RECLAMATION PLANT OUTFALL AND BATTERY D EFFLUENT, AND WEIGHTED TOTAL PHOSPHORUS CONCENTRATIONS IN PRIMARY EFFLUENT



Note: Battery D was converted to EBPR configuration since May 2012.

effluent concentrations were less than 0.6 mg/L. Poorer performance was observed in all four batteries starting in October 2013, probably due to a plant nitrification upset, carbon limitations, elevated P in the plant influent, recycle stream loadings, or transition to cold weather. These conditions are being examined in 2014.

At the Calumet WRP, Battery A was converted to the EBPR process on February 19, 2013, and operated similarly to Battery D at the Stickney WRP. The converted battery did not achieve significant P removal, most likely due to a carbon limitation; the average effluent TP concentration was 3.49 mg/L in the demonstration battery and 3.37 mg/L in the plant outfall from February 19, 2013 to December 31, 2013. A sequencing batch reactor (SBR) study will be conducted in 2014 to address process optimization and carbon needs in order to establish an efficient EBPR process at the Calumet WRP.

The initial stages of EBPR implementation at the O'Brien WRP began in November 2013 by stress testing to investigate how two different technologies (return activated sludge pump and a dispersion baffle) responded to different loading rates to the secondary clarifiers. As solids removal and, therefore P removal is often limiting, especially during winter conditions, one of these technologies may be included in the O'Brien WRP P removal implementation. The technology study will be completed in summer 2014.

In August 2013, an evaluation of the Kirie WRP influent quality was initiated. The evaluation included historical influent biochemical oxygen demand (BOD) and TP data analysis (2001 through 2013) and data from an ongoing examination of VFAs, Chemical Oxygen Demand (COD), readily biodegradable COD, filter flocculated COD, and soluble COD (sol-COD). This evaluation indicated that organic carbon (OC) loading to the aeration tanks should be sufficient for the EBPR process to reduce plant effluent TP to less than 1.0 mg/L. However, based on literature recommendations the amount of OC in the readily biodegradable form may not be sufficient. Fermentation of mixed liquor (ML) or return activated sludge (RAS) will be considered as potential methods to provide more readily biodegradable carbon for EBPR. The task force started the design process of converting two aeration tanks to implement EBPR at the Kirie WRP. The design entails establishing a quasi anoxic/anaerobic zone followed by an aerobic zone in the tanks. Infrastructure modification will be constructed in 2014 followed by a test demonstration.

The WML provided analytical and technical support to the EBPR project. The WML developed methods and SOPs for staining, identifying and quantifying PAOs in activated sludge samples. Duplicate slides made from each sample were stained using the Sudan Black and the Neisser staining procedures. An example of images of the PAO from the Stickney WRP Battery D is shown in Figure 12. Also, data in Table 13 show that PAOs were higher in the test battery (Battery D) than in the control battery at the Calumet WRP and this trend was less pronounced at the Stickney WRP.

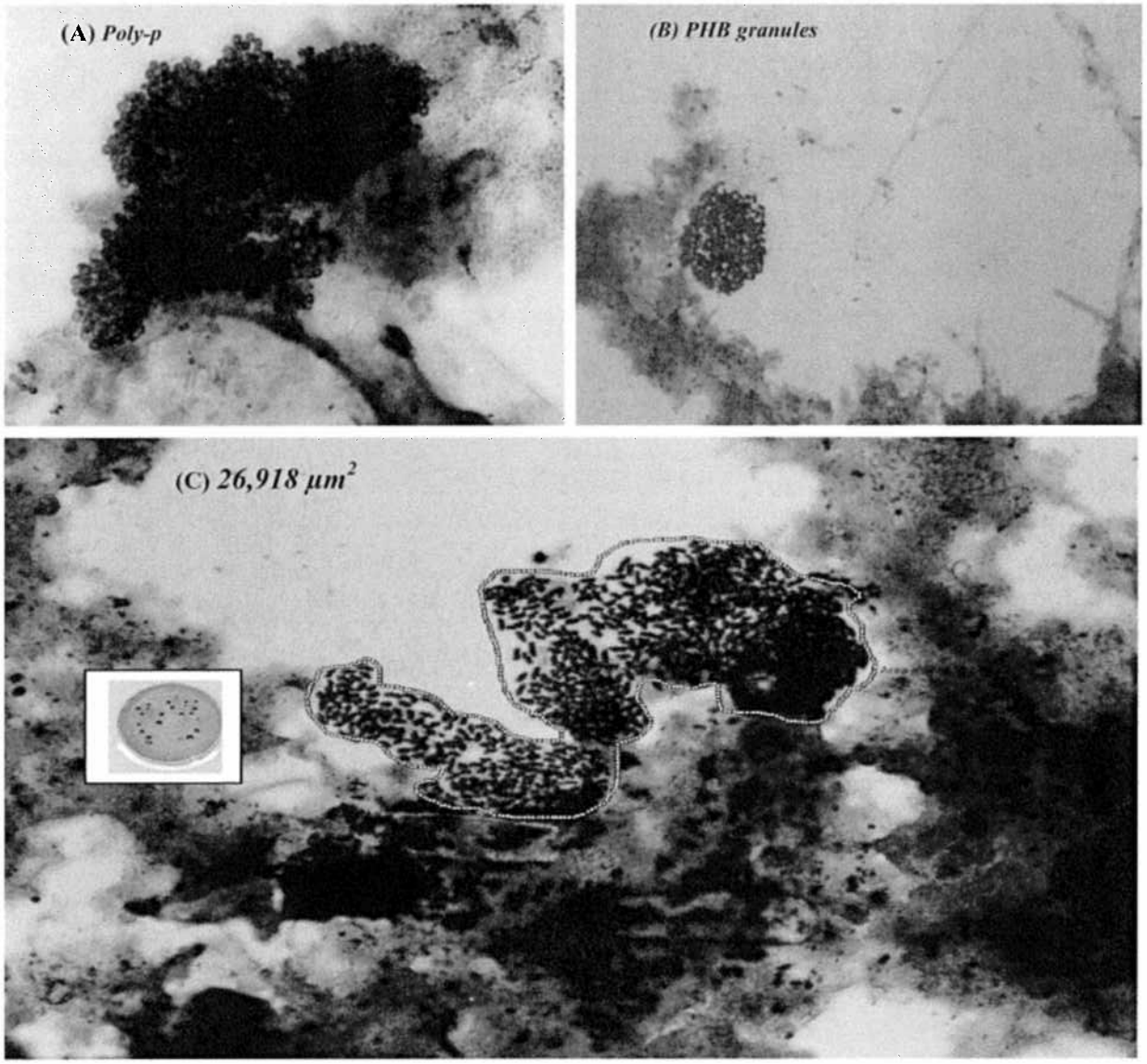
Evaluation of an Odor Control Technology for Wastewater. Due to odors and corrosion problems in the District's interceptors and indoor facilities due to hydrogen sulfide generation, one traditional and one advanced odor mitigation treatment were evaluated. Hydrogen peroxide alone (traditional) and hydrogen peroxide with a proprietary Fenton type catalyst (advanced), were evaluated in a laboratory bench-scale study on mixture of Stickney raw wastewater and preliminary sludge. Both treatments were effective at increasing and/or maintaining elevated oxidation-reduction potentials above 0 mV up to 7 hours in the mixture, which is an indicator of generating an odor alleviation environment. Figure 13 shows the change in oxidation reduction potential after the treatments.

Effect of Sewer Cleaning on Odors in the James C. Kirie Water Reclamation Plant Interceptor System. Two phases of full scale field monitoring (pre- and post-cleaning) were conducted by M&R during late 2012 and early 2013, respectively, to investigate the effect of sewer cleaning in alleviating odors and corrosion potential in interceptors UDP14A and UDP20B. During the pre-cleaning phase from October 16 through November 21, 2012, a calcium nitrate solution was injected at a rate of 75 gpd between Stations 2B and 3C (Injection Station 1 [IS1]) (Figure 14). Following this phase of the study, sewer cleaning was done from Station 5E (junction of Rand and Wolf Roads) to immediately upstream of station 7G as conducted by the North Side Sewer Management office in early December 2012. Cleaning involved removing the sediment and biofilm from the reach where most of the odors and H_2S generation take place. A post-cleaning phase test was then performed from January 15 through February 7, 2013. During this phase, calcium nitrate was not injected by M&O due to expiration of contract with the calcium nitrate vendor. Continuous H_2S monitoring and periodic wastewater sampling and analyses at eight monitoring locations along the interceptor system were performed during both the pre- and post-cleaning phases.

During both phases in the affected reach, average H_2S concentrations were less than one part per million by volume (ppmv). However, maximum H_2S concentrations were lower during the post-cleaning phase as summarized in Table 14. These H_2S concentration trends were supported by the total sulfide concentrations between 4D and 8H (data not shown). The post-cleaning total sulfide concentrations were lower than the pre-cleaning at 4D through 5E (~0.18 mg/L and 0.29 mg/L, respectively). The pre-cleaning sulfide concentrations increased from 5E through 8H up to 0.64 mg/L, while, the post-cleaning sulfide concentrations remained steady at 0.18 mg/L in the same reach after cleaning.

Much higher and relatively steady oxidizing conditions (ORP=~55 mV) were observed during post-cleaning. During pre-cleaning ORPs varied, likely due to the calcium nitrate injection. During pre-cleaning, ORPs increased from -131 mV at 2B to -17 mV at 5E before reducing again to below -50 mV at 7G and 8H. The highest levels of ORP (-17 mV) and nitrate nitrogen (0.6 mg/L) were observed at 4D and 5E, which paralleled the lowest sulfide and H_2S levels during the pre-cleaning. Additionally, the temperature was much lower during the post-cleaning (~13-14 deg C) relative to the pre-cleaning (~20 deg C), which would further inhibit the biological activity of the sulfate reducing bacteria responsible for H_2S generation.

FIGURE 12: MICROSCOPIC IMAGES OF PAOS FROM THE STICKNEY WATER RECLAMATION PLANT BATTERY D, MIXED LIQUOR OBSERVED UNDER 100X OIL IMMERSION, BRIGHTFIELD (A); NEISSER STAIN POSITIVE POLY-P; (B) SUDAN BLACK STAIN PHB GRANULES; (C) MICROSCOPIC MEASURED AREA OF PHB[1] POSITIVE PAO CLUSTER



[1]PHB=Poly-B-hydroxybutyrate

TABLE 13: ABUNDANCE OF PHOSPHORUS-ACCUMULATING ORGANISMS IN THE STICKNEY AND CALUMET WATER RECLAMATION PLANTS ACTIVATED SLUDGE DURING THE ENHANCED BIOLOGICAL PHOSPHORUS REMOVAL PROJECT

WRP/ Sample Date	PHB[1] Test Battery[3] μm^2/mg VSS[5]	PHB[1] Control Battery[4] μm^2/mg VSS	POLY-P[2] Test Battery μm^2/mg VSS	POLY-P[2] Control Battery μm^2/mg VSS
Stickney				
01/09/13	2×10^4	21×10^4	57×10^4	15×10^4
01/30/13	601×10^4	35×10^4	39×10^4	42×10^4
Calumet				
04/23/13	31×10^4	22×10^4	28×10^4	22×10^4
05/08/13	82×10^4	37×10^4	29×10^4	10×10^4
05/21/13	163×10^4	20×10^4	1×10^4	43×10^4
06/04/13	13×10^4	10×10^4	48×10^4	5×10^4
06/18/13	14×10^4	6×10^4	14×10^4	3×10^4
07/02/13	2×10^4	5×10^4	32×10^4	7×10^4

[1]PHB – Poly-β-hydroxybutyrate –Sudan Black staining procedure.
[2]Poly-P – Polyphosphate granules – stained using the Neisser staining procedure.
[3]The test battery for Calumet WRP is Battery A.
[4]The control battery for Calumet WRP is Battery B.
[5]μm^2/mg VSS - The abundance of phosphorus accumulating organisms (PAO) expressed as total area per milligram of volatile suspended solids.

FIGURE 13: OXIDATION-REDUCTION POTENTIAL RESPONSE TO HYDROGEN PEROXIDE TREATMENT WITH AND WITHOUT A CATALYST ADDED TO A 1:1 BLEND BY VOLUME OF THE STICKNEY WATER RECLAMATION PLANT PRELIMINARY SLUDGE AND WEST SIDE RAW WASTEWATER

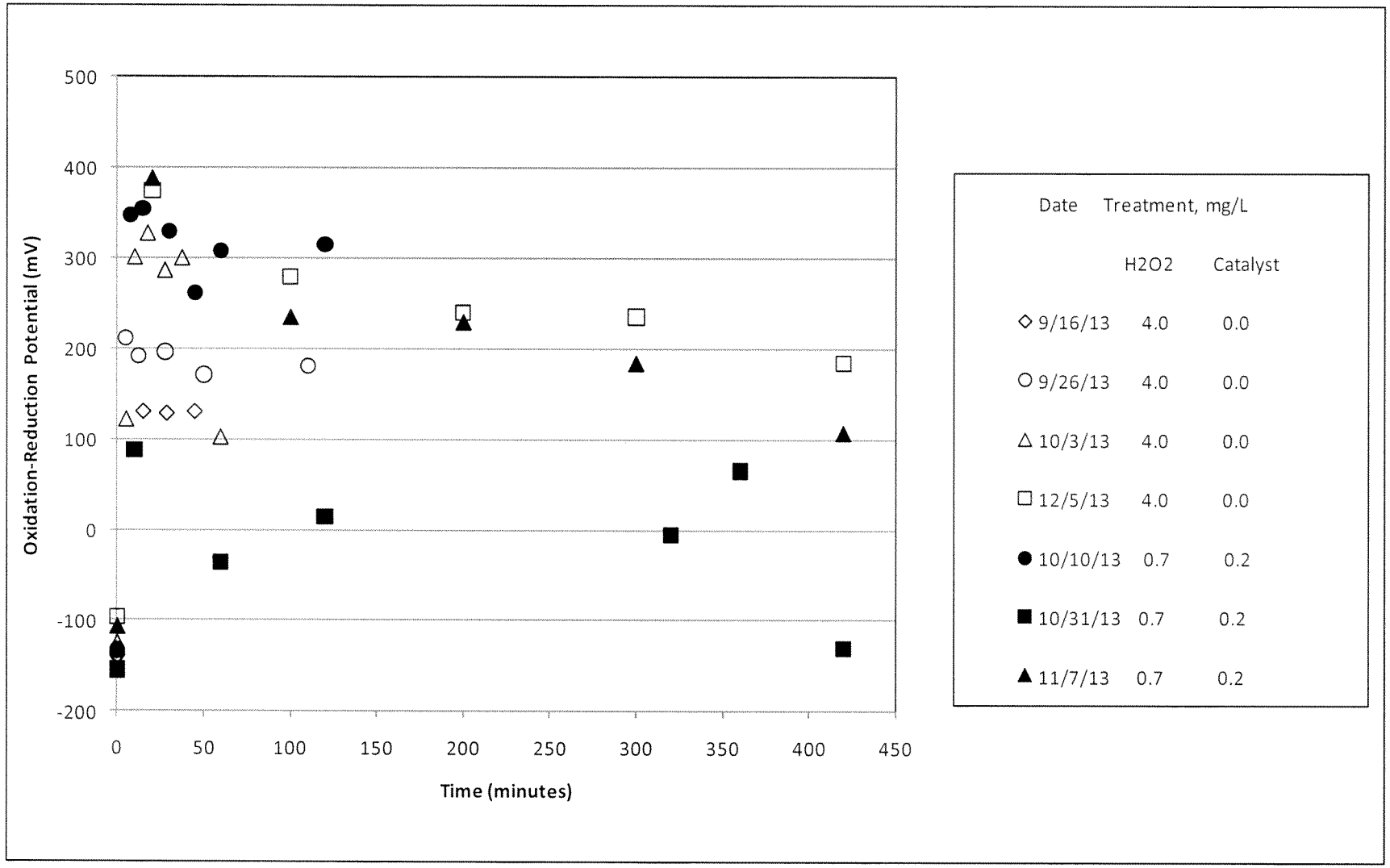


FIGURE 14: SCHEMATIC OF ODOR MANAGEMENT AT DROP SHAFT 5 IN THE JAMES C. KIRIE WATER RECLAMATION PLANT SERVICE AREA

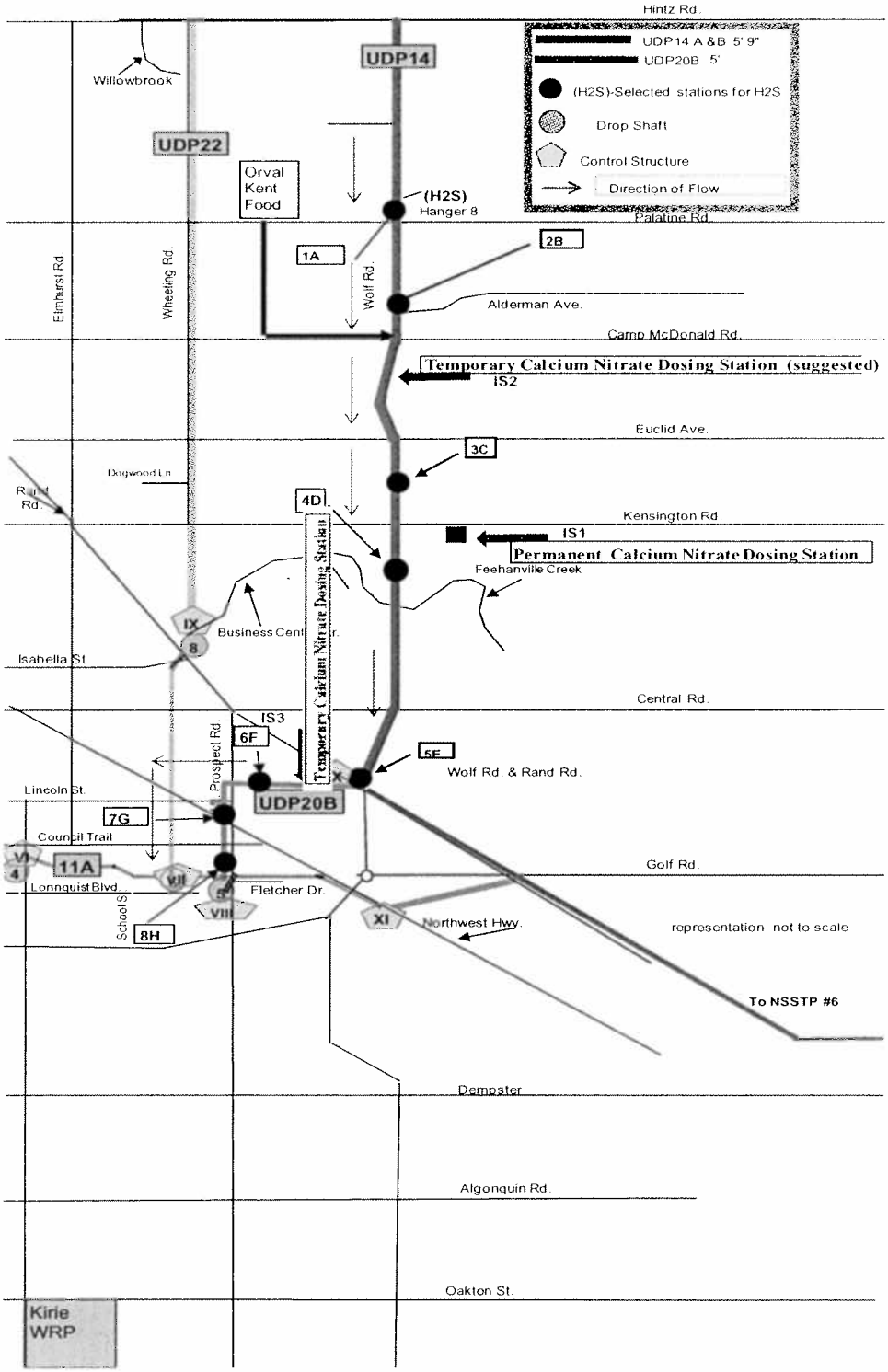


TABLE 14: MAXIMUM ODALOG READINGS OF HYDROGEN SULFIDE ALONG THE INTERCEPTORS UPPER DES PLAINES 14A AND 20B DURING THE PRE-CLEANING AND POST-CLEANING STUDY PHASES

Stations	Maximum H_2S (ppmv)	
	Pre-Cleaning[1]	Post-Cleaning[2]
1A	37	1
2B	20	2
3C	8	1
4D	1	5
5E	2	1
6F	13	1
7G	24	2
8H	42	3

[1]October 16, 2012, through November 21, 2012.
[2]January 15, 2013, through February 2, 2013.

In summary, the lower H_2S headspace concentrations and sulfide concentrations in the affected stretch during the post-cleaning relative to pre-cleaning shows the effectiveness of sewer cleaning, even without calcium nitrate addition during this period. However, the relatively high ORP conditions and low temperatures in the affected reach during the post-cleaning can also inhibit H_2S and sulfide levels. The limited data suggests that cleaning is beneficial to reducing H_2S generation, but that the results are not conclusive due to the influence of other factors such as temperature and ORP.

James C. Kirie Water Reclamation Plant Interceptors Multipoint Chemical Injection Odor Control. A study was initiated in collaboration with M&O to determine the effectiveness of injection of a calcium nitrate solution at two, rather than one, locations along the Kirie WRP interceptors. The second injection system (IS3) was installed in summer 2013 to supplement chemical injection at the station (IS1) previously installed (Figure 14). IS1 was dosed at 75 gpm, and IS3 at 25 gpm from July 31, 2013 through August 30, 2013, with an interruption of one week (August 5, 2013 through August 11, 2013) to create baseline conditions. Continuous headspace H_2S concentrations and periodic wastewater sampling and analyses were conducted at eight locations along the interceptors, two of which were upstream of the chemical injection stations.

Injection at the second station reduced the maximum H_2S concentrations in the treated reach by 30 percent relative to the 2013 baseline period (Figure 15). Average H_2S concentrations were below 1 ppmv in the treated reach during injection but ranged between 1.7 to 11.4 ppmv during the baseline without injection (Figure 16). Additionally, total sulfide concentrations in the wastewater were maintained below 1 mg/L during injection (Figure 17). These results were observed despite conditions very conducive to H_2S and sulfide production.

Stickney Water Reclamation Plant Waste Activated Sludge Stripping to Remove Internal Phosphorus. With the implementation of the EBPR process in all batteries at SWRP in fall 2013, there could be increased concentrations of TP and magnesium (Mg) in the WAS stream. As part of the plan to install Ostara® reactors at the plant for P recovery, a WAS Stripping to Remove Internal Phosphorus (WASSTRIP®) process is being planned that can strip off the P and Mg in the WAS which can subsequently be recovered through struvite precipitation in the Ostara® reactors. This WASSTRIP® process is based on holding WAS quiescently under anaerobic conditions with available readily degradable carbon to promote Ortho-Phosphate (Ortho-P) release from the PAO biomass. Magnesium cations carry the Ortho-P across the PAO cell walls. An advantage with WASSTRIP® is that the extraction from the WAS stream will reduce Ortho-P and Mg concentrations in the digester feed sludge, reduce the potential for struvite formation in the digesters, and reduce the amount of Mg addition needed for the Ostara reactor.

FIGURE 15: MAXIMUM HEADSPACE HYDROGEN SULFIDE CONCENTRATION WITH AND WITHOUT INJECTION OF CALCIUM NITRATE SOLUTION AT INJECTION STATION 1 AND INJECTION STATION 3 IN 2013

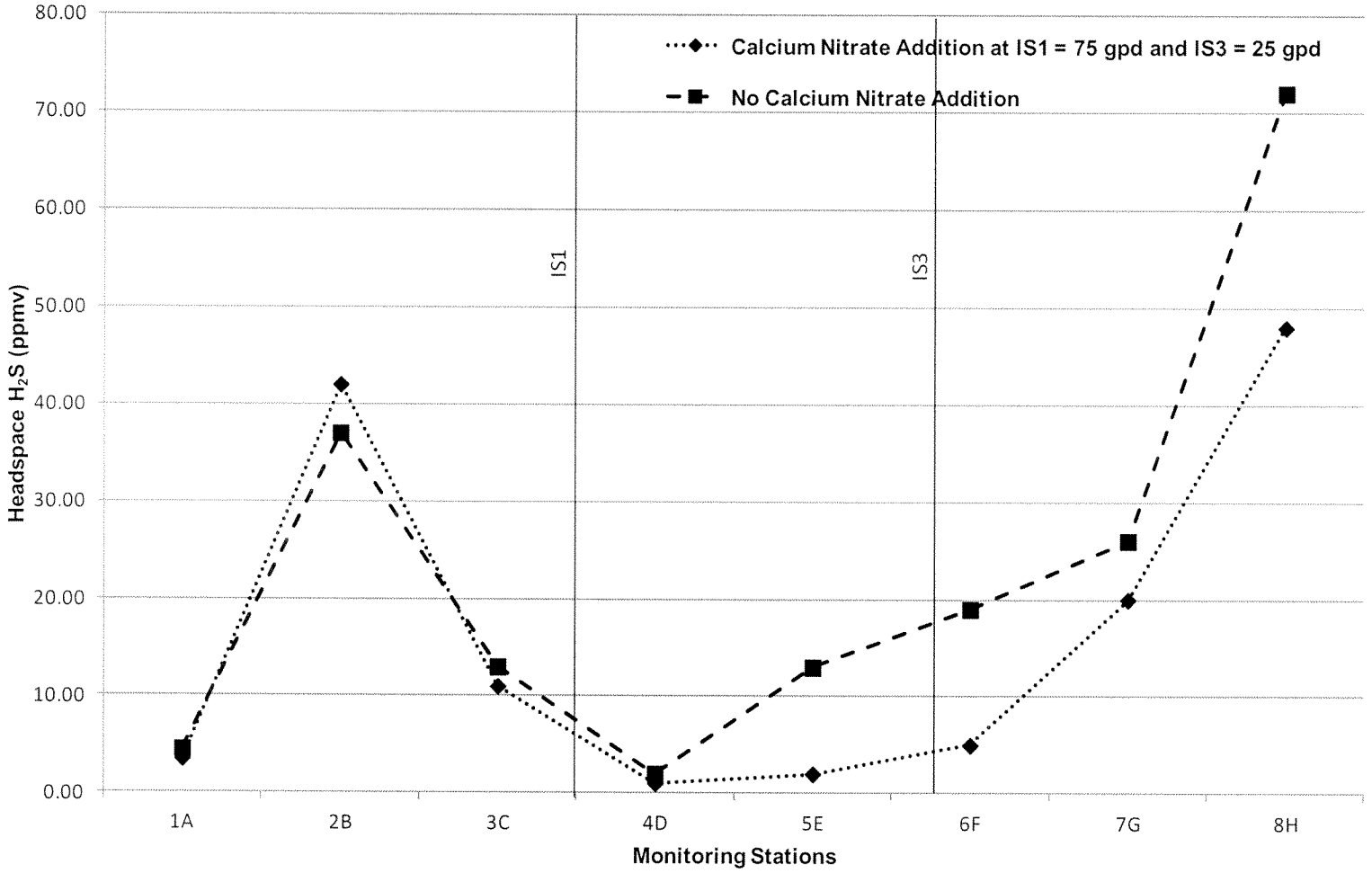


FIGURE 16: AVERAGE HEADSPACE HYDROGEN SULFIDE CONCENTRATION WITH AND WITHOUT INJECTION OF CALCIUM NITRATE SOLUTION AT INJECTION STATION 1 AND INJECTION STATION 3 IN 2013

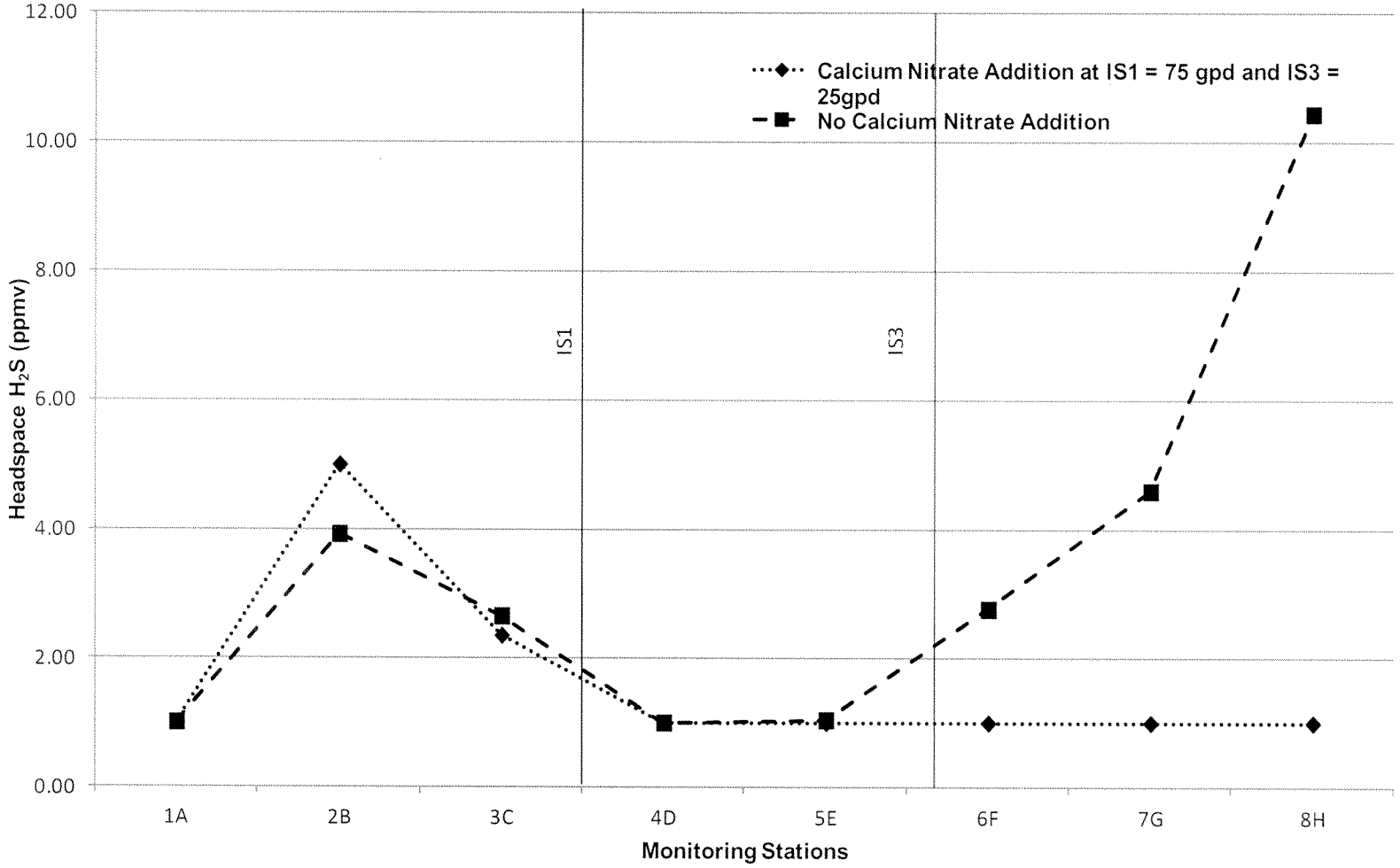
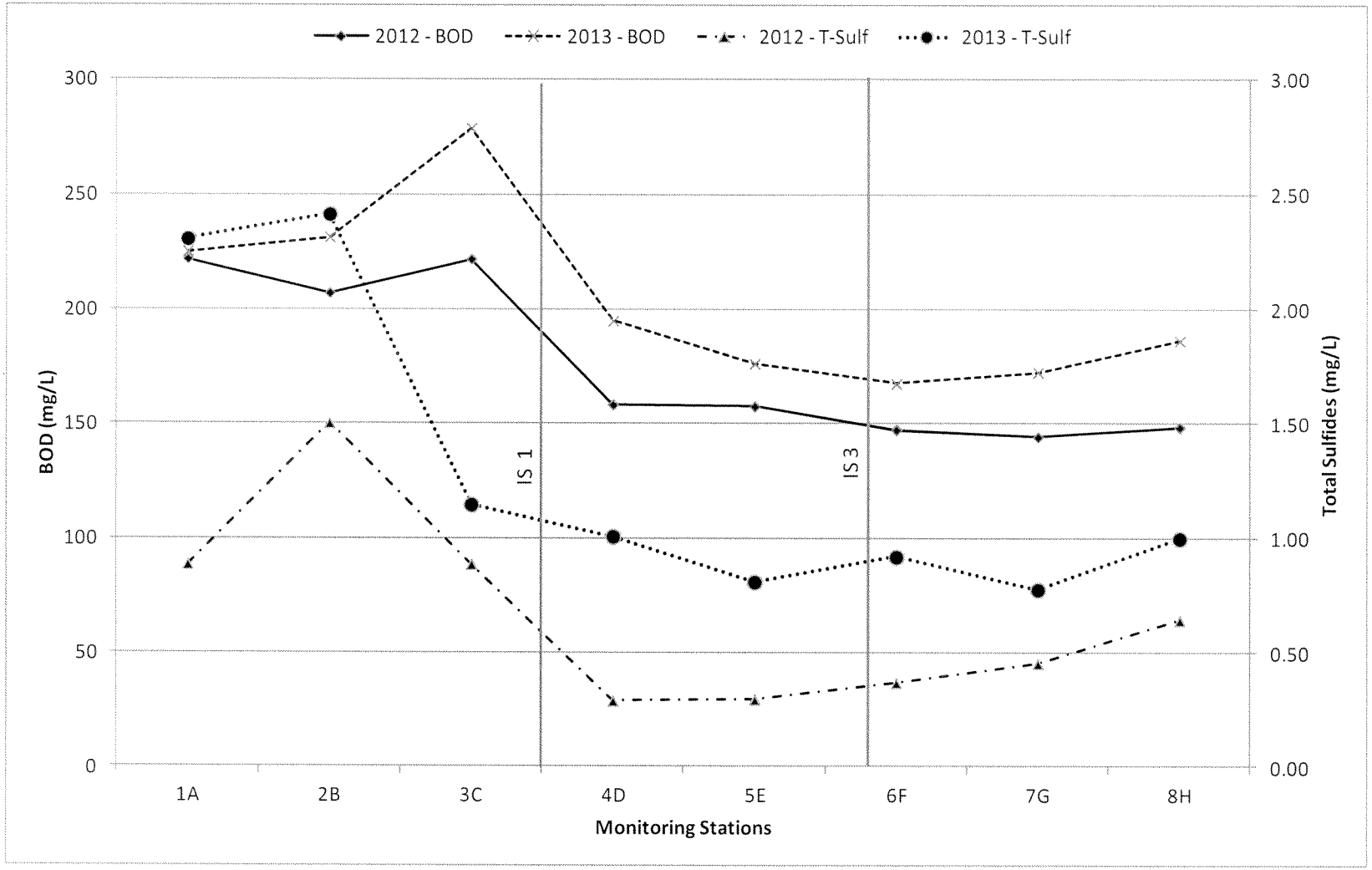


FIGURE 17: VARIATION OF AVERAGE BIOCHEMICAL OXYGEN DEMAND AND TOTAL SULFIDE CONCENTRATIONS WITH CALCIUM NITRATE INJECTION AT 75 GALLONS/DAY AT INJECTION STATION 1 IN 2012 AND CALCIUM NITRATE INJECTION AT 75 GALLONS/DAY AT INJECTION STATION 1 AND 25 GALLONS/DAY AT INJECTION STATION 3 IN 2013



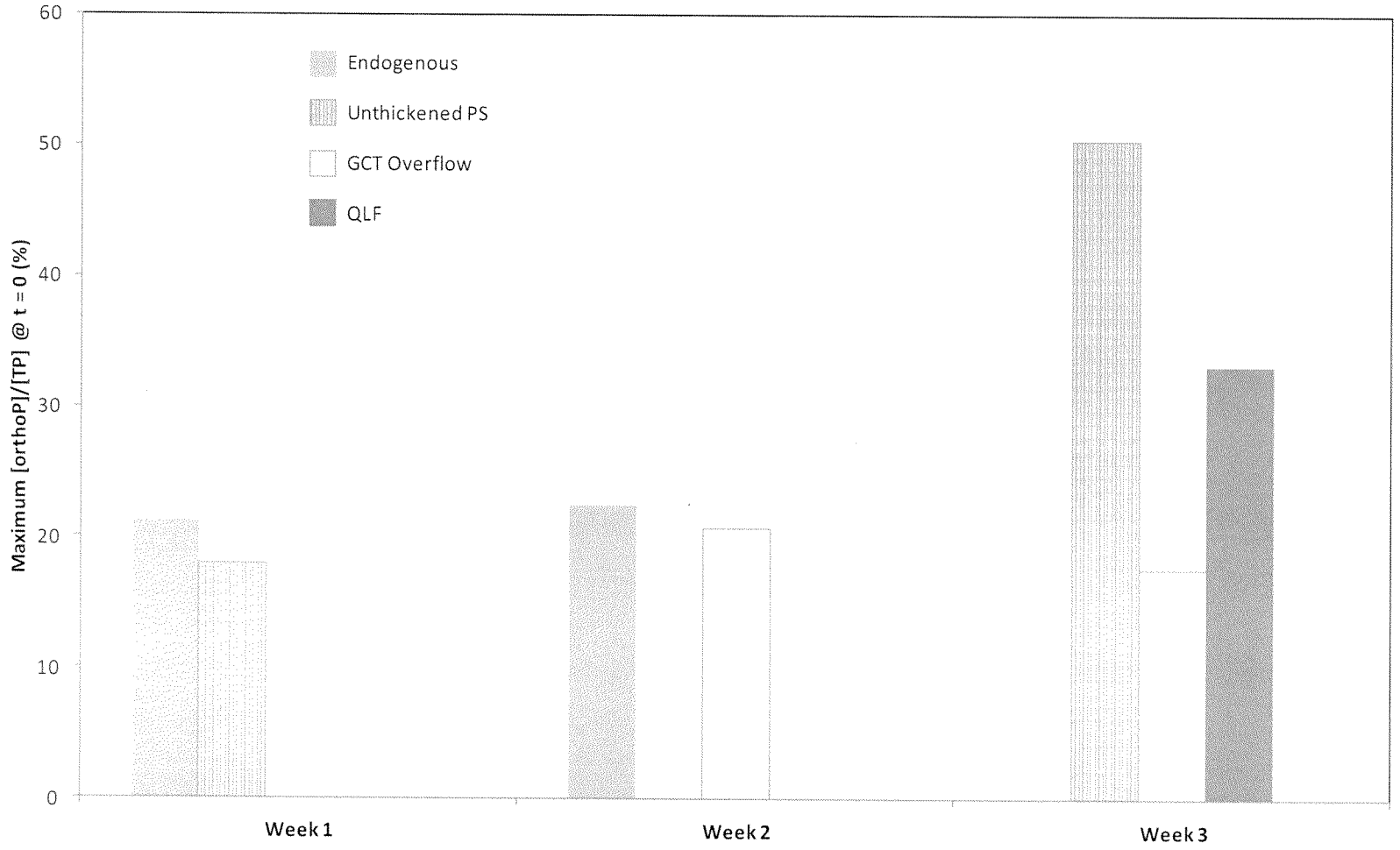
As such, the inclusion of the WASSTRIP® process as an integral part of the Ostara P recovery system would require the construction of WASSTRIP® reactors and, likely, thickening tanks. Therefore, the true potential of WASSTRIP® at the Stickney WRP, with and without carbon sources (internal from plant or external), was examined with respect to capital and operational costs. The engineering economic evaluation of the WASSTRIP® process would require critical information such as the degree of WAS thickening, type and amount of carbon addition to the WASSTRIP® reactor required, initial TP concentration in the WAS, retention time in both the thickening and WASSTRIP® reactors, the subsequent released concentrations of Ortho-P and Mg, and respective release rates. Generally, lower retention times and use of carbon can expedite the process, resulting in smaller reactor sizes.

In order to provide the information mentioned above to the Engineering Department a lab-scale study was initiated during fall 2013. Thickened and unthickened WAS was used with internal plant carbon sources (such as thickened, unthickened, or fermented primary sludge, and endogenous decay of cells), and external carbon sources (such as sodium acetate, QLF - Quality Liquid Feeds, a molasses-based commercial carbon source). For testing, WAS was added to simple WASSTRIP bench scale 5-gallon reactors with or without carbon addition. The reactors were kept under anaerobic conditions and periodic samples were collected over an 80-hour period.

The preliminary results indicated that the overall stripped or released Ortho-P concentrations and percent release were less than the 30 to 50 percent of the initial TP observed at other full-scale WASSTRRIP® plants for all treatments. The peak Ortho-P concentrations in the bench scale tests occurred at different times for different treatments and varied significantly at the end of the reaction period, both for thickened and unthickened WAS, with and without carbon supplementation. Generally, higher maximum Ortho-P concentrations were observed with thickened WAS treatments compared to unthickened WAS treatments. Additionally, release rates (as percent of initial TP) were higher with carbon supplementation. However, over time, the Ortho-P percent released rates were eventually near the range of approximately 20 to 30 percent for all treatments (Figures 18 and 19). Additional experiments will be conducted during 2014.

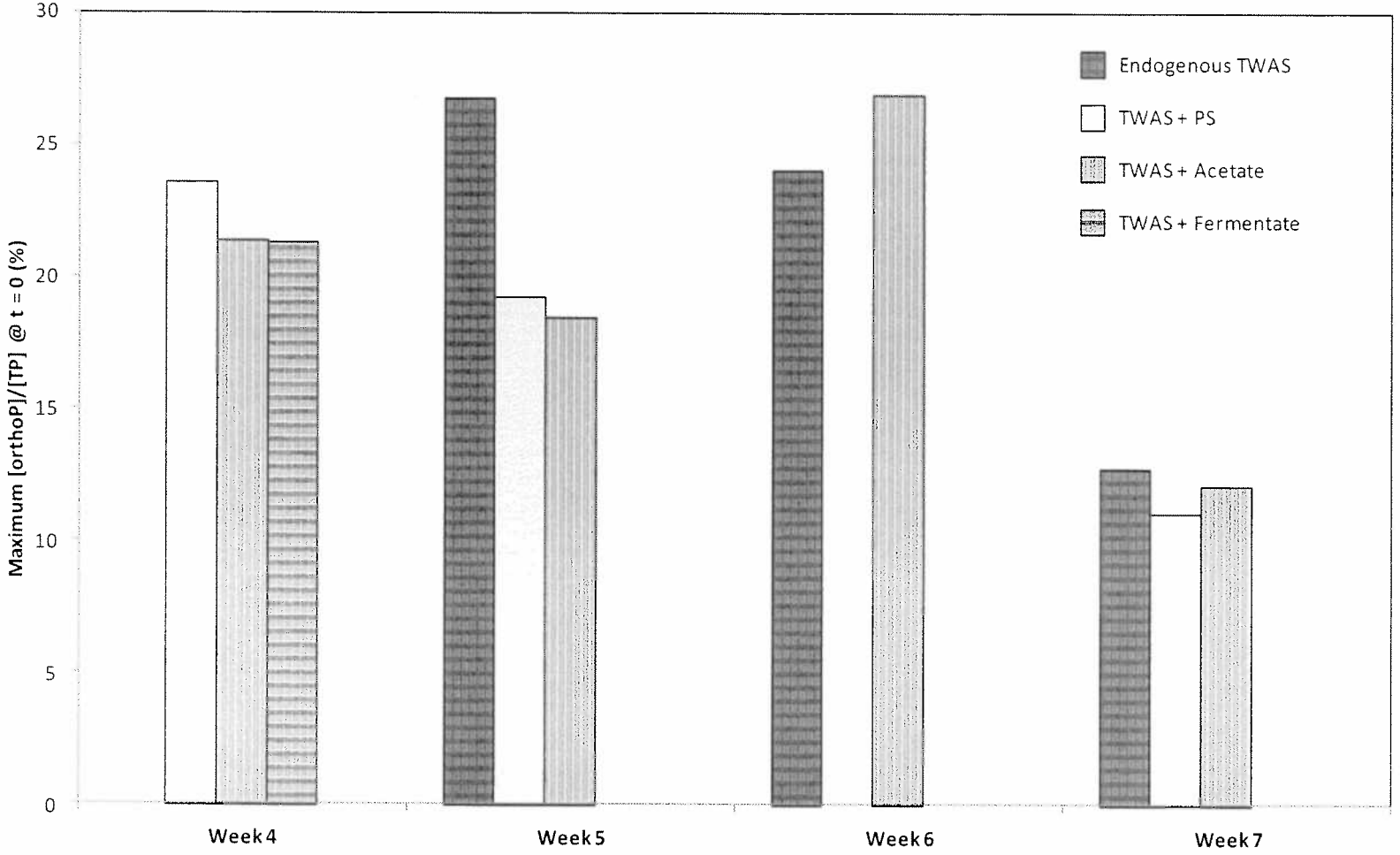
Stickney Water Reclamation Plant Centrate Characterization. The recycle streams at the Stickney WRP are pumped back to the head of the treatment plant for complete treatment, which significantly increases nutrient loadings on mainstream treatment. The District is determined to manage these recycle streams using nutrient removal and recovery to achieve pending effluent P standards. An EBPR process was implemented in 2013, and the Ostara® technology was selected for P-recovery from the post-centrate recycle stream to be implemented in 2015 in conjunction with the WASSTRIP® process. To aid in the design and expectations of the recovery potential in the Ostara® reactors, a six-month centrate characterization was initiated in November 2013. Weekly composite samples are being collected and analyzed for TP, Sol-P, Ortho-P, TKN, soluble TKN, NH_3-N, five-day biochemical oxygen demand (BOD_5), COD, Sol-COD, suspended solids (SS), volatile suspended solids (VSS), Ca, Mg, pH, and alkalinity. A data report of the characterization is planned for August 2014.

FIGURE 18: MAXIMUM ORTHO-P PERCENT RELEASE FOR UNTHICKENED WASTE ACTIVATED SLUDGE WITH AND WITHOUT CARBON SUPPLEMENTATION FOR THE STICKNEY WATER RECLAMATION PLANT WASSTRIP® PROCESS*



*During the WASSTRIP® trials, not all treatments were completed every week. Endogenous trials were run in Weeks 1 and 2, and carbon supplementation treatments were unthickened primary sludge (PS) in Week 1; gravity concentration tank (GCT) overflow in Weeks 2 and 3; and Quality Liquid Feeds (QLF), a proprietary carbon source, in Week 3.

FIGURE 19: MAXIMUM PERCENT ORTHO-P RELEASE FOR THICKENED WASTE ACTIVATED SLUDGE WITH AND WITHOUT CARBON SUPPLEMENTATION FOR THE STICKNEY WATER RECLAMATION PLANT WASSTRIP® BENCH-SCALE TEST



*During the WASSTRIP® trials with thickened waste activated sludge (TWAS), not all treatments were completed every week. Endogenous trials were run in Weeks 5, 6, and 7, and carbon supplementation treatments were primary sludge (PS) in Weeks 4, 5, and 7; acetate in Weeks 4, 5, 6, and 7; and fermentate in Week 4.

Sodium Sulfate Injection Pilot Test. The District was approached by Solvay Industries with a proposal to convey its process wastewater stream from its Chicago Heights facility (which is located outside the District's service area) to the Calumet WRP. The wastewater stream consists of a high strength sodium sulfate (2.76 percent) solution. The plan is to discharge this waste at a maximum flow rate up to approximately 600,000 gallons per day. During September 9, 2013 through November 1, 2013, a short-term pilot study was conducted to examine the potential effects in the collection system as well as in plant by injecting a 6% sodium sulfate solution at 0.13 mgd at the expected tie-in location to the Calumet interceptor. Before, during, and after the injection of the solution, the following were examined: (1) Periodic wastewater quality in the interceptor system; (2) Continuous H_2S headspace concentrations in the interceptor; (3) Daily plant influent, effluent, and operational data such as SVIs; (4) Microbiological health in the aeration basins; (5) H_2S concentrations in the Calumet Grit and Gravity Concentration Tank Buildings and around the plant; and (6) The effect on EBPR performance. Some potential concerns were identified in the collection system with respect to elevated H_2S concentrations, sulfide concentrations, and temperature; stress conditions in the activated sludge process; and inhibitory effects of the EBPR process. However, we could not draw any strong conclusions, primarily due to the short length of the study and the low sodium sulfate injection rate used in the study relative to the projected future loadings from Solvay.

Evaluation of Potential Reduction of Polymer Consumption Strategies at the Post-Centrifuge Facility at the Stickney Water Reclamation Plant. In order to reduce polymer consumption, the WTPR Section worked with M&O to optimize post-digestion centrifuge operations at the Stickney WRP. A multi-dimensional evaluation was done during 2012 through 2013 which consisted of: (1) Establishing and evaluating full-scale baseline centrifuge operations and polymer consumption; (2) Evaluating polymer quality; and (3) Conducting laboratory tests and exploring innovative measures for potential polymer use reduction. The results of this evaluation was reported in 2013 and concluded that: (1) The use of city water had no distinct advantage for dilute polymer preparation compared to the existing use of secondary effluent; (2) Decay of charge density occurs following 4 to 5 hours of storage of dilute polymer that can result in decreased effectiveness and higher polymer consumption; 3) Polymer dilution lower than the currently used 15 percent had no impact on polymer savings; and 4) Based on historical data, high VS content in centrifuge feed negatively affects polymer consumption, clarity of centrate, and cake solids content.

As a follow-up to this study, the WTPR Section began to prepare a guidance manual for use by the operating engineers at the post-centrifuge facility to maintain consistent polymer preparation and centrifuge operations, and thus achieve polymer savings. This guidance manual will be completed in 2014.

Corn Fertility Experiment at the 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 managing land application of biosolids for crop production. 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 is on unmined land. 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 experiment is also aimed to collect sufficient data to evaluate biosolids P management practices to address future state regulations that may stipulate P-based agronomic rates of biosolids. The experiment includes a chemical fertilizer treatment, annual agronomic rate of biosolids for two types of biosolids (Class B centrifuge-dewatered biosolids and Class A air-dried biosolids), three high (reclamation) rates applied one time, and compost applied at the annual agronomic and the reclamation rates. Therefore, there are eight treatments in the revised design (one chemical fertilizer control, two compost references, two types of biosolids for annual agronomic rates, and four treatments of biosolids for land reclamation application). The corn yield and stover dry matter for 2013 are shown in Table 15.

Composting Biosolids with Woodchips. The District started the biosolids composting initiative in 2011. The main goal of this initiative is to produce a value-added and odor-free biosolids product that meets the EQ criteria for distribution in the Chicago metro area. In 2013, in collaboration with M&O, biosolids composting was done at the Harlem Avenue Solids Management Area (HASMA) using woodchips provided by the city of Chicago and centrifuge cake biosolids. Briefly, approximately 121 dry tons (DT) of centrifuge cake biosolids and 144 DT of woodchips were mixed with a wheel loader, and the mixture was further processed using an auger and a rototiller to break clumps and to achieve the desired solids content for the composting process. The mixture was piled into windrows. The temperature in the windrows was monitored continuously using temperature probes with dataloggers. The windrows were turned using a wheel loader as needed to meet the time and temperature requirement for producing Class A material. Approximately 223 DT of composted materials were recovered at the end of the composting process. The final dry weight of biosolids compost after screening to < 0.5 inches was 133 DT. Pathogen testing for FC, HO, V and Salmonella spp were done by AMBS laboratories to confirm that the composting process achieved the Class A criteria. The levels of the Part 503 trace metals and total P in the composted biosolids were lower than in the uncomposted biosolids due primarily to dilution by the woodchips. The pH and electrical conductivity in the composted biosolids were within the ranges recommended by the U.S. Composting Council.

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

TABLE 15: CORN GRAIN YIELD AND STOVER DRY MATTER AT THE BIOSOLIDS LONG-TERM EXPERIMENT AT THE FULTON COUNTY SITE[1] IN 2013

Treatment	Grain Yield	Stover Dry Matter
	---------- kg/ha ----------	
Chem. fert. 300-100-100 (N-P-K) kg/ha/yr (Control 1)	1,399	3,709
Compost 33 Mg/ha/yr (Control 2)	699	4,125
Aged biosolids 33 Mg/ha/yr	1,243	3,974
Unaged biosolids 25 Mg/ha/yr	4,481	4,867
Aged biosolids 165 Mg/ha + 3/4 chem. fert. rate[2]	2,547	4,180
Aged biosolids 330 Mg/ha + 1/2 chem. fert. rate	5,784	5,822
Aged biosolids 495 Mg/ha + 1/4 chem. fert. rate	1,045	2,955
Compost 165 Mg/ha + 3/4 chem. fert. rate	4,561	6,306

[1]The overall low corn biomass production was due to severe damage by deer in most plots.
[2]For the biosolids and compost plus chemical fertilizer treatments, the fertilizer was applied annually.

District collaborated 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 conducted a three-year field study that consisted of plots amended with four rates of biosolids application each year, including control plots that received only the recommended rate of commercial fertilizers. All plots were planted with corn and four vegetable crops, i.e., tomatoes, zucchini, carrots, and lettuce. The soil and plant tissue samples were collected at the time of crop maturity and shipped to CSM for analysis of PFCs. Due to, shortage of funds, only a small number of samples were analyzed. The District is in the process of establishing a contract with CSM to analyze all soil and plant tissue samples from the field study to generate a dataset to adequately evaluate the uptake of PFCs by the vegetable crops grown in biosolids-amended soils.

Phosphorus Removal Using Phycoremediation. In 2013, the EM&RD, in collaboration with the Engineering Department, evaluated many technologies for phycoremediation using algae for nutrient removal from waste water treatment streams. The moving flat panel bioreactor developed at the Iowa State University showed promise. A collaborative research project between the District and Iowa State University is being developed to evaluate a pilot-scale, algae-based system for nutrient recovery at the O'Brien WRP.

Microbial Source Tracking Study of the Chicago Area Waterway System. A collaborative research project with Argonne National Laboratory (ANL) was initiated to track the microbial sources in the CAWS as the District begins disinfecting to comply with the new primary contact use designated effluent bacteria limitations. The goal of the study is to measure changes in FC in the final effluent and to understand the microbial community and their sources in the CAWS. The research, which began in 2013, will take place over a period of seven years (2013 – 2019) and will be defined by three phases of facility improvements in the Calumet and Chicago River Systems. Disinfection treatment operations at the Calumet WRP (Calumet River System) and the O'Brien WRP (Chicago River System) are scheduled for completion in 2015. Both WRPs will be disinfecting starting in the 2016 disinfection season, which is March through November. In the Calumet River System, the Thornton Composite Reservoir portion of the TARP, serving the south side of Chicago and south suburbs of Cook County, is scheduled for completion in 2015. In the Chicago River system, the McCook Reservoir is being constructed in two stages and Stage 1 is scheduled for completion in 2017. Therefore, the three phases of the project are defined as:

- Phase I – Pre-disinfection and pre-TARP reservoir completion, in both Calumet and Chicago River Systems (2013 – 2015).
- Phase II – Post-disinfection and pre-TARP reservoir completion, in the Chicago River Systems (2016 – 2017).
- Phase III – Post-disinfection and post-TARP reservoir completion, in the Calumet River System (2016 – 2019) and in the Chicago River Systems (2018 – 2019).

Begining in May 2013, approximately 230 samples were collected, which included final effluents, CAWS, sediment from CAWS locations and two final effluent waters from the O'Brien and Calumet WRPs. Water and sediment samples were collected monthly (May-November). Water and sediment samples were analyzed for general chemistry, EC and/or FC. The genomic DNA of samples was isolated and analyzed by ANL using two approaches: (1) Amplicon sequencing: the 16S rRNA genes of the environmental samples were amplified and sequenced through next generation sequencing that gives information about the microorganism taxa present; (2) Shotgun metagenomics: The sequencing of the pool of genome fragments of the environmental sample that give information about the potential functions of the community. Isolates of EC and FC cultures from the WRP final effluent samples have been sequenced and their genomes were reconstructed and annotated to track them across the CAWS. The potential sources of the detected microorganisms and taxa will be statistically inferred using Bayesian tools including SourceTracker, and using potential sources from databases in the Earth Microbiome Project (www.earthmicrobiome.org), which includes ~25,000 microorganisms from a myriad ecosystems, including soil, feces, water sediment, etc.

Nitrifier Identification and Quantification. The WML of the AMB Section investigated the use of a Vermicon Identification gene probe kit (called Nitri-VIT), developed by Vermicon AG (Munich, Germany), to evaluate the health of the nitrifier population in the activated sludge process. The kit was used to identify ammonia oxidizing bacteria (AOB) and nitrite oxidizing bacteria (NOB). The Nitri-VIT kit uses fluorescent probes which cause the cells to light up in red or green under a fluorescent microscope. An index based on the amount of fluorescent cells present was used to determine the abundance of AOB or NOB. Six grab samples were collected from Stickney WRP and two grab samples were collected from Calumet WRP from January through July 2013. The results shown in Tables 16 and 17, respectively, represent baseline levels of AOB and NOB in the Stickney and Calumet WRPs activated sludge process.

South Branch Chicago River Slip Study. This study will determine which slips in the South Branch Chicago River (SBCR) have the most abundant aquatic life and why, and then determine if and how less productive slips can be modified to be more favorable to fish. The SBCR slips are comprised of Mason's Slip, Stetson's Slip, Sampson's Slip, and Arnold's Slip. Lack of adequate habitat is a primary stressor for fish in the CAWS. In 2010, LimnoTech Inc. determined that off-channel bays (OCBs) were positively correlated with positive fish metrics. The OCBs are defined as areas greater than five-square meters located downstream of protective structures. They provide refuge for fish and are prevalent in healthy natural river systems. The SBCR slips are some of the largest OCBs in the CAWS.

During 2013, each slip was assessed individually for habitat quality and physical assets, quality and quantity of benthic invertebrates, fish abundance and health, and water quality. Hester-Dendy samplers were deployed and retrieved in all four SBCR slips during 2013 to collect resident benthic invertebrates. Many barges are always docked at Sampson's Slip making it unavailable for fish, habitat, and water quality assessments; therefore, it is not assessed in this study. The Mason's, Stetson's, and Arnold's Slips were electrofished using a pulse DC

TABLE 16: VERMICON IDENTIFICATION TECHNOLOGY INDEX SUMMARY FOR AMMONIA AND NITRITE OXIDIZING BACTERIA IN THE STICKNEY WATER RECLAMATION PLANT ACTIVATED SLUDGE PROCESS

Date	Battery A		Battery B		Battery C		Battery D	
	AOB[1]	NOB[2]	AOB	NOB	AOB	NOB	AOB	NOB
01/09/2013	3.3	2.8	NT[3]	NT	NT	NT	3.1	2.3
01/21/2013	2.8	1.6	NT	NT	NT	NT	2.2	1.5
10/27/2013	1.9	1.6	1.7	1.3	1.7	1.5	1.9	1.5
10/28/2013	2.6	1.8	2.1	1.9	2.5	2.2	2.0	2.2
10/30/2013	2.4	2.0	2.6	2.0	2.7	2.5	2.7	2.6
11/01/2013	2.3	2.0	2.3	1.9	2.8	2.3	2.7	2.4

[1]Ammonia Oxidizing Bacteria.
[2]Nitrite Oxidizing Bacteria.
[3]Not Tested.

TABLE 17: VERMICON IDENTIFICATION TECHNOLOGY INDEX SUMMARY FOR AMMONIA AND NITRITE OXIDIZING BACTERIA IN THE CALUMET WATER RECLAMATION PLANT ACTIVATED SLUDGE PROCESS

	Battery A		Battery B	
Date	Ammonia Oxidiser	Nitrite Oxidiser	Ammonia Oxidiser	Nitrite Oxidiser
04/23/2013	2.1	1.1	2.1	1.0
05/08/2013	1.7	1.1	2.0	1.0
07/16/2013	2.0	1.5	2.2	1.5

[1]Ammonia Oxidizing Bacteria.
[2]Nitrite Oxidizing Bacteria.

electrofishing boat in June, August, and October, during 2013. A summary of the fish data is presented in Table 18. Physical assessments of habitat were completed at select transects in each of the available slips in July. Dissolved oxygen cross-sectional measurements were also conducted in the available slips at select transects in August and October. A summary of the physical assessments and average DO in cross-sections is presented in Table 19.

Investigation of Endocrine Disrupting Chemicals in the Chicago Area Waterway System. In collaboration with St. Cloud State University, the AEWQ Section conducted an on-site exposure experiment at the Calumet WRP in spring 2013. The experiment involved the use of a mobile exposure laboratory trailer (MELT) that was set up with a flow-through design to expose male fathead minnows to various concentrations of the final effluent. The MELT is used to evaluate the relationship between a water source and observed endocrine disruption and the compounds that may be responsible. After 12 days of continuous exposure, the male fathead minnows were analyzed for various biological endpoints to identify any biological effects from exposure to WRP effluents. The results of the experiment showed subtle effects and were comparable to previous studies conducted in 2010 – 2012. The results from all of the MELT experiments were compiled in a research paper which was accepted for publication in *Journal of the American Water Resources Association.*

The study confirmed that estrogenic endocrine active compounds enter the CAWS by several means, including WRP effluent, CSOs, and storm water runoff. The fish exposed to these compounds showed physiological responses but no widespread histopathological changes.

Research Collaboration. The Division staff participated in the following collaborative research activities:

- Water Environment Research Foundation Research Projects – The Division staff served on project sub-committees and provided technical review of the research projects and regulatory documents. This included attendance at meetings, evaluation of project proposals, and a final report.

- National Association of Clean Water Agencies – Division staff participated as an advisory member of the National Association of Clean Water Agencies' Recreational Criteria Workgroup that conducted review of the USEPA's efforts to develop new recreational water quality criteria.

- 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 QMRA.

TABLE 18: SAMPLING TIME, NUMBER, WEIGHT, AND NUMBER OF SPECIES FOR FISH COLLECTED FROM SLIPS IN THE SOUTH BRANCH CHICAGO RIVER DURING 2013

Location	Sampling Time (seconds)	Number of Fish	Weight (kg)	Number of Species		Most Abundant Species
				Total	Game	
Mason's Slip	3,322	294	47	14	7	Gizzard shad, Bluegill, Common carp
Stetson's Slip	5,825	1399	123	17	7	Gizzard shad, Bluegill, Pumpkinseed
Arnold's Slip	10,824	682	46	13	6	Bluegill, Gizzard shad, Pumpkinseed
TOTAL	19,971	2,375	216	20	9	Gizzard shad, Bluegill, Pumpkinseed

TABLE 19: 2013 HABITAT AND WATER QUALITY ASSESSMENTS OF THE SOUTH BRANCH CHICAGO RIVER SLIPS

Parameter / Physical Measurement	Mason's Slip	Stetson's Slip	Arnold's Slip
Maximum depth (ft)	20	13	10
Mean width (m)	49	31	28
Total length (m)	240	630	415
Maximum depth of fines (ft)	3.7	3.3	8.2
Predominant sediment component	Silt	Silt	Silt
Predominant bank type	Concrete	Concrete	Natural Concrete
Pecent of bank with a >45° angle	95	100	100
Percent overhanging vegetation	< 5	10	15
Number of manmade structures	3	5	3
Mean secchi depth (m)	1.5	1.2	1.1
Mean Dissolved Oxygen Concentration (mg/L)	5.7	5.8	5.4
Mean Temperature (°C)	20.9	20.3	20.1
Mean Specific Conductance (µm/cm)	623	613	632

- Cyber-physical System on Water Reclamation Plant Performance – This is an IIT project funded by the National Science Foundation. The project involves cyber physical systems in which intelligent sensor networks and software are applied to achieve more efficient and effective operations by providing real-time response for wastewater treatment should plant upsets occur or performance deteriorate. The IIT project is using the Calumet WRP as a basis for this study. The Division provided plant data for the creation of a process model, technical support, and aided in the collection of DO monitoring data within a test battery.

Outreach Activities

The EM&RD staff continued outreach support activities to promote public awareness and acceptance of District operations. The staff attended and presented at the local and national 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. The following two workshops presented real-life examples covering several different aspects of wastewater process control:

    - "Pathogens for the 21st Century: Assays, Indicators and Fate" in the Monitoring and Research Department's Microbiology laboratory. The workshop focused on hands-on laboratory demonstrations to test for pathogens in biosolids.

    - "Activated Sludge and Biological Nutrient Removal Process Control: Hands-on in the real World" in the Egan WRP.

- Laboratory Tours. Laboratory tours are conducted as part of the District's tours and are also conducted, upon request, for any person or group interested in learning about the EM&RD's laboratory operations. Individual and group tours were provided in 2013.

APPENDIX I

APPENDIX I

MEETINGS AND SEMINARS 2013

January 2013

American Institute of Chemical Engineers, 5th Annual Midwest Regional Conference, Chicago, Illinois.

DuPage River Salt Creek Workgroup, Annual Meeting (and follow-up meetings throughout the year), Downers Grove, Illinois.

Illinois Water Environment Association and the Illinois Section of the Central States Water Environment Association, 2013 Government Affairs (and follow-up meetings throughout the year), Willowbrook, Illinois.

Midwest American Institute of Chemical Engineers 2013 Annual Meeting, Chicago, Illinois.

Midwest Water Analyst Association, Winter Expo 2013 (and follow-up meetings throughout the year), Kenosha, Wisconsin.

Water Research Foundation, Iodine 131 Workshop, Philadelphia, Pennsylvania.

February 2013

Asian Carp Regional Coordinating Committee, Technical and Policy Workgroup Meeting (and follow-up meetings throughout the year), Chicago, Illinois.

Michigan State University Workshops: 100-year Study and Quantitative Microbial Risk Assessment, Chicago, Illinois.

March 2013

American Academy of Environmental Engineers Conference, Washington, D.C.

Illinois Chapter of the American Fisheries Society, Annual Meeting, Whittington, Illinois.

Illinois Association of Water Pollution Control Operators Conference, Springfield, Illinois.

APPENDIX I

MEETINGS AND SEMINARS 2013 (Continued)

Illinois Section of the American Water Works Association and Illinois Water Environment Association, WaterCon 2013, Joint Conference and Expo, Springfield, Illinois.

National Partnership for Environmental Technology Education Conference, Greenville South Carolina.

The Conservation Foundation 4th Beyond the Basics: Stormwater Best Management Practices Seminar, Woodridge, Illinois.

United States Environmental Protection Agency, Region 5 Headquarters Training Session for Illinois Beaches Implementation Tool, Chicago, Illinois.

April 2013

Illinois Nutrient Research and Education Council Meeting, Champaign, Illinois.

May 2013

American Society for Microbiology, 2013 Meeting, Denver, Colorado.

Illinois Association of Wastewater Agencies, Technical Committee Meeting (and follow-up meetings throughout the year), Utica, Illinois.

Illinois Environmental Protection Agency, Nutrient Stakeholders Workgroup Meetings (and follow-up meetings throughout the year), Springfield, Illinois.

Lake County North Branch Chicago River Planning Committee Meeting, Deerfield, Illinois.

June 2013

United States Department of Agriculture, W-2170 Committee Meeting, Denver, Colorado.

APPENDIX I

MEETINGS AND SEMINARS 2013 (Continued)

Wastewater Operator Hands-on Training on Online Process Instrumentation for Activated Sludge Monitoring, Delafield, Wisconsin.

Water Environment Federation Activated Sludge on it's 100th Birthday: Challenges and Opportunities, Easton Massachusetts.

Water Environment Research Foundation Exploratory Committee, Teleconference (and follow-up meetings throughout the year), Stickney, Illinois.

July 2013

Chicago Area Waterway System, Use Attainability Analysis, Illinois Pollution Control Board Hearing (and follow-up meetings throughout the year), Chicago, Illinois.

Ecological Restoration Conference, Schaumburg, Illinois.

Peregrine Lake Homeowners Association Meeting, Palatine, Illinois.

August 2013

Fox Valley Operator Association Conference, Carpentersville, Illinois.

September 2013

7th Annual Algae Biomass Summit, Orlando, Florida.

Illinois Water Environment Association 2013 Nutrient Removal and Reuse Workshop, Addison, Illinois.

October 2013

Great Lakes Beach Association Conference, Sheboygan, Wisconsin.

APPENDIX I

MEETINGS AND SEMINARS 2013 (Continued)

Illinois Water Environment Association Seminar, Loves Park, Illinois.

Society for Ecological Restoration, 5th World Conference, Madison, Wisconsin.

Water Environment Federation and Water Environment Research Foundation Mainstream Deammonification and Shortcut TN Removal: Innovation and Implementation, Chicago, Illinois.

Water Environment Federation Challenges with Nutrients-Troubleshooting and Optimizing Nutrient Removal, Chicago, Illinois.

Water Environment Federation, Technical Exhibition and Conference 2013, Chicago, Illinois.

November 2013

Air and Waste Management Association, Lake Michigan States Section, 2013 Air Quality Management Conference, Oak Brook, Illinois.

Illinois Water Environment Association and Central States Water Environment Association Biosolids Seminar, Stickney, Illinois.

The Society of Environmental Toxicology and Chemistry North America Conference, Nashville, Tennessee.

December 2013

None

APPENDIX II

APPENDIX II

PRESENTATIONS 2013

January 2013

"Deammonification for Sidestream Treatment: Process Mechanisms and Pilot Test Results from the Egan Water Reclamation Plant." Presented at the Midwest American Institute of Chemical Engineers Annual Meeting, Chicago, Illinois, by J. Kozak. PP

"Preliminary Assessment of Chemical Analysis and Toxicity of Sediment in the Chicago Area Waterway System." Presented at the Midwest Water Analyst Association, Winter Expo Meeting 2013, Kenosha, Wisconsin, by D. Gallagher. PP

February 2013

"Microbial Assessment of Biological Nutrient Removal." Presented at the 5th Annual American Institute of Chemical Engineers Midwest Regional Conference, Chicago, Illinois by G. Rijal. PP

"Phosphorus Removal and Recovery Initiatives at the Metropolitan Water Reclamation District of Greater Chicago." Presented at the Northwestern University Department of Civil and Environmental Engineering Bi-Weekly Seminar, Evanston, Illinois, by J. Kozak. PP

March 2013

"Land Application of Biosolids: Federal and Illinois State Regulations." Presented at the National Partnership for Environmental Technology and Education/HAZMAT Refresher Workshop, Greenville, South Carolina, by P. Lindo. PP

"Primary Effluent Chlorination." Presented at the Illinois Section of the American Water Works Association and Illinois Water Environment Association, WaterCon 2013, Joint Conference and Expo, Springfield, Illinois, by D. Bernstein. PP

"Sidestream Nitrogen Removal at the John E. Egan Water Reclamation Plant by DEMON® Process." Presented at the Illinois Section of the American Water Works Association and Illinois Water Environment Association, WaterCon 2013, Joint Conference and Expo, Springfield, Illinois, by D. Qin. PP

"Using a Mobile Laboratory to Assess Estrogenicity in Water Reclamation Plant Effluents, Experimental Design & Procedure." Presented at the Illinois Section of the American Water Works Association and Illinois Water Environment Association, WaterCon 2013, Joint Conference and Expo, Springfield, Illinois, by J. Vick. PP

APPENDIX II

PRESENTATIONS 2013 (Continued)

April 2013

"Developing a Wastewater Microbiology Laboratory Program." Presented at the Illinois Association of Water Pollution Control Operators Conference, Springfield, Illinois by A. Glymph-Martin. PP

May 2013

"Enumeration of Ammonia and Nitrite Oxidizing Bacteria in the Metropolitan Water Reclamation District of Greater Chicago's Stickney Water Reclamation Plant Using the Molecular Gene Probe Method." Presented at the American Society for Microbiology 113th General Meeting, Denver, Colorado, by G. Rijal. PS

"MWRDGC's Environmental Monitoring in the North Branch Chicago River Watershed." Presented to the Lake County North Branch Chicago River Planning Committee, Deerfield, Illinois, by J. Wasik. PP

June 2013

"Sidestream Nitrogen Removal at the John E. Egan Water Reclamation Plant by DEMON® Process." Presented at Water Environment Federation/International Water Association Nutrient Removal and Recovery 2013 Conference, Vancouver, British Columbia, Canada, by H. Zhang. PP

"Water Quality Within the Chicago Area Waterway System, Where Are We Today and Where Are We Headed?" Presented at the Midwest Water Analysts Association, Spring Meeting 2013, Chicago, Illinois, by T. Minarik. PP

July 2013

"The Impact of Sanitation on Chicago's Geography" Presented at the Chicago State University, Chicago, Illinois, by D. Bernstein. PP

APPENDIX II

PRESENTATIONS 2013 (Continued)

August 2013

"What do the Bugs Indicate about the Health of the Treatment Process?" Presented at the Fox Valley Operator Association Mini Conference, Carpentersville, Illinois, by A. Glymph-Martin. PP

September 2013

"Biosolids: Beneficial & Sustainable Management." Presented at the 2013 Sustainability Workshop, Midlothian, Illinois, by K. Kumar. PP

"Phosphorus Removal and Recovery Initiatives." Presented at the Illinois Water Environment Association Nutrient Removal and Recovery Workshop, Addison, Illinois, by J. Kozak. PP

"Resource Recovery and Utilization from Waste Water." Presented at the Stewart Environmental Inc. Field Day, Sheridan, Illinois, by K. Kumar. PP

"Sustainability of Biosolids Land Application." Presented at the Stewart Environmental Inc. Field Day, Sheridan, Illinois, by K. Kumar. PP

October 2013

"A Laboratory Program for Wastewater Microbiology." Presented at the Illinois Water Environment Association Plant Operations Seminar, Loves Park, Illinois by A. Glymph-Martin. PP

"Activated Sludge and Biological Nutrient Removal Process Control: Hands-on in the Real World - Wastewater Microbiology Session." Presented at the Water Environment Federation Annual Conference, Schaumburg, Illinois, by A. Glymph-Martin. PP

"Collimated Beam Testing and Ultraviolet Dosage Rates: How They Can Lower Costs as Shown in the O'Brien Water Reclamation Plant Ultraviolet Disinfection Project." Presented at the Water Environment Federation, Technical Exhibition and Conference 2013, Chicago, Illinois, by J. Moran-Andrews. PP

"Pathogens for the 21st Century: Assays, Indicators and Fate Workshop." Presented at the Water Environment Federation, Technical Exhibition and Conference 2013, Chicago, Illinois, by G. Rijal, R. Gore, and H. Shukla. PP

APPENDIX II

PRESENTATIONS 2013 (Continued)

"Performance of Sustainable Streetscapes in Chicago." Presented at the Water Environment Federation, Technical Exhibition and Conference 2013, Chicago, Illinois, by K. Kumar. PP

November 2013

"MWRD Initiative to Co-Compost Biosolids and Wood Chips to Produce a Value-Added Product." Presented at the Illinois Water Environment Association Biosolids Seminar, Cicero, Illinois, by L.S. Hundal. PP

"Resource Recovery from Waste Water." Presented at the Illinois Water Environment Association Biosolids Seminar, Cicero, Illinois, by K. Kumar. PP

December 2013

None

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* PP=Available as PowerPoint Presentation
  PS=Poster Presentation

APPENDIX III

APPENDIX III

PAPERS PUBLISHED 2013

Blaine, A. C., C. D Rich, L. S Hundal, C. Lau, M. A. Mills, K. M. Harris, and C. P. Higgins, "Uptake of Perfluoroalkyl Acids into Edible Crops via Land Applied Biosolids: Field and Greenhouse Studies." *Environmental Science and Technology*, 47:14062-14069, 2013.

Broadhurst, C. L., R. L. Chaney, A. P. Davis, A. Cox, K. Kumar, R. D. Reeves, and C. E. Green, "Growth and Cadmium Phytoextraction by Swiss Chard, Maize, Rice, Noccaea Caerulescens and Alyssum Murale in pH Adjusted Biosolids Amended Soils." *International Journal of Phytoremediation*, Accepted (DOI: 10.1080/15226514.2013.828015), 2013.

Hundal, L.S., "Restoring Ecological Health to Your Land." *Journal of Environmental Quality*, 42(1):293-293, 2013.

Martinovic-Weigelt D., T. Minarik, E. Curran, J. Marchuk, M. Pazderka, E. Smith, R. Goldenstein, C. Miresse, T. Matlon, M. Schultz, and H. Schoenfuss, "Environmental Estrogens in an Urban Aquatic Ecosystem: I. Spatial and Temporal Occurrence of Estrogenic Activity in Effluent-Dominated Systems." *Environment International*, 61: 127 -137.

Oladeji O. O., G. Tian, A. Cox, T. C. Granato, C. O'Connor, Z. Abedin, and R. I. Pietz, "Effect of Long Term Application of Biosolids for Mine Land Reclamation on Groundwater Chemistry: Nitrogen, Phosphorus, and Other Qualities." *Journal of Environmental Quality*, 42(1):94-102, 2013.

Schultz M., T. Minarik, D. Martinovic-Weigelt, E. Curran, S. Bartell, and H. Schoenfuss, "Environmental Estrogens in an Urban Aquatic Ecosystem: II. Biological Effects." *Environment International*, 61: 138 – 149.

Singh, A., S. Gupta, K. Kumar, S. Gupta, Y. Chander, A. Gupta, and R. Saxena, "Quantitative Analysis of Conjugated and Free Estrogens in Swine Manure: Solutions to Overcome Analytical Problems due to Matrix Effect." *Journal of Chromatography*, A 1305: 203-212, 2013.

Thangarajan R, N. S. Bolan, G. Tian, R. Naidu, and A. Kunhikrishnan, "Role of Organic Amendments Application on Greenhouse Gas Emission from Soil." *Science of the Total Environment*, 465: 72–96, 2013.

Tian G, A. J. Franzluebbers, T. C. Granato, A. Cox and C. O'Connor, "Stability of Soil Organic Matter Under Long-Term Biosolids Application." *Applied Soil Ecology*, 64: 223-227, 2013.

APPENDIX IV

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO
MONITORING AND RESEARCH DEPARTMENT 2013 SEMINAR SERIES (Revised 2/19/13)

January 18, 2013 ***Using Biosolids to Restore and Revitalize Soil Ecosystem Services to Degraded Soil in the Calumet Region***
Professor Nick Basta, Soil and Environmental Chemistry, Ohio State University, Columbus, Ohio

February 22, 2013 ***Challenges of Relocating Metropolitan Water Reclamation District of Greater Chicago Interceptor near Wacker Drive***
Mr. Brad Bacilek, Resident Project Manager, Alfred Benesch & Company, Chicago, Illinois

April 5, 2013 ***Implementation and Operation of Enhanced Biological Removal at the Metropolitan Wastewater Treatment Plant (St. Paul, Minnesota),*** Mr. George Sprouse, Manager of the Process Engineering Group, Metropolitan Council Environmental Services, St. Paul, Minnesota

April 26, 2013 ***Los Angeles County Sanitation Districts' Odor Control Practices***
Mr. Rob Morton, Supervising Engineer, Sanitation Districts' of Los Angeles County, Whittier, California

May 24, 2013 ***Nutrient Removal at the Metro Wastewater Reclamation District in Denver***
Mr. Jim McQuarrie, Metro Wastewater Reclamation District, Denver, Colorado

June 28, 2013 ***Plant and Animal Survey of Woodlands and Wetlands on 25 Metropolitan Water Reclamation District of Greater Chicago Properties***
Mr. Irwin Polls, Ecological Monitoring and Assessment, Chicago, Illinois

July 26, 2013 ***Adaptive Watershed Management to Achieve the Designated Use for Aquatic Life: Salt Creek and the Upper DuPage River***
Mr. Stephen McCracken, Program Manager, DuPage River Salt Creek Workgroup, Naperville, Illinois

August 23, 2013 ***Components of a Successful Biosolids Composting Facility-A Case Study***
Ms. Lorrie Loder, Director of Product Marketing at Synagro, Orange County, California

September 27, 2013 ***Regulation of Phosphorus Fertilizer Application to Turf in Minnesota: History and Environmental Implications***
Professor Carl Rosen, Department Head of Soil, Water, and Climate, University of Minnesota, Twin Cities, Minnesota

October 25, 2013 ***Controlling Infiltration and Inflow into Sewer Systems within the Metropolitan Water Reclamation District of Greater Chicago,*** Ms. Maureen Durkin, Supervising Civil Engineer, Engineering Department, Metropolitan Water Reclamation District of Greater Chicago (District), Chicago, Illinois

November 22, 2013 ***Moving Towards Effluent Disinfection at the District's Terrence J. O'Brien (formally North Side) and Calumet Water Reclamation Plants ,*** Mr. Ed Brosius, Supervising Civil Engineer, Engineering Department, District, Chicago, Illinois

December 13, 2013 ***Evaluation of the Impact of Lake Discretionary Diversion on Water Quality of the Chicago Area Waterways System***
Professor Charles Steven Melching, Marquette University, Department of Civil and Environmental Engineering, Milwaukee, Wisconsin

RESERVATIONS REQUIRED (at least 24 hours in advance); PICTURE ID REQUIRED FOR PLANT ENTRY
CONTACT: Dr. Heng Zhang, 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: 1:30 P.M.
NOTE: These seminars are eligible for Professional Development Credits/CEUs

APPENDIX V

Environmental Monitoring and Research Division

13-Dec

Heng Zhang, Assistant Director of M&R (121[7])

Bettina Gregor, Secretary

Albert Cox, Environmental Monitoring Research Manager, Zainul Abedin, Biostatistician, Vacant, Radiation Chemist, Ed Podczerwinski, Supervising Civil Engineer, Kathleen Quinlan, Administrative Assistant

Wastewater Treatment Process Research (122 [16]	Biosolids Utilization & Soil Science (123 [12])	Analytical Microbiology & Biomonitoring (124 [15]	Aquatic Ecology and Water Quality (126 [22])	Capital Planning (129 [8])
Joseph Kozak, Supv. Env. Research Scientist	Lakhwinder Hundal, Supv. Env. Research Scientist	Geeta Rijal, Supv. Env. Microbiologist	Jennifer Wasik, Supv. Aquatic Biologist	
Laura Franklin, Administrative Specialist	Coleen Maurovich, Administrative Specialist	Marie Biron, Administrative Specialist		
Senior Environmental Research Scientist	**Senior Environmental Soil Scientist**	**Senior Env. Microbiologist**	**Senior Aquatic Biologist**	**Principal Civil Engineer**
Ali Oskouie	Guanglong Tian	Auralene Glymph	Thomas Minarik	Jonathan Grabowy
Kamlesh Patel	Kuldip Kumar			
Fenghua Yang		**Associate Env. Microbiologist**	**Associate Aquatic Biologist**	**Senior Civil Engineer**
	Associate Env. Soil Scientist	Richard Gore	Dustin Gallagher	Matthew McGregor
Associate Env. Research Scientist	Pauline Lindo		Justin Vick	Daniel Salabaj
Doris Bernstein	Olawale Oladeji	**Assistant Env. Microbiologist**		
Dongqi Qin	Vacant	Hemangini Shukla	**Assistant Aquatic Biologist**	**Senior Env. Research Scientist**
Dale MacDonald			Nick Kollias	Judith Moran-Andrews
Vacant	**Assistant Environmental Chemist**			
	Minaxi Patel	**Laboratory Technician II's**	**Laboratory Technician II's**	**Associate Civil Engineer**
Laboratory Technician II's		Andrea Maka	Marvin Banal	Peter O'Brien
Anthony Haizel	**Laboratory Technician II's**	Kathleen Jackowski	Richard Schackart	
Thota Reddy	Ilyse Mackoff	Shafiq Rahman	Angel Whitington	**Associate Electrical Engineer**
	Tiffany Tate	James Kaehn	Victoria Miller	Vacant
Laboratory Technician I				
Robert Bodnar	**Laboratory Technician I's**	**Laboratory Technician I's**	**Laboratory Technician I's**	**Associate Env. Research Scientist**
Marc Byrnes	Richard Adams	Dave Roberts	Panu Lansiri	Avanti Kavathekar
Kim Iu		Syed Hussaini	Craig Shingles	
Shaun Kowalski	**Laboratory Assistant**	Mathew DeGutes		**Associate Mechanical Engineer**
Harold Robinson	Andrew Scott	Amanda Saverson	**Pollution Control Officer I**	Vacant
			Al Wilczak	
		Laboratory Assistants		
		Lora Buco	**Patrol Boat Operator**	
		Loren Pilgrom	Javier Salazar	
			John Jacob	
			Vacant	
			Pollution Control Technician II	
			Ryan Kirkland	
			James Rivera	
			Pollution Control Technician I	
			David Zintak	
			Bob Chmela	
			Patty Sandrik	
			Janis Dickerson	
			Vacant	

Total Positions in EM&RD [80]