Protecting Our Water Environment

Metropolitan Water Reclamation District of Greater Chicago

RESEARCH AND DEVELOPMENT DEPARTMENT

REPORT NO. 2000-11

RESEARCH AND DEVELOPMENT

1999

ANNUAL REPORT

June 2000

Metropolitan Water Reclamation District of Greater Chicago
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RESEARCH AND DEVELOPMENT
1999
ANNUAL REPORT

Research and Development Department
Richard Lanyon, Director

June 2000

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DISCLAIMER

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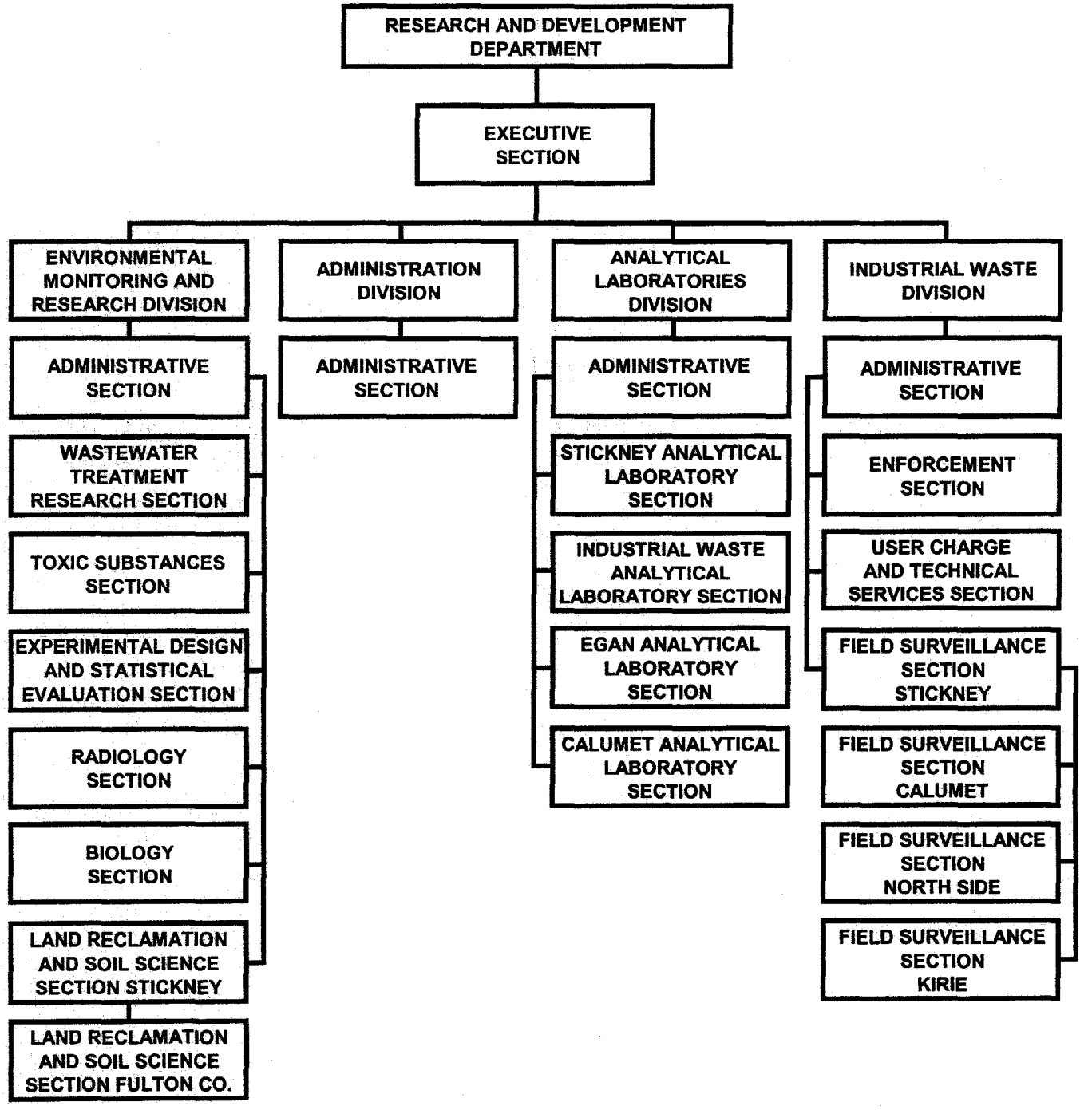
METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

RESEARCH AND DEVELOPMENT DEPARTMENT ORGANIZATION CHART FOR 1999



ADMINISTRATION DIVISION

The Administration Division is responsible for the coordination of all departmental services pertaining to personnel administration, purchasing, computer systems, and administrative assistance to the Director. Primary functions of the Division include: coordination and preparation of budget documents; preparation and administration of contract documents; preparation and administration of consultant agreements; administration of requisitions and purchase orders; administration of departmental personnel actions; planning and coordination of departmental computer systems, training, and security requirements; liaison with other departments; and preparation of Board Letters, correspondence, and reports, required by the Director.

Personnel Administration

The Department had 353 budgeted positions during 1999 with a total salary and wage appropriation of $18,275,627. All personnel transactions, including merit wage increases, personnel requisitions, service rating forms, personnel vacancy reports, overtime records, personnel transfers, appointments, resignations, leaves of absence, payroll changes, and disciplinary actions for the Department were either originated or coordinated by this Division. During 1999, the Department reviewed personnel actions relative to 13 retirements, and 72 personnel requisitions and appointments. In addition, as part

of adopting the 1999 Budget and the District's attrition program, five existing positions were designated for elimination when vacated during 1999. By year-end, actual positions eliminated upon vacancy by incumbents totaled four. This decrease in positions led to an average expenditure to appropriation ratio of 94 percent.

Greater Chicago Pollution Prevention Program

In January 1994, the Greater Chicago Pollution Prevention Program (GCP3) was initiated as a cooperative project between the Metropolitan Water Reclamation District of Greater Chicago (District) and the Illinois Waste Management and Research Center (Center), which is funded by a grant from the United States Environmental Protection Agency (USEPA).

Technical assistance is provided directly to companies requesting such assistance by a member of the Center staff located in the District offices. During 1999, 86 industrial site visits or assessments to provide technical assistance were conducted under GCP3.

Most of the assistance provided has been for industry, but others, such as citizens community groups, schools, government, and trade associations have also benefited. Technical assistance includes pollution prevention, regulatory compliance, regulatory information, and guidance material. For-

mal presentations on the GCP3 and pollution prevention were given to 4 organizations in 1999.

The Annual District Pollution Prevention Award program honors industrial and/or commercial dischargers for outstanding multimedia pollution prevention efforts.

The District and the Center are participating in the USEPA's Common Sense Initiative - Strategic Goals Program for Metal Finishers. This program includes commitments by industry to go beyond compliance, substantially reducing pollution from their operations. The Center, working with other local stakeholders has developed a proposal for providing technical assistance to achieve these reductions to the participating metal finishers.

Computer Systems Administration

In 1999, the Administration Division continued a broad review of all departmental computer systems, local and wide area networks, software utilization, compliance with District security and access procedures, training requirements, etc.

In April 2000, the District's current financial, budgeting, procurement and human resource systems will be replaced with a new District-wide integrated system or enterprise system. The new system will replace the current multiple systems with one system having several modules that feed data to one another, and eliminate the duplicate data entries required

with the current systems. The Administration Division will coordinate the training on this new system for all R&D employees and coordinate its use throughout the department.

Budget Administration

A comparison of appropriations to expenditures for 1999 shows the following:

	Appropriation	Expenditure
Personnel (Line Item 101)	$18,275,627	$17,233,483
Other Line Items	4,967,173	3,938,526
Total	$23,242,800	$21,172,009

Purchasing Administration

During 1999, more than 400 requisitions were reviewed and processed by the Administration Division, prior to being forwarded to the Purchasing Department. This review verified the availability and proper use of department funds for all requisitioned items. The Division will ensure that all departmental purchase orders are properly closed out at year's end and will process purchase order decreases or increases as appropriate.

Contract Administration

During 1999, the Division was involved in the preparation and administration of 25 contracts for a total cost of approximately $1,655,290, including multiyear contracts. This

involved the preparation of detail specifications, Board letters, advertisements, receipt and review of bids, recommendations to award, and monitoring of performance for acceptance and payment.

The Division administered 14 consulting agreements having a total value of approximately $1,379,945 during 1999. This involved preparing requisitions, Board letters, and monitoring performance for acceptance and payment.

Laboratory Accreditation

The Division is coordinating the Laboratory Accreditation by the Illinois Environmental Protection Agency (IEPA) of six R&D Laboratories. The Toxic Substances Laboratory's application was submitted in July 1999, and has been reviewed by the IEPA. IEPA review comments have been received and reviewed in preparation for the IEPA site inspection. The Calumet Analytical Laboratory application and the Egan Analytical Laboratory application were submitted in October and December 1999, respectively. Both applications are under review by the IEPA. The applications for Stickney and Industrial Waste Analytical Laboratories and the Radiochemistry Laboratory were in preparation as of the end of 1999.

Departmental Reports

During 1999, the Department published 32 formal reports dealing with various aspects of the District's operations. A list of these reports is given in Tables 1 and 2.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 1

RESEARCH AND DEVELOPMENT REPORTS PUBLISHED DURING 1999

	Report Title	Author (s)	Date	Organization Receiving Report
99-1	Effect of Pulse Power Technology on the Dewaterability of Anaerobically Digested Sludge	S. Soszynski, J.S. Jain, P. Tata, C. Lue-Hing, K. Carns, D. Perkins	Jan-99	Electric Power Research Institute
99-2	Publication List of Reports	R&D Department	Jan-99	Internal District Report
99-3	Hanover Park Water Reclamation Plant Fischer Farm Report for Third Quarter 1998	G. Pump, R.I. Pietz	Feb-99	Illinois Environmental Protection Agency
99-4	Study of the Sources of Inorganic Sulfur to the Calumet Water Reclamation Plant	J.J. Bertucci, W. Robinson, P. Tata, B. Sawyer, D.R. Zenz, C. Lue-Hing	Feb-99	Internal District Report
99-5	Environmental Protection System Report for Fulton County, Illinois, December 1998	G. Pump, R.I. Pietz	Feb-99	Illinois Environmental Protection Agency
99-6	Report on City of Chicago's Phosphorus Ban and Its Effect Upon Effluent Quality	C. Lue-Hing, D.T. Lordi	Feb-99	Internal District Report
99-7	Biological Water Quality Within the Calumet Waterway System During 1988	S.G Dennison, W.G. Schmeelk, I. Polls, P. O'Brien, S.J. Sedita, P. Tata, C. Lue-Hing	Mar-99	Internal District Report
99-8	Biological Water Quality Within the Calumet Waterway System During 1989	S.G Dennison, W.G. Schmeelk, I. Polls, P. O'Brien, S.J. Sedita, P. Tata, C. Lue-Hing	Mar-99	Internal District Report

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 1 (Continued)

RESEARCH AND DEVELOPMENT REPORTS PUBLISHED DURING 1999

	Report Title	Author (s)	Date	Organization Receiving Report
99-9	Environmental Protection System Report for Fulton County, Illinois, January 1999	G. Pump, R.I. Pietz	Apr-99	Illinois Environmental Protection Agency
99-10	Environmental Protection System Report for Fulton County, Illinois, February 1999	G. Pump, R.I. Pietz	Apr-99	Illinois Environmental Protection Agency
99-11	Land Application of Sewage Sludge: Papers and Publications by the R&D Department, and Research Funded by the District - A Bibliography, 1968 - 1998	S.R. Nelson, T.C. Granato, R.I. Pietz, P. Tata, C. Lue-Hing	May-99	Internal District Report
99-12	1996 Annual Summary Report Water Quality Within the Waterways System of the MWRDGC	Z. Abedin, G. Knafl, B. Sawyer, P. Tata, C. Lue-Hing	May-99	Internal District Report
99-13	Hanover Park Water Reclamation Plant Fischer Farm Report for First Quarter 1999	G. Pump, R.I. Pietz	May-99	Illinois Environmental Protection Agency
99-14	Environmental Protection System Report for Fulton County, Illinois, March 1999	G. Pump, R.I. Pietz	May-99	Illinois Environmental Protection Agency
99-15	Environmental Protection System Report for Fulton County, Illinois, April 1999	G. Pump, R.I. Pietz	Jun-99	Illinois Environmental Protection Agency
99-16	Monitoring of Environmental Waters for Echerichia Coli with 4-Methylumbelliferyl-β-D-Glucuronide (MUG): Evaluation of the Colilert™ System	J.T. Zmuda, S.J. Sedita, P. Tata, D.R. Zenz, C. Lue-Hing	Jun-99	Internal District Report

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 1 (Continued)

RESEARCH AND DEVELOPMENT REPORTS PUBLISHED DURING 1999

	Report Title	Author (s)	Date	Organization Receiving Report
99-17	Bacteria in Raw Sewage and Viable Helminth Ova in Raw Sewage and Primary Sludge at the Water Reclamation Plants of the Metropolitan Water Reclamation District of Greater Chicago	R. Gore, S.J. Sedita, B. Sawyer, P. Tata, C. Lue-Hing	Jun-99	Internal District Report
99-18	Environmental Protection System Report for Fulton County, Illinois, May 1999	G. Pump, R.I. Pietz	Jul-99	Illinois Environmental Protection Agency
99-19	Radiological Monitoring of the Raw Sewage, Final Effluent, Sludges, and Biosolids of the Metropolitan Water Reclamation District of Greater Chicago 1997 Annual Report	A. Khalique, W. Augustine, R. Pietz, P. Tata, C. Lue-Hing	Jul-99	Internal District Report
99-20	Improvements in the Quality of Sewage Sludge at the Metropolitan Water Reclamation District of Greater Chicago	R.I. Pietz, R. Sustich, P. Tata, G. Richardson, C. Lue-Hing	Jul-99	Internal District Report
99-21	Research and Development Department 1998 Annual Report	R&D Department	Jul-99	Internal District Report
99-22	1997 Annual Summary Report Water Quality Within the Waterways System of the Metropolitan Water Reclamation District of Greater Chicago	Z. Abedin, G. Knafl, B. Sawyer, P. Tata	Aug-99	Internal District Report
99-23	Effect of Time After Cessation of Biosolids Applications on the Concentration of Cadmium, Copper, Nickel, and Zinc in Soil, Leaves and Grain of Corn	T.C. Granato, R.I. Pietz, G. Knafl, C.R. Carlson, Jr., P. Tata, C. Lue-Hing	Sep-99	Internal District Report

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 1 (Continued)

RESEARCH AND DEVELOPMENT REPORTS PUBLISHED DURING 1999

	Report Title	Author (s)	Date	Organization Receiving Report
99-24	Radiological Monitoring of Southwestern Lake Michigan and the Chicago Waterways 1998 Annual Report - Final Report	A. Khalique, W. Augustine, R. Pietz, P. Tata	Sep-99	Internal District Report
99-25	Statistical Analysis of Monitoring Frequency for Mainstream Tunnel and Reservoir Plan (TARP) Water Level and Quality Monitoring Wells	G. Knafl, Z. Abedin, J.S. Jain, B. Sawyer, P. Tata, R. Lanyon	Nov-99	Illinois Environmental Protection Agency

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TABLE 2

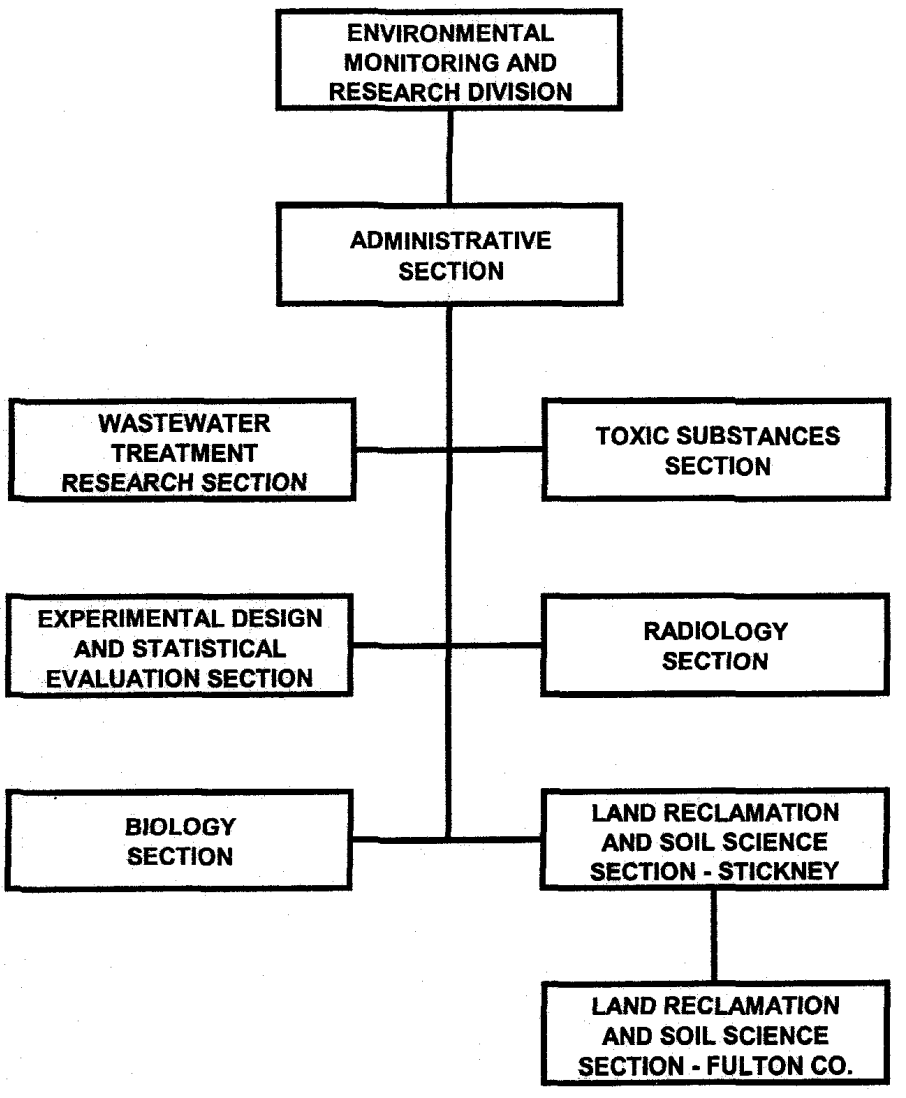
RESEARCH AND DEVELOPMENT UNNUMBERED REPORTS PUBLISHED DURING 1999

Report Title	Author (s)	Date	Organization Receiving Report
Report on Lake Michigan Water Quality Clean Water Semiannual Report July Through December 1998	R&D Department	Apr-99	Board of Commissioners
Emergency Response Activities Biannual Report, July Through December 1998	R&D Department	May-99	Board of Commissioners
Annual Publicly Owned Treatment Works (POTW) Pretreatment Report -- 1998	R&D Department	Jun-99	Illinois Environmental Protection Agency
Groundwater Monitoring Report, Tunnel and Reservoir Plan Des Plaines Tunnel System 1998 Annual Report	R&D Department	Aug-99	Illinois Environmental Protection Agency, United States Environmental Protection Agency
Groundwater Monitoring Report, Tunnel and Reservoir Plan Upper Des Plaines Tunnel System 1998 Annual Report	R&D Department	Aug-99	Illinois Environmental Protection Agency, United States Environmental Protection Agency
Groundwater Monitoring Report, Tunnel and Reservoir Plan Mainstream Tunnel System 1998 Annual Report	R&D Department	Aug-99	Illinois Environmental Protection Agency, United States Environmental Protection Agency
Groundwater Monitoring Report, Tunnel and Reservoir Plan Calumet Tunnel System 1998 Annual Report	R&D Department	Aug-99	Illinois Environmental Protection Agency, United States Environmental Protection Agency

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

Figure 1

ENVIRONMENTAL MONITORING AND RESEARCH DIVISION ORGANIZATION CHART



ENVIRONMENTAL MONITORING AND RESEARCH DIVISION

The Environmental Monitoring and Research Division has 79 employees, and is comprised of eight Sections, viz.,

1. Administrative
2. Wastewater Treatment Research
3. Land Reclamation and Soil Science - Stickney
4. Land Reclamation and Soil Science - Fulton County
5. Biology
6. Toxic Substances
7. Radiochemistry
8. Experimental Design and Statistical Evaluation

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

- Monitoring the environmental quality of Lake Michigan, area rivers and canals, and the Illinois River to document the effectiveness of the District's wastewater treatment program;
- Assisting in the resolution of sewage treatment and solids disposal operations problems;

- Providing technical assistance to other departments and agencies with respect to issues related to wastewater treatment, waterways management, and solids processing, utilization, and marketing;
- Conducting applied and operations research to achieve improvement and cost reductions in District wastewater treatment, waterways management, and solids processing activities.
- Assessing the impacts of new or proposed regulations on District activities.

Wastewater Treatment Research Section

The Wastewater Treatment Research (WTR) Section is responsible for conducting basic, applied, and problem solving research on various wastewater and sludge treatment processes currently utilized by the District. Technical assistance is provided to the M&O Department for solving WRP operating problems. This section also investigates innovative treatment processes for future use. The investigation of current operations may originate as the result of a WRP problem, or

interest in arriving at new knowledge concerning certain aspects of a wastewater treatment process.

Studies of future operations are concerned with maximizing the efficiency of an existing process at the lowest cost, or the development of new processes. Investigations may take the form of surveys, literature reviews, laboratory bench testing, pilot plant studies, full-scale testing, special analyses, or a combination or progression of any or all of the above. Plans and specifications are also reviewed at the request of the Engineering Department for the purpose of optimizing process design criteria.

The major areas of study included the following:

CHEMICAL CHARACTERISTICS OF CSOs

A report was prepared on chemical characteristics of the combined sewer overflows (CSOs) and Tunnel and Reservoir Plan (TARP) pumpback flows for the period 1995 through 1997. The report included priority pollutants in CSOs and TARP pumpback, and some conventional pollutants in the CSOs.

MESOPHILIC AND THERMOPHILIC ANAEROBIC DIGESTION TO PRODUCE CLASS A BIOSOLIDS

A bench scale study was conducted on inactivation of fecal coliforms, helminth ova, polio virus, and Salmonella during mesophilic and thermophilic digestion. The experimental work and sample analyses were completed. Data analysis and report preparation are expected to be completed in early 2000.

OXYGEN TRANSFER EFFICIENCY OF DIFFUSER PLATES

Tests were conducted to determine oxygen transfer efficiency (OTE) of the aeration tank diffuser plates at the North Side WRP during the summer and fall of 1999. The main objectives were (1) to evaluate the effectiveness of steam cleaning of diffuser plates on the OTE of the diffuser plates, and (2) to evaluate the OTE of diffuser plates in selected tanks of Batteries A, B, and C. A report on this study is under preparation.

TECHNICAL ASSISTANCE TO THE UNITED STATES ARMY CORPS OF ENGINEERS

Under contract with the U. S. Army Corps of Engineers (ACOE), the Research and Development (R&D) Department is providing technical assistance to support the design of the aeration system and washdown of the McCook Reservoir. This

project involves desktop feasibility studies as well as some field work.

GROUNDWATER MONITORING OF THE TARP SYSTEMS

Groundwater monitoring reports for the year 1998 were prepared for the four TARP systems which included the Mainstream Tunnel System, the Calumet Tunnel System, the Des Plaines Tunnel System, and the Upper Des Plaines Tunnel System. These reports were submitted to the IEPA as well as to the USEPA. In addition, a report on O'Hare Reservoir Groundwater Monitoring for the year 1998 was also prepared and submitted to the IEPA and USEPA.

APPLICATION OF ON-LINE RESPIROMETER TO CONTROL AERATION IN THE ACTIVATED SLUDGE SYSTEM

Studies on the application of an on-line respirometer to control aeration in the activated sludge system were conducted at the Kirie WRP. The purpose of the study was to minimize energy costs for the aeration system. The study has been completed and the final report on the project is near completion.

ODOR MONITORING AT DISTRICT FACILITIES

A routine odor monitoring program at several locations in and around the District's WRPs was carried out. In addition,

odor monitoring was also conducted at the District's biosolids management and air drying facilities, along with the determination of the odor potential of the dried biosolids.

POLYMER TESTING

Evaluations of the polymers used at the gravity belt thickener at the Hanover Park WRP and at the Stickney WRP postdigestion centrifuge complex were conducted in 1999.

A laboratory study to determine the effects of additional pumping on the polymer demand of digested sludge was concluded in support of the expansion of the Stickney WRP centrifuge complex.

Land Reclamation and Soils Science Section

The Land Reclamation and Soil Science Section is responsible for determining, through monitoring and research activities, the environmental impact of the District's biosolids applications on agricultural fields, disturbed and urban lands, and landfill sites. The section is also responsible for providing technical support for biosolids marketing. The section's laboratory in Fulton County performed 26,564 analyses on 1,890 samples in 1999.

ENVIRONMENTAL MONITORING ACTIVITIES

The environmental monitoring component of the program includes the sampling and analyses of waters, soils, and plants at land application sites, landfills, and solids drying facilities receiving biosolids. The results of this monitoring program are reported to the IEPA and the USEPA. In 1999 the section submitted 56 reports to the IEPA, one report to the USEPA, and 12 reports to the M&O Department for reporting to IEPA as per the regulatory requirements.

RESEARCH ACTIVITIES

The following research studies are being conducted to support local marketing of biosolids:

1. screening plants for suitability to grow in biosolids used as a soil conditioner or soil substitute,
2. establishing demonstration plots for reclamation of slag deposits,
3. analyzing samples of urban street dusts and surface soils for their metals contact,
4. studying soluble salts in biosolids and their effect on plant growth,

5. studying toxicity of metals to plants, and
6. studying changes over time in bioavailability of metals to plants grown in biosolids amended soils.

The section also conducts applied research to support land reclamation activities at the District's 15,600 acre site in Fulton County including maintaining experimental corn plots which have received cumulative applications of as much as 773 tons biosolids per acre on maximum amended plots. These plots are utilized to study changes in fertility of mine spoil, uptake of metals into corn, and fate of nutrients from continuous annual applications of biosolids.

TECHNICAL SUPPORT FOR BIOSOLIDS MARKETING

In addition to conducting applied research projects, the section provides technical support for biosolids marketing by maintaining continuous demonstrations of turfgrasses, prairie grasses, reclamation species and wild flowers in a greenhouse at the Lue-Hing R&D Complex and provides technical information to biosolids users such as local landfill operators, golf course superintendents, park districts, and environmental consultants.

Biology Section

The Biology Section is organized into four groups which performed specific monitoring or research activities. The four groups were: 1) Analytical Microbiology and Parasitology; 2) Virology, Toxicology, and Biomonitoring; 3) Fisheries Biology; 4) Water and Sediment Quality, and Chironomid Midge (Midge Fly) Abatement. The activities of the Biology Section in 1999 are summarized below.

ANALYTICAL MICROBIOLOGY AND PARASITOLOGY GROUP

The Analytical Microbiology Group conducted *Salmonella* and fecal coliform analyses in support of the WTR Section projects mentioned earlier. The group also conducted fecal coliform and other microbiological analyses in support of monitoring studies of the following areas: Illinois Waterway; Salt Creek (Ecosystematic Study); Chicago Area Waterways; Lake Michigan beaches; offshore waters of Lake Michigan; solids area monitoring wells; TARP monitoring. The group also monitored potable water at District facilities for total coliforms, fecal coliforms, and total heterotrophic bacteria. The group performed 9,419 analyses on 2,905 samples in 1999.

The Parasitology Group analyzed numerous dried biosolids samples for helminths for compliance with the Class A biosolids criteria in the Part 503 biosolids regulations. No viable helminths were isolated from any of the samples analyzed, and all of the samples analyzed were in compliance with the USEPA Class A biosolids criteria. The group performed 67 analyses on 67 samples in 1999.

The Parasitology Group conducted analyses in support of two WTR Section projects. The first was undertaken to microbiologically characterize centrifuge centrate and digester supernatant. The second was designed to study helminth inactivation in pilot-scale mesophilic and thermophilic digesters. This group also conducted seeding studies to determine laboratory efficiencies of helminth recovery from biosolids. The group performed 103 analyses on 95 samples in 1999.

VIROLOGY, TOXICOLOGY AND BIOMONITORING GROUP ACTIVITIES

The Virology Group analyzed numerous dried biosolids samples for viruses for compliance with the USEPA Class A biosolids criteria in the Part 503 biosolids regulations. No viruses were found in any of these samples. The Virology

Group also studied the inactivation of viruses in pilot-scale mesophilic and thermophilic digesters. This group also conducted seeding studies to determine laboratory efficiencies of virus recovery from biosolids. The group performed 103 analyses on 93 samples in 1999.

The Biomonitoring Group was selected to participate in the USEPA Whole Effluent Toxicity (WET) Test Interlaboratory Variability Study after completing a prequalification process. The group conducted acute and chronic WET tests with fish (*Pimephales promelas*) and daphnids (*Ceriodaphnia dubia*) for this study. The group also conducted an inhouse research project to investigate the effects of the age of fish used in acute WET tests on fish survival after exposure to toxicants. Finally, WET tests were conducted on effluent samples from the Hanover Park and Kirie WRPs in compliance with the respective NPDES permits for these WRPs. Biomonitoring reports for these WRPs were submitted to the IEPA. The group performed 116 WET tests.

FISHERIES BIOLOGY GROUP ACTIVITIES

The Fisheries Biology Group carried out fish collections at 35 locations in the Chicago and Calumet River systems in

cluding five Sidestream Elevated Pool Aeration (SEPA) stations. During 1999, 2,467 fish composed of 27 species were identified, weighed, measured for length and examined for incidence of parasites and disease. Fifty-six composite fish fillet samples were prepared and sent to the IEPA laboratory in Springfield to be analyzed for contaminants. Ten separate fish collections were also conducted as part of the Ecosystematic Study of Salt Creek. During 1999, 482 fish were processed from the Salt Creek collections.

WATER AND SEDIMENT QUALITY GROUP ACTIVITIES

In 1999, the Water and Sediment Quality Group continued work on the CSO monitoring program. CSO samples were collected during April, June, July, and December and analyzed for biochemical oxygen demand (BOD_5), dissolved oxygen (DO), and suspended solids (SS) during large storm events from selected CSO tributary areas in Cook County. These data will be used by the ACOE to determine the maximum oxygen requirements for designing a cost-effective aeration system for the TARP storage reservoirs.

The Water and Sediment Quality Group also continued work on a comprehensive field monitoring program to assess the DO

levels in the Chicago Waterway System. DO was measured hourly using remote (in situ) water quality monitors deployed at 20 stations in the waterways from the Wilmette Pumping Station on the North Shore Channel to the Lockport Lock and Dam on the Chicago Sanitary and Ship Canal. Some areas of low DO levels have been identified, and work is continuing on assessing the overall DO regime in the waterways.

The water and Sediment Quality Group also continued work on the Illinois Waterways water and sediment quality monitoring program. Water samples were collected and analyzed twice during August and October from each of 49 sampling stations along the Illinois Waterways from the Lockport Lock and Dam to the Peoria Lock and Dam to demonstrate improvement in water quality from the Lockport navigational pool to the Peoria pool.

Toxic Substances Section

The Toxic Substances Section is responsible for the analysis of samples for all organic priority pollutants, including more than 100 organic parameters listed by the USEPA, and the analysis for non-listed organic compounds when the detected peaks are ten times higher than the background and analysis of numerous non-listed organics compounds. The

section currently analyzes for more than 120 non-listed organic compounds.

Quality Assurance/Quality Control (QA/QC) requirements were conducted by the section in 1999 to guarantee the high quality of the laboratory analyses and results, and to evaluate the analytical performance for the numerous parameters analyzed. A total of 593 samples were analyzed during 1999. These consisted of 21 samples from Lake Michigan, 187 from industrial users, 178 from WRPs, 19 from Toxicity Characteristic Leaching Procedure, and 188 to meet QA/QC requirements.

ANALYSIS OF WRP SAMPLES

Final effluent, raw sewage, and biosolids samples from the seven District WRPs are analyzed twice annually. Biosolids and scum are analyzed to ensure that they are safe for disposal.

Raw sewage samples are analyzed monthly for volatile organic compounds (VOCs) to estimate through the use of mathematical models, the VOC air emissions from the WRPs. Actual VOC emissions will also be estimated by the analysis of organics in air samples collected at the WRPs. The section has established the ability to analyze air samples for 62 VOCs.

ANALYSIS OF INDUSTRIAL WASTE SAMPLES

The section is also responsible for the analysis of organic priority pollutants in discharges from industrial users as part of the District's Pretreatment Program in order to ensure compliance with Discharge Authorizations and USEPA categorical standards.

ANALYSIS OF ENVIRONMENTAL MONITORING SAMPLES

As part of the District's monitoring of the quality of Lake Michigan, the section analyzed samples collected from the southwest portion of the lake for organic priority pollutants.

Radiochemistry Section

The Radiochemistry Section is responsible for the radiological monitoring of waters, wastewater, and biosolids, the maintenance of radiation safety at the District, and the performance of any special tasks involving the use of ionizing radiation and radioisotopes. The section performed 4,294 tests in 1999.

RADIOLOGICAL MONITORING OF WATERWAYS

The radiological monitoring of the area's waterways under the jurisdiction of the District includes the Calumet, Chicago, and Des Plaines River systems. The concentration of

radioactivity in water samples analyzed in 1999 from all the three river systems were within USEPA Drinking Water Standards for gross alpha and gross beta radioactivity.

RADIOLOGICAL MONITORING OF WASTEWATERS AND BIOSOLIDS

The radiological monitoring of raw and treated wastewater, from the District's WRPs was initiated in 1967 and continues to date. In 1999, the radioactivity in the final effluent of all the WRPs was generally lower than the corresponding raw sewage of the WRP, indicating that the wastewater treatment process is removing radioactivity from the raw sewage. The amount of gross alpha and gross beta radioactivity in the final effluent is also less than the USEPA standards for gross alpha and gross beta radioactivity contaminant levels in the community water system. This shows that the final effluent from the District's seven WRPs do not adversely affect the radiological quality of Chicago River Systems.

The section also performs radiological monitoring of biosolids from the seven WRPs and biosolids from the eight drying sites of the District. The monitoring data serves as a measure of present-day radioactivity levels in comparison to

levels in the past years for gross alpha, gross beta and gamma-emitting radionuclides in biosolids.

RADIATION SAFETY PROGRAM ACTIVITIES

The section maintains the radioactive material license issued to the District by the Illinois Department of Nuclear Safety, assuring that activities are conducted according to the license conditions and regulations. These activities include radiological monitoring of personnel and work areas in the Radiochemistry laboratory, leak testing of nickel-63 detectors in gas chromatographs at the R&D laboratories, leak testing of nuclear gauges used by the Engineering Department, and an x-ray fluorescent paint analyzer used by the M&O Department.

LABORATORY QUALITY ASSESSMENT PROGRAM ACTIVITY

The section continued to participate in the U.S. Department of Energy, Environmental Measurements Laboratory's Quality Assessment Program. Water samples were analyzed for gross alpha, gross beta, tritium, cobalt-60, and cesium-137 activity, and soil samples were analyzed for potassium-40,

cesium-137, bismuth-212, lead-212, bismuth-214, and lead-214 activity.

Experimental Design And Statistical Evaluation Section

The Experimental Design and Statistical Evaluation Section is responsible for providing assistance in the design of laboratory and full-scale experiments, collection of appropriate data, development of guidelines for data collection method, and statistical analyses. For the optimum performance of the statistical analyses and to reduce cost, the personnel of this section successfully transferred the computing media from the VAX computers to personal computers in 1999. They also developed programs to create tables/reports in Visual Basic programs interlinking SAS and Excel software programs.

STATISTICAL AND COMPUTING SUPPORT

During 1999, an associate statistician and a statistical consultant in the section provided statistical and computing support to various programs and projects. The following is a description of some activities:

1. Statistical support was provided in the analyses of monitoring frequency for TARP groundwater

level and quality monitoring wells. As a result of the study, the District received guidelines for reducing the frequency of monitoring TARP wells.

2. Statistical support was provided to the Biology Section on the toxicity studies with *Pimephelas promelas*. Studies are being conducted on the variation of a mortality rate due to age and the level of the toxicant, and to develop a mathematical model of the mortality rate due to age and toxicant level for a known toxicant. The studies began in the middle of 1999 and are expected to be finished by January 2000.

3. Statistical support was provided on the study of OTE of diffuser plates in aeration tanks. The project was started in July 1999, and is expected to be finished by March 2000.

WATER QUALITY DATA

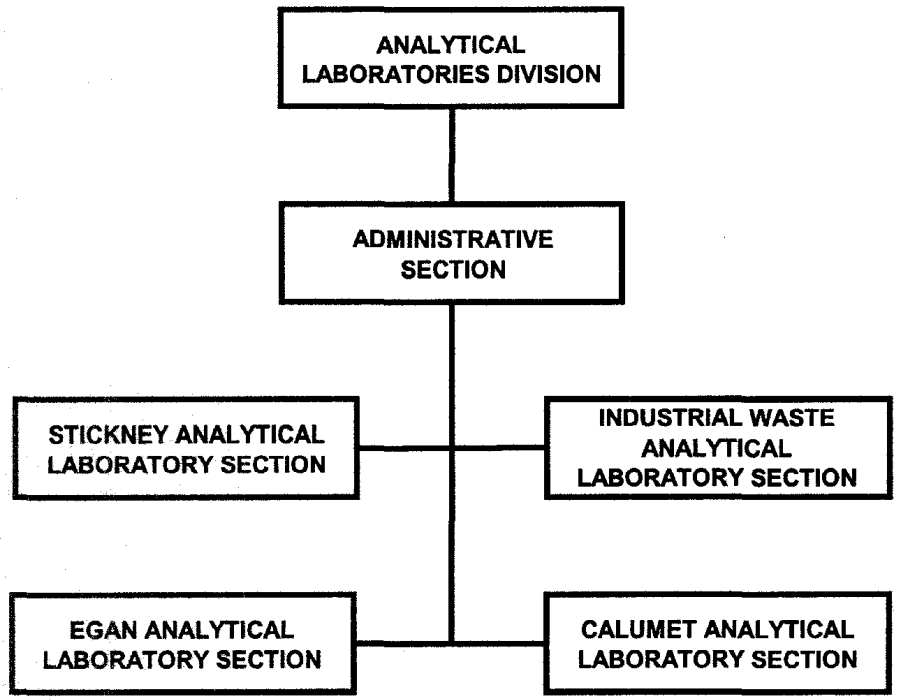
Each year, the section prepares an annual report describing the water quality of the streams and channels within the District's jurisdiction for the preceding year. Surface water

quality data for 1996, 1997, and 1998 were evaluated regarding compliance with water quality standards set by the Illinois Pollution Control Board (IPCB). In 1998, 27 water quality parameters (phenols, zinc, cadmium, copper, chromium, nickel, lead, boron, arsenic, selenium, barium, un-ionized ammonia, manganese, WAD cyanide, DO, temperature, pH, ammonium nitrogen, total dissolved solids, sulfate, iron, mercury, silver, fecal coliform, soluble iron, and fluoride) were assayed. The first 14 parameters listed were in total compliance in General Use Waters of all river systems.

The section also prepares annual summary reports on the effectiveness of Sewage and Waste Control Ordinance limits to maintain compliance with Pretreatment Program requirements.

Figure 2

ANALYTICAL LABORATORIES DIVISION ORGANIZATION CHART



ANALYTICAL LABORATORIES DIVISION

The Analytical Laboratories Division (ALD) functions as an analytical service to the District. The Maintenance and Operations (M&O) Department receives analytical support for operational control and process evaluations, and for the National Pollutant Discharge Elimination System (NPDES) reports to the USEPA, and the IEPA. The Engineering Department receives data necessary for the planning and design of future water reclamation plants (WRPs).

The Industrial Waste Division (IWD) receives analytical services pursuant to the monitoring of industrial discharges for verification of User Charge revenue, and for compliance with sewer discharge standards. Analytical support is supplied to the Environmental Monitoring and Research Division (EM&R) for a variety of long- and short-term studies and for environmental monitoring programs. In addition to these functions, analytical service is extended through intergovernmental cooperation to outside agencies such as the IEPA, the Illinois Attorney General, and various federal agencies.

In order to implement these functions, there are four laboratory sections, one each is located at the Calumet and John E. Egan WRPs and two are located at the Dr. Cecil Lue-Hing Research and Development Complex (Lue-Hing R&D Complex) at the Stickney WRP.

The large number of analyses performed by the ALD, as shown in the table on the next page, could not be accomplished without automation and instrumentation. To integrate this automation, the existing Laboratory Information Management System (LIMS) was upgraded in 1999 to ensure year 2000 compliance and support, increase processing and reporting speed, and take advantage of new functionality.

Stickney Analytical Laboratory

This laboratory is located at the Lue-Hing R&D Complex and performed 846,354 solids, nutrients, and metals analyses on 43,384 samples in providing service for the following:

M&O DEPARTMENT

1. Analysis for Solids Management Areas at Harlem Avenue, Lawndale Lagoons, Ridgeland Avenue, Stony Island, and Calumet.
2. Process Control, Operations Monitoring, and NPDES Compliance Monitoring for the Stickney WRP.
3. USEPA and IEPA Split Sampling Program.

EM&R DIVISION

1. Environmental and Permit Compliance Monitoring for the Prairie Plan Project in Fulton County involving biosolids quality, test well water quality, surface water quality, and plant tissues.

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

TOTAL NUMBER OF ANALYSES PERFORMED IN 1999

Program	Nutrients	Oxygen Demands	Metals	Solids	Others	Total Program
4652 Liquid Monitoring	104,373	81,469	211,458	65,013	61,482	523,795
TARP	3,578	614	1,335	629	2,415	8,571
Treatment Facilities	100,795	80,855	210,123	64,384	59,067	515,224
4653 Solids Monitoring	21,705	1,818	48,717	105,375	53,739	231,354
4662 Sewage & Waste Control	2,762	310	591,273	627	34,668	629,640
4663 User Charge	0	96,764	0	40,196	60,255	197,215
4671 Lake Michigan	834	50	162	66	141	1,253
4672 Waterways	6,662	2,102	15,557	2,685	14,000	41,006
4673 Inspection Events	0	0	26,454	0	0	26,454
4674 IPCB Water Quality	0	0	0	0	0	0
4681 Assistance to M&O	250	86	476	2,309	11,568	14,689
4682 Assistance to Others	0	909	0	446	912	2,267
4690 Operations & Research	6,147	343	16,510	102	1,523	24,625
Totals	142,733	183,851	910,607	216,819	238,288	1,692,298

2. USX South Works Reclamation Demonstration and Slag Leachate Study.
3. Analytical Support for Biosolids Marketing.
4. Pilot Plant Thermophilic Digestion Study.
5. Characteristics of Combined Sewer Overflows.
6. Fish Survey of the Chicago Waterway System.
7. Biosolids Odor Monitoring Program.
8. Biosolids Research at Stickney Greenhouse.
9. Tunnel and Reservoir Project (TARP) Groundwater Monitoring Program.

IWD

Metals analyses are conducted on regulated categorical industrial discharges to determine compliance with the Sewage and Waste Control Ordinance. The following 13 metals are regulated: arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, and zinc.

OTHER SERVICES

In addition to typical water, wastewater, and biosolids analyses, this laboratory also performs analyses on materials such as lubricants, sodium hypochlorite, and ferric chloride purchased by the District for verification of contract requirements.

Analytical services for certain essential processes at the Stickney WRP are provided seven days a week. The following critical areas are supported: (1) the boiler water opera-

tion, (2) the raw sludge thickening process, and the biosolids dewatering operation.

In addition, technical assistance is extended to the M&O Department for short-term process control test programs.

Industrial Waste Analytical Laboratory (IWAL)

The IWAL is located at the Lue-Hing R&D Complex and performed 294,556 analyses on 45,196 samples. The laboratory performs analysis for fats, oil and grease; several methods for cyanide and phenols; total organic carbon; total and suspended solids; biochemical oxygen demand and dissolved oxygen in support of the following:

M&O DEPARTMENT

Process Control, Operations Monitoring, and NPDES Permit Compliance Monitoring for the District's seven WRPs.

EM&R DIVISION

Various environmental monitoring and research programs.

IWD

Administration of the Sewage and Waste Control Ordinance and the User Charge Ordinance.

In 1999, the laboratory initiated a cyanide methodology study in conjunction with a Water Environment Federation Research Foundation study and implemented a new USEPA-approved method for the preparation and analysis of fats, oil and grease. This method, Solid Phase Extraction, was implemented

because it shortened analysis time and utilized less solvent than the older Liquid-Liquid extraction method.

Calumet Analytical Laboratory

This laboratory is located at the Calumet WRP and performed 283,764 analyses on 26,159 samples in providing service for the following:

M&O DEPARTMENT

1. Process control and operations monitoring and NPDES Compliance Monitoring for the Calumet and Lemont WRPs.
2. USEPA and IEPA Split Sample Study.
3. Monitoring of Hydrogen Sulfide Concentrations at the Kirie WRP.
5. Ongoing Assistance to Investigate Increased Zinc Loadings to the Calumet WRP.

EM&R DIVISION

1. Analytical Support for Calumet Biosolids Processing Operations and the Fulton County Prairie Plan Project.
2. Sulfate Analyses of Waterways, TARP, and Lysimeter Samples.

John E. Egan (Egan) Analytical Laboratory

This laboratory is located at the Egan WRP and performed 266,606 analyses on 28,337 samples in providing service for the following:

M&O DEPARTMENT

1. Process Control Analyses and NPDES Compliance Monitoring for Egan, Kirie, Hanover Park and North Side WRPs.
2. USEPA and IEPA Split Sampling Program.
3. Materials and Boiler Water Testing Programs.
4. Process Stream Evaluations of Suspected Incidents of Toxic Interferences or Pass-Through.
5. Polymer Testing for Raw Sludge Dewatering at the Egan and Hanover Park WRPs.
6. Development, Implementation and Support of LIMS Reports for Use by M&O Personnel at the Four North Area WRPs.

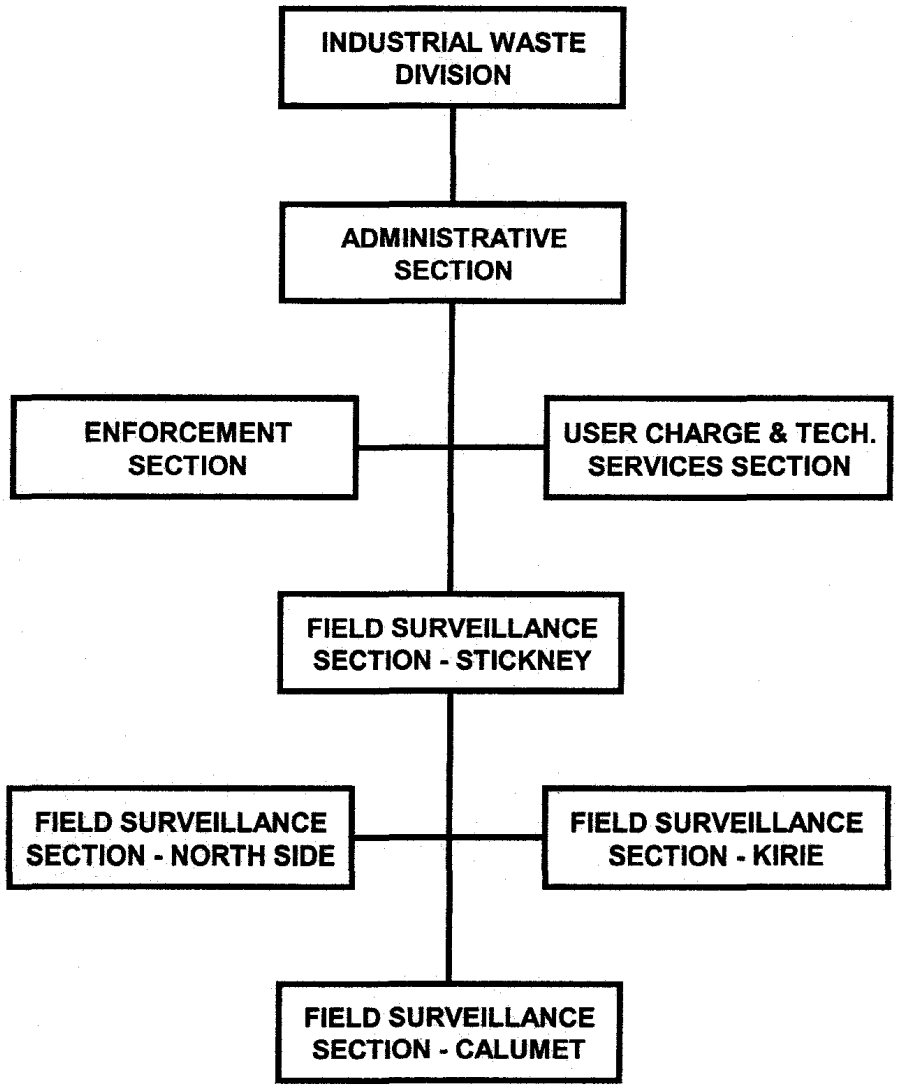
EM&R DIVISION

1. Monitoring of Biosolids Utilization Activities at Hanover Park WRP.
2. Hanover Park WRP Final Clarifier Bulking Study.
3. Analysis of CSO Samples for the Kirie and North Side WRPs.
4. Street Dust Characteristic Study.

5. Soluble Phosphorus Study at the Four North Area WRPs.
6. Soluble Copper Study at Kirie and Hanover Park WRPs.
7. Egan WRP Centrifuge Cake Testing for Application of Sludge to Land, Part 503 Reporting Requirements.

Figure 3

INDUSTRIAL WASTE DIVISION ORGANIZATION CHART



INDUSTRIAL WASTE DIVISION

The Industrial Waste Division consists of four sections: Administrative, Enforcement, User Charge and Technical Services, and Field Surveillance and Studies. The Division's primary responsibilities are the enforcement of the District's Sewage and Waste Control Ordinance (SWCO) and User Charge Ordinance (UCO). It is responsible for the compilation and presentation of data pertaining to industrial user discharges to the District's sewerage system. Finally, the Division executes the District's responsibility as a primary response agency for hazardous materials emergencies in Cook County.

Administrative Section

This Section is responsible for the general administration of the Division and for coordination and direction of the work of the Enforcement, User Charge and Technical Services, and Field Surveillance and Studies Sections. It is responsible for budgetary preparations and control, and prepares and maintains Division procedural manuals. The Section reviews and comments on pretreatment and wastewater regulations proposed by federal and state agencies.

The Administrative Section also coordinates the supply of technical data, technical support activities, and recommendations provided by the Division to other divisions of the R&D Department, and to other departments of the District. It presents data in report form for a variety of purposes and prepares illustrative charts and tables pertinent to those reports.

Enforcement Section

The Enforcement Section is responsible for the routine administration and enforcement of the SWCO, which incorporates the federal pretreatment regulations for certain industrial categories and specifies limits for concentrations of contaminants discharged to the District's sanitary sewerage system and to the waterways within the District's boundaries.

Administrative activities performed by the Enforcement Section during 1999 include the issuance or renewal of 243 Discharge Authorizations, review of 1,037 Continued Compliance Reports and the review of 28 Spill Prevention, Control and Countermeasure Plans. Enforcement activities for the period from 1995 through 1999 are depicted in the following table.

Year	Cease and Desist Orders / Amendments	Board Orders	Legal Actions / Amendments
1995	835	27	247
1996	657	6	139
1997	618	8	110
1998	512	4	70
1999	595	6	58

The Enforcement Section also prepares the District's list of significant violators of applicable pretreatment regulations which is required to be published annually in the newspaper with the largest daily circulation within the jurisdiction of the District. The trend for the period from 1995 through 1999, which

shows continuing improvement in industrial user significant non-compliance rates, is depicted in the following table.

Year	Effluent Limitations	Reporting Requirements	Other Requirements[1]	Total Number of Industrial Users Published
1995	68	85	13	166
1996	91	98	3	192
1997	50	61	2	113
1998	30	28	1	59
1999	30	36	0	66

[1]Other violations include dilution, failure to provide access for inspection purposes, failure to install adequate sampling facilities, failure to provide adequate spill containment, failure to maintain and install adequate pretreatment facilities.

User Charge and Technical Services Section

The User Charge and Technical Services Section administers the federally approved system as authorized by the District's UCO.

In 1999, the Section received and reviewed reports filed by 3,864 users (1,030 commercial-industrial and 2,834 tax-exempt users) containing the calculation of their User Charge liability under the UCO and documentation corroborating their data. The Section classified 53 new commercial-industrial and tax-exempt users in 1999.

The Section requests verification sampling of certain facilities by the Field Surveillance and Studies Section, and determines the acceptability of the user's proposed sampling meth-

odology. In 1999, the Section approved 40 user proposals for sampling, monitoring and/or installations; sealed 144 privately owned water meters used for reporting volume deductions or discharge volumes; and conducted 985 field inspections to verify user data and/or compliance with the UCO.

The following table shows the User Charge revenue, as reported by the District's Finance Department, collected over the period from 1995 through 1999.

Year	User Charge Revenue Collected
1995	$52,031,797
1996	$52,634,723
1997	$53,616,869
1998	$49,686,666
1999	$53,354,085

Field Surveillance and Studies Section

The Field Surveillance and Studies Section investigates and surveys industrial facilities within the jurisdiction of the District, and samples their effluent discharges to determine their compliance with the SWCO and as verification of user data as required by the UCO. During 1999, 2,398 SWCO and 1,231 UCO inspection and sampling programs were performed.

The collection of samples to monitor the quality of Lake Michigan and District waterways, in order to detect and reduce the incidence of pollution, is also performed by the Section. In

1999, 9,357 water quality samples were collected. Further, all groundwater monitoring wells installed for the District's Tunnel and Reservoir Plan (TARP) were routinely sampled. In 1999, 510 samples were obtained at 122 TARP groundwater monitoring wells. Chemical toilet service companies who, under District permit, discharge cleanings at the Stickney Water Reclamation Plant (WRP) are also monitored and sampled. During 1999, three chemical toilet service companies made 471 disposals at the Stickney WRP. For these disposal events, 150 samples were randomly obtained.

The Section is also responsible for the investigation of spills or discharges of pollutants and hazardous, toxic or volatile materials to sewer systems and waterways within the District's boundaries, and initiates containment and cleanup activities pertaining to such events. Through such actions, Section personnel execute the District's role as primary response agency for hazardous materials emergencies in suburban Cook County, provide support to the Chicago Fire Department for such emergencies, and provide support to the Cook County Department of Environmental Control for toxic gas discharge incidents.

In 1999, 315 investigations were conducted in response to requests from federal, state and local agencies, municipalities and private citizens; 52 investigations were conducted in response to self-reported industrial activities; and 28 investigations were conducted in response to requests from the District's M&O Department.

MEETINGS AND SEMINARS

1. United States Department of Agriculture W-170 Regional Technical Committee Meeting, Charlotte, North Carolina, January 1999.

2. Water Environment Federation/American Water Works Association Joint Specialty Conference on Water and Wastewater Treatment Residuals, Charlotte, North Carolina, January 1999.

3. Illinois Water Environment Association Government Affairs in Water Pollution Control Seminar, Lisle, Illinois, January 1999.

4. 1999 Midyear Water Environment Federation Meeting, Program Committee Meeting, New Orleans, Louisiana, January 1999.

5. "Forecasting Techniques Using SAS/ETS Software," Chicago, Illinois, February 1999.

6. Association of Metropolitan Sewerage Agencies 1999 Winter Conference, Air Quality Committee Meeting and General Session III, Phoenix, Arizona, February 1999.

7. "Optimizing Productivity and Data Compliance in the Analytical Laboratory," Seminar, Hewlett Packard, Elk Grove Village, Illinois, February 1999.

8. Lake Michigan Water Analysts Winter Meeting, Kenosha, Wisconsin, February 1999.

9. Chicago Public Schools Science Fair, Chicago, Illinois, March 1999.

10. United States Environmental Protection Agency, Region 5, Workshop on Biological Effects/Indicators of Nutrient Enrichment, Chicago, Illinois, March 1999.

11. 1999 Pittsburgh Conference and Short Courses, Orlando, Florida, March 1999.

12. Illinois Water Environment Association Annual Conference and Exhibition, Peoria, Illinois, March 1999.

13. "Analytical Solutions for the Environmentally Responsible," Seminar, Hewlett Packard, Elk Grove Village, Illinois, March 1999.

14. Association of Metropolitan Sewerage Agencies Whole Effluent Toxicity Training Course, Arlington, Virginia, March 1999.

15. "GC Open Forum Workshop," Hewlett Packard, Elk Grove Village, Illinois, April 1999.

16. Lake Michigan Water Analysts Second Quarter Meeting, Waukegan, Illinois, April 1999.

17. Association of Metropolitan Sewerage Agencies National Environmental Policy Forum and 29th Annual Meeting, Washington, DC, May 1999.

18. United States Environmental Protection Agency, Stakeholders Meeting on National Strategy to Develop Regional Nutrient Criteria, Arlington, Virginia, June 1999.

19. Annual Meeting of the North American Benthological Society, Duluth, Minnesota, June 1999.

20. General Meeting of the American Society for Microbiology, Chicago, Illinois, June 1999.

21. 47th American Society for Mass Spectrometry and Allied Topics (ASMS) Conference, Dallas, Texas, June 1999.

22. 15th Annual Waste Testing and Quality Assurance Symposium, Arlington, Virginia, July 1999.

23. Association of Metropolitan Sewerage Agencies Summer Conference Meeting, Unifying Urban Wet Weather Programs and Air Quality Committee Meetings, Philadelphia, Pennsylvania, July 1999.

24. Illinois Environmental Protection Agency, Bureau of Water, Public Hearing, Springfield, Illinois, August 1999.

25. Dionex Corporation New Developments in Ion Chromatography Seminar, Chicago, Illinois, September 1999.

26. Illinois Department of Public Health Environmental Laboratory Seminar, Springfield, Illinois, September 1999.

27. United States Environmental Protection Agency, Stakeholders Meeting on Total Maximum Daily Load Rulemaking, Atlanta, Georgia, September 1999.

28. Industrial Water, Waste and Sewage Group Meeting, Chicago, Illinois, September 1999.

29. Association of Metropolitan Sewerage Agencies Fall Leadership Retreat and Strategy Session, Washington, DC, September 1999.

30. Electric Power Research Institute Municipal Water and Wastewater program Meeting, Nashville, Tennessee, October 1999.

31. Water Environment Research Foundation, Biocriteria Workshop, New Orleans, Louisiana, October 1999.

32. Water Environment Federation 72nd Annual Conference and Exposition, New Orleans, Louisiana, October 1999.

33. Annual Meeting of the Society of Environmental Toxicology and Chemistry, Philadelphia, Pennsylvania, November 1999.

34. Illinois Water Environment Association Industrial Pretreatment and Hazardous Waste Committee Annual Meeting, Lombard, Illinois, November 1999.

35. Illinois Water Environment Association Industrial Pretreatment and Hazardous Waste Committee Meeting, Yorktown, Illinois, November 1999.

36. Wet in the City, Teachers Education for Household Hazardous Waste at the Field Museum, Chicago, Illinois, December 1999.

PAPERS PRESENTED

1. "Assessing the Phytotoxic Threshold for Zn in the Part 503 Biosolids Regulation Risk Assessment." Presented at Annual Meeting of United States Department of Agriculture W-170 Regional Technical Committee, Charlotte, North Carolina, January 1999, by Thomas Granato.

2. "A National Sewage Sludge Survey: Quality Status Relative to Part 503 Rule." Presented at Illinois Water Environment Association Twentieth Annual Conference and Exhibition, Peoria, Illinois, March 1999, by R.I. Pietz, R. Johnson, R. Sustich, T.C. Granato, P. Tata, and C. Lue-Hing.

3. "The Chicago River Fishery." Presented at the Annual Spring Fishing Extravaganza, Henry's Sport and Bait Shop, Chicago, Illinois, March 1999, by Sam Dennison.

4. "Growing Grasses and Wildflowers in Biosolids." Presented at Research and Development Department Annual Seminar Series, Stickney, Illinois, August 1999, by Thomas Granato.

5. "Environmental Chemistry as it Relates to Wastewater Treatment." Presented at Associated Colleges of the Chicagoland Area Fall 1999 Seminar Series, Lemont, Illinois, September 1999, by Bernard Sawyer.

6. "Management of Odor Monitoring Programs and Odor Complaints at the Metropolitan Water Reclamation District of Greater Chicago." Presented at the Water Environment Federation Annual Conference, New Orleans, Louisiana, October 1999, by Thomas K. O'Connor, Prakasam Tata, David T. Lordi, and Cecil Lue-Hing.

7. "A National Sewage Sludge Survey: Quality Status Relative to Part 503 Rule." Presented at Residuals and Biosolids Management Symposium: Biosolids Regulations and Privatization, Water Environment Federation Annual Conference, New Orleans, Louisiana, October 1999, by C. Lue-Hing, R.I. Pietz, P. Tata, R. Johnson, R. Sustich, and T.C. Granato.

PAPERS PUBLISHED

1. Lue-Hing, C., R.I. Pietz, P. Tata, R. Johnson, R. Sustich, and T.C. Granato. "A 1996 National Sewage Sludge Survey: Quality Status Relative to the Part 503 Rule," in Residuals and Biosolids Management Symposium: Biosolids Regulations and Privatization, Water Environment Federation Annual Conference, New Orleans, Louisiana, 1999.