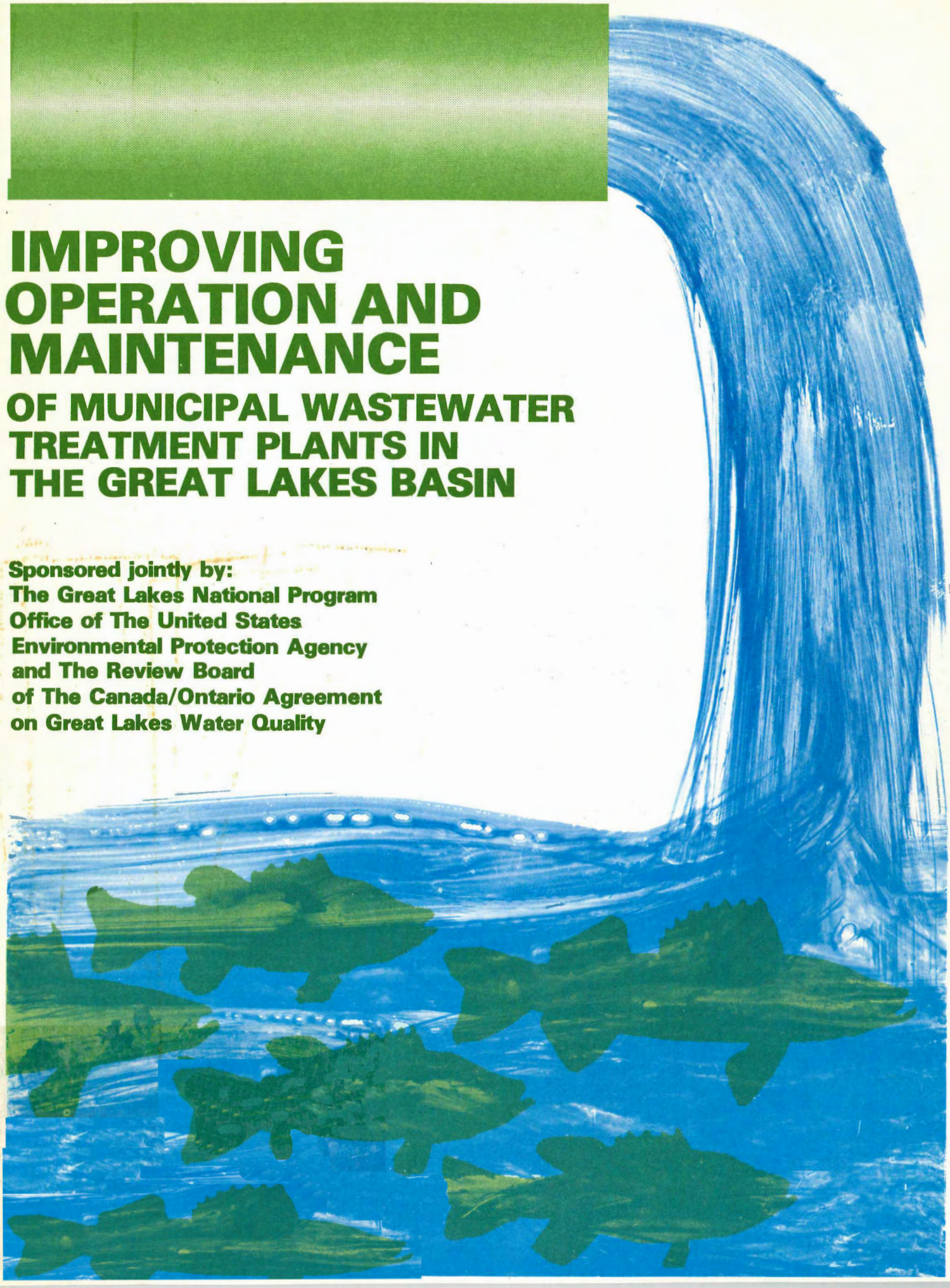
IMPROVING OPERATION AND MAINTENANCE

OF MUNICIPAL WASTEWATER TREATMENT PLANTS IN THE GREAT LAKES BASIN

Sponsored jointly by:
The Great Lakes National Program Office of The United States Environmental Protection Agency and The Review Board of The Canada/Ontario Agreement on Great Lakes Water Quality



IMPROVING
OPERATION AND MAINTENANCE
OF MUNICIPAL WASTEWATER TREATMENT PLANTS IN THE GREAT LAKES BASIN

An Opinion Paper Derived From The Canada-United States Great Lakes Workshop On Operation And Maintenance Of Municipal Wastewater Treatment Plants, Held In Itasca, Illinois, USA, On March 15-17, 1978.

Page Intentionally Blank

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

The joint support of the Review Board of the Canada/Ontario Agreement on Great Lakes Water Quality and of the Great Lakes National Program Office of the U.S. Environmental Proteciton Agency in making this program possible, is gratefully appreciated. The valuable assistance of many departments in both the United States and Canadian organizations is acknowledged.

We also gratefully acknowledge the dedicated efforts of the Great Lakes O&M Workshop Steering Committee members before, during and after the Workshop, which made this program possible.

Most of all we especially recognize the dedicated efforts and interest of over 60 participants in the Workshop who brought their diversified experience together to find joint solutions to common operation and maintenance problems in municipal wastewater treatment plants in the Great Lakes Basin.

We also acknowledge the efforts of our consultant, Mr. Norman Wei of Norman S. Wei & Associates Limited in Toronto, for the preparation of this report and of Ms. Jan Pickett and the 'E' Company of Chicago who made the necessary arrangements for the conference including the management of an extensive library at the Workshop.

PREFACE

The Joint U.S.-Canada Workshop on the Operation and Maintenance of Municipal Wastewater Treatment Plants in the Great Lakes Basin was established by the Joint Action Memorandum of the Director General, Ontario Region, Environmental Protection Service of Environment Canada, and the Regional Administrator, Region V of the U.S. Environmental Protection Agency. The Joint Memorandum is reproduced on the following pages.

These officials, and the organizations which they represent, are responsible for environmental control in the Great Lakes Basin. They sought recommendations for more effective operation and maintenance of municipal treatment facilities. The Workshop accomplished that in a model inter-disciplinary review and discussion of the combined opinions of the representatives of the constituencies and disciplines involved in this profession. By this means, the Workshop succeeded in formulating practical recommendations for more effective operation and maintenance of municipal treatment facilities.

The opinions and recommendations of the Workshop participants as described in this report, are advisory and do not necessarily reflect the official positions of any of the governmental organizations.

We are hopeful, however, that those who are in a responsible position to make changes will adopt the recommendations of this Workshop to improve plant operation and maintenance.

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
REGION V
230 SOUTH DEARBORN ST.
CHICAGO, ILLINOIS 60604

JOINT ACTION MEMORANDUM August 22, 1977

SUBJECT: Joint U.S.-Canada Workshop on Operation and Maintenance of Municipal Wastewater Treatment Plants in the Great Lakes Basin

TO: Max Hanok, Great Lakes National Program Office
Region V, U.S. Environmental Protection Agency

Alex Redekopp, Training and Technology Transfer Division, Environmental Protection Service, Fisheries and Environment Canada

BACKGROUND

In recognition of the complexity and diversity of common problems and issues associated with the operation and maintenance of municipal waste treatment plants in the Great Lakes Basin of the U.S. and Canada a workshop on the subject had initially been considered under the sponsorship of the IJC. Subsequently, in March 1976, the Honorable Jean Marchand, Minister of the Environment in Canada, and the Honorable Russell E. Train, Administrator of EPA, under sponsorship of the U.S. Department of State, and the Canadian Department of External Affairs, entered into a broad agreement providing for the direct exchange of technical information between the two Governments. With the consummation of that agreement, it seemed to be more appropriate and in keeping with the responsibilities of the two Governments, to sponsor the workshop as a joint undertaking. Participation and input to the workshop shall be from a broad cross-section of interests involved in municipal waste treatment facility operation. The general goals, objectives and format for the workshop as initially proposed to the Water Quality Board should serve as a guide to the Steering Committee under this joint undertaking.

JOINT ACTION

Pursuant to the Train-Marchand Agreement in keeping with the responsibilities of the Governments, it is hereby concluded that the subject workshop should be conducted under joint U.S.-Canadian sponsorship as follows:

A. On the part of the U.S., the Regional Administrator of Region V of the U.S. Environmental Protection Agency will provide the necessary personnel to organize and conduct the workshop and will provide approximately two-thirds of the funding necessary.

B. On the part of Canada, approximately one-third of the necessary funds will be provided by the Review Board of the Canada-Ontario Agreement on Great Lakes Water Quality. In addition, Canada will provide membership on a Steering Committee, to be appointed, which members will participate in deliberations of the Steering Committee and will also make initial arrangements for participation of Canadian personnel in the workshop itself.

APPOINTMENT AND DELEGATION OF RESPONSIBILITY

A Steering Committee is hereby created for the purpose of providing overall direction and consultation for planning and coordinating the Seminar. The Steering Committee will consist of ten members, five from Canada and five from the U.S.

A. One member from each country is hereby designated as co-chairman of the Steering Committee as follows:

For Canada: Mr. Alex Redekopp
Training and Technology Transfer Division
Environmental Protection Service
Fisheries & Environment Canada

For the U.S.: Mr. Max Hanok
Great Lakes National Program Office
Region V
U.S. Environmental Protection Agency

B. The co-chairmen shall have overall responsibility for conducting the business of the Steering Committee and shall share responsibilities for conducting the workshop commensurate with the "Joint Action" paragraph above. The co-chairmen shall have the responsibility for arranging for participation of the other four members from their respective countries. The co-chairmen shall report periodically to their respective jurisdictions, orally or in writing as directed, regarding the progress of the planning, organization, and conduct of the workshop.

It is expected that the final product of the workshop will result in recommendations in the form of a published report which will be useful to municipal, State and Federal and Provincial agencies in furthering their programs for more effective operation and maintenance of municipal treatment facilities in the International Great Lakes Basin. It is also anticipated that such a report will provide valuable assistance to

jurisdictions outside of the Basin since, in addition to problems peculiar to the Great Lakes Basin, many of the problems of operation and maintenance are common to other areas of the two countries. This Joint Action Memorandum is intended to assign broad responsibilities and to provide a broad latitude of action and decision to the Steering Committee and to the co-chairmen to produce a viable report which will provide a guide to improve operation and maintenance of municipal wastewater treatment facilities in the Great Lakes Basin.

Robert W. Slater
Director General
Ontario Region
Environmental Protection Service
Department of Fisheries & Environment
Toronto, Ontario, Canada

George R. Alexander, Jr.
Regional Administrator
Region V
Environmental Protection Agency
Chicago, Illinois

EXECUTIVE SUMMARY

The experience of both Ontario and the United States in building and operating effective municipal wastewater treatment facilities as a part of maintaining good water quality in the Great Lakes Basin, has shown that actual application and experience are the best teachers.

The problems with performance of municipal treatment plants have been known for some time in the United States. For example, the General Accounting Office (GAO) in 1975 pointed to the need for improved performance of municipal wastewater treatment plants in the Great Lakes to resolve the high costs of operation. In 1977, the GAO specifically identified areas where O&M of treatment plants can be improved. The U.S. EPA has also been active in promoting the importance of O&M. Agency components include the Regional Office staff; Office of Water Program Operations in Washington, D.C.; the National Training and Operational Technology Center in Cincinnati, Ohio; and the Municipal Environmenal Research Laboratory in Cincinnati. In 1977, the U.S. EPA appointed an intra-agency Task Force to define problems and recommend solutions to improve O&M of municipal wastewater treatment plants in the United States.

In Canada, when Ontario implemented its subsidized plant construction program in the 1950's, there was an immediate and extensive expansion of the entire system and similar problems to those identified during the recent O&M Workshop were experienced. As a means of overcoming some of these problems, Ontario set up a bid depository and also instituted a practice of preselecting major mechanical equipment. At the time, the Province also experienced a similar critical shortage of trained staff, at all levels. To meet the agency requirements, the then Ontario Water Resources Commission began to send new staff back to the universities for post-graduate training in Sanitary Engineering and instituted an operator training program to staff the new facilities. However, there is no complete substitute for on-the-job experience, and it was some years before a fully

experienced staff was established in the plants, at the agency, municipalities, and with consultants and equipment suppliers to service the higher level of activity.

The United States and Canadian participants at the Great Lakes O&M Workshop defined over 30 major issues or problem areas encountered in municipal wastewater treatment plants. These were developed by each of the major groups of experts involved in various aspects of treatment plant operation. The groups included consultants, equipment manufacturers and suppliers; treatment plant operators; municipal officials and regulatory officials; public interest groups, and environmental and management scientists. The Workshop was unique in the use of organized homogeneous (participants of similar disciplines) and heterogeneous (participants of dissimilar disciplines) work sessions to reach concensus on issues.

The Workshop participants distilled the issues to 13 major areas of concern and proceeded to propose mutually acceptable solutions to each of the issues. These 13 major O&M issues and their recommended solutions represent the combined opinions of the Workshop participants as to how O&M can be improved. They are summarized in Table 1.

TABLE 1

WORKSHOP OPINIONS ON O&M

Identified Issues	Recommended Solutions
* Formulation of O&M policies requires sufficient inputs from operators, consultants, municipal officials, equipment manufacturers and the public.	* Utilize more external technical input into the development of O&M policies. * Ensure that more qualified engineers, who have significant O&M experience, are in key decision-making positions.
* Need for maintenance management programs to prevent O&M problems.	* Consultants and equipment manufacturers should design maintenance programs and establish responsibility for their operation.
* Uncontrolled industrial waste discharges cause O&M problems at treatment plants.	* Development of programs for monitoring non-conventional parameters. * Require industrial waste surveys and characterization of wastes as prerequisite to design. * Establish a sewer charge system for industrial wastes.
* Provide incentives for above average O&M performance.	* Use the U.S. EPA's NPDES reporting system for identifying O&M or process problems, implementing control programs and setting priorities for construction grants.
* Need for clear definition of responsibility between consultant, owner, and regulatory agencies.	* Modify existing guidelines to clarify the responsibilities of the owner, contractor, consultant, and equipment suppliers.
* Need for sufficient supply of competent staff.	* Mandatory and meaningful certification of operators. * Hands-on training for operators.

TABLE 1 (CONTINUED). . .

Identified Issues	Recommended Solutions
* Need for plants that are flexible, reliable, easy to control and maintain.	* Increase awareness and understanding of design consultants to incorporate consideration of plant operations features.
	* Provide continuing eduction for design engineers through feedback of operator problems and experience.
	* Improve communication between operators and design engineers.
* Proper equipment selection and maintenance.	* Require specifications to ensure proper life cycles equipment selection, supply or spare parts.
	* Require pre-qualification of equipment.
	* Consider life cycle, quality, and price in equipment selection.
* Equipment manufacturers need to supply technically trained personnel in installation and plant operation.	* Consulting engineers should specify adequate technical services during installation and start-up of equipment.
* Need for in-plant monitoring systems.	* Provide adequate process data collection, monitoring devices, and laboratory facilities for process control and effluent monitoring.
	* Require certification and training of laboratory personnel.
	* Accelerate research and development of sensors that will record different plant operational parameters.

TABLE 1 (CONTINUED) . . .

Identified Issues	Recommended Solutions
* Need for more definitive support at the municipal administrative level.	* Plant owners should provide adequate O&M budgets and minimize political interference, consider performance incentives in agreements, and provide adequate, qualified, and trained personnel.
	* Provide awareness training to owners.
* Require greater interest and understanding on the part of elected officials and the general public in supporting O&M programs.	* Expand O&M public awareness programs at the Federal, State and local levels by promoting plant operation.
	* Invite elected officials from all levels to treatment plants.
	* Improve publicity on the cost-effective nature of good O&M programs.
	* Provide incentives for outstanding plant performance and penalties for poor performance.
	* Offer public O&M recognition awards.
* Need to significantly improve the public's image of the high skill requirements of treatment plant operators.	* Upgrade working conditions for operators (e.g., provide uniforms, safety equipment, etc.).
	* Improve operators' image through active public awareness programs.

Some of the key issues are as follows: availability and adequate supply of qualified plant personnel; improved operator training; proper selection, supply and operation of equipment; better communications among all disciplines; and improved awareness of the benefits of good O&M. Availability of technology did not surface as an issue although greater automation of treatment plant equipment and consideration of reduced cost phosphorus removal techniques were mentioned as possible aids in improving O&M. The consensus was that better application of available technologies is required.

Essentially, all of the major issues identified can be totaled to a need for more effective management of a complex system of independent decision points. Wastewater treatment plants are conceived as having all of the management functions: training, personnel, equipment, etc., of any complex manufacturing plant with some additional requirements superimposed by the social and economic impact of good O&M on the water quality of the Great Lakes.

The workshop first derived a series of specific solutions for each of the issues which had been identified. These were then synthesized into recommendations for municipal officials, consultants, operators, regulatory officials, equipment suppliers and manufacturers, and public interest groups.

It was not surprising that consulting engineers as a group were called upon by the participants to play a pivotal role in many phases of O&M, from the design stage, to equipment specification, to start-up and to on-site training. The participants also recommended that public interest and environmental groups play a primary role in fostering the image of wastewater treatment plant operation as a highly skilled and socially beneficial profession.

Municipal officials were advised to provide the necessary statutory incentives to promote good treatment plant operator training and certification, and to effectively regulate the discharge of industrial wastes into sewage treatment plants.

The Workshop recommended that the regulatory agencies at the State, Federal, and provincial levels act as focal points for the efforts of the various groups and to provide the funding and regulatory emphasis to promote effective O&M at the plants.

The Workshop also recommended that equipment manufacturers and suppliers ensure that the best equipment is designed and manufactured for the treatment plants through closer interrelationships with plant personnel and with regulatory agencies on matters of technical assistance and training. These recommended roles are outlined in greater detail in this report.

In an attempt to make our recommendations more readily applicable to improving O&M of sewage treatment plants, we have derived a series of management principles, based on the combined experience of the Workshop principles. Three key samples of the participants which we derived deal with the accomplishment of a programmatic approach to good O&M, the means for enlisting support of elected officials for these programs, and the good practices evolved from industry to ensure improved equipment performance at the wastewater treatment plants. These principles are as follows:

1. O&M at the treatment plant must be a delivered program that is supported by and has participation from all the different groups of professionals involved in the management system.

2. The interest and understanding of elected officials and the general public in improving O&M of municipal wastewater treatment plants is best enhanced through educational and public awareness programs and through incentives that instill a desire or need to emphasize the significance of O&M.

3. Equipment supply and performance can be significantly improved for municipal wastewater treatments plants if the suppliers and the users employ the same kind of design, training and service programs that are typical at other industrial plants.

These and other management principles are given in greater detail in Chapter 4 of this report.

The recommendations in this report are advisory. They represent the best opinions at the time of the meeting, of the people in the United States and Canada most concerned with all aspects of operating efficient wastewater treatment plants. The participants at the Workshop were acutely aware that not only does greater efficiency translate into lower costs, it also means an improved effluent quality from the treatment plants.

We have defined the major problems confronting good operation and maintenance of municipal wastewater treatment plants in the Great Lakes Basin. We have also presented the most considered recommendations, dictated by experience, for resolving these problems. As an aid in using these recommendations, we have attempted to make them equally applicable to both Ontario and the United States by presenting them as a set of recommended management principles or rules for achieving good O&M.

The participants, advisors, and steering committee for the Great Lakes O & M Workshop, join us in hoping that you will find our recommendations useful in achieving optimum operation and maintenance of municipal wastewater treatment plants in the Great Lakes Basin.

Respectfully

Max Hanok

Max Hanok

U.S. Co-Chairman
Joint U.S.-Canada Great Lakes
Workshop for Improving
O & M of Municipal Wastewater
Treatment Plants

Alex Redekopp

Alex Redekopp

Canada Co-Chairman
Joint U.S.-Canada Great Lakes
Workshop for Improving
O & M of Municipal Wastewater
Treatment Plants

Page Intentionally Blank

CHAPTER 1: BACKGROUND AND INTRODUCTION

Since 1971, the Federal, State and provincial governments in Canada and the United have spent over $4.5 billion in the construction of municipal wastewater treatment plants in the Great Lakes Basin. It is important that such expensive facilities be maintained and operated at their optimum design efficiences in order to produce the best possible effluent quality. Unfortunately, this is often not the case. Both the United States and Canadian governments have recognized that there are common problems and issues associated with the operation and maintenance of sewage treatment plants in the Great Lakes area which need to be addressed. For example, in its 1976 Research Needs Report[1], the Research Advisory Board of the International Joint Commission identified as "critical" the need to evaluate the performance of wastewater treatment facilities in the Great Lakes Basin.

A summary[2] of three annual surveys of United States municipal wastewater treatment facilities conducted by the U.S. EPA from 1973 - 1975 showed that about one-third of the Nation's publicly owned treatment plants were not meeting original design criteria for BOD removal, and about one-half failed to meet the criteria for total suspended solids removal. Problems with operations and maintenance (O&M) were the prime causes. For example, there were problems with infiltration and inflow, lack of O&M manuals, insufficient follow-up to correct operational problems, shortage of parts in inventory, lack of laboratory facilities, and hydraulic overloading. Specifically, the surveys showed that the ability to evaluate plant operational performance was often seriously affected by inadequate process data and/or inadequate laboratory programs. Plants that were performing efficiently generally had O&M manuals written specifically for them. There has been inadequate attention given to regular attendance of training programs by plant operators. The surveys concluded that the plant operator is the key to success and that technical assistance to the operators should be strengthened at the State level and in the private sector.

The provision of an adequate operating budget at the local level was also considered to be important to efficient and reliable plant operation. Results from the surveys suggested that a much greater level of effort should be placed on controlling and understanding the treatment process. There was also a need for instrumentation and automation for process monitoring and control.

A 1977 report[3] to the U.S. Congress by the General Accounting Office (GAO) was equally critical of the operation and maintenance of publicly owned sewage treatment plants in the country. Problems identified in the GAO investigation were quite similar to those revealed in U.S. EPA's own annual surveys. The office visited 28 plants in six States and noted that there were insufficient qualified plant operating personnel, inadequate budgets, inadequate controls over industrial wastes, inadequate laboratory controls, inadequate plant design and equipment, and infiltration/inflow problems. A 1978 analysis[4] of 140 treatment plants by U.S. equipment manufacturers also identified problem priorities. The 1977 GAO report noted that U.S. EPA was aware of these O&M problems and had identified corrective actions in many instances. However, the GAO was concerned that U.S. EPA's Regional Offices were too slow in effectively implementing the corrective actions.

In Canada, problems with O&M were identified in a 1974 survey[5] of 162 treatment plants in the Province of Ontario. This study was carried out under provisions of the Canada-Ontario Agreement on Great Lakes Water Quality. The survey showed that the major problem area was hydraulic overloading. It also identified a need for revised design considerations for grit removal facilities, heat exchanger capacities in sludge digesters and more flexible flow distribution between process units in large treatment plants. The Ontario survey showed that equipment performance, maintenance and reliability were satisfactory. However, there was a need for additional flow measuring devices at the treatment plants. There was a considerable

need for further operator education in plant testing procedures, interpretation and application of laboratory results, wastewater treatment processes, and safety and equipment repair. There was also considerable misunderstanding on the degree of process testing required and the minimum hours of supervision necessary for proper process control.

Formation of the Workshop

In recognition of the O&M problems and in keeping with the spirit of friendship and cooperation between Canada and the United States, the two countries decided in late 1977 to sponsor a Workshop to identify issues and solutions that are pertinent to sewage treatment plants in the Great Lakes Basin. This joint Workshop was carried out under the authority of a formal agreement between the Canadian Federal Minister of the Enviornment and the Administrator of the U.S. EPA which provides for the direct exchange of technical information between the two countries. The responsibility for planning and organizing the Workshop was delegated to the U.S. EPA, Region V, Great Lakes National Program Office, and the Review Board of the Canada-Ontario Agreement on Great Lakes Water Quality. A Steering Committee with members from both countries was formed to plan and manage the O&M Workshop.

The Great Lakes Workshop on Improving Operation and Maintenance of Municipal Wastewater Treatment Plants was held on March 15-17, 1978, in Itasca, Illinois, U.S.A. The Workshop Agenda appears in Appendix I. The members of the Steering Committee and technical advisors are listed in Appendix II and the participants observers and the staff in Appendix III.

Opening Remarks at the Workshop

Mr. George R. Alexander, Jr., Regional Administrator
U.S. EPA, Region V.

The following are excerpts from a speech made by Mr. George R. Alexander, Jr., at the Workshop:

"The purpose of this Workshop is to come up with ways of improving the operation and maintenance of municipal wastewater treatment plants.

Just as one of the major sources of automobile pollution is the failure to keep motor vehicles tuned, one of the major problems with the enormously expensive new sewage treatment plants we are building is our inability to keep then tuned and operating at peak efficiency. In the case of the automobile, we find that problems can be caused by poor operator training, which is true with sewage treatment plants as well. But . . . there are some real problems also arising from the instructions given by those who designed the plants, and there may even be some service design problems in the plans themselves. In other words, maybe they weren't built right to begin with. We need to look at this.

I want you to be expansive in thought. To develop strategies and recommendations on training; manpower; administration; process control; technology and technical support; public awareness, and legislation development.

We at the U.S. EPA are very committed towards ensuring that there will be well-run and efficiently-operated sewage treatment plants on the Great Lakes. We will, if necessary, take enforcement action against municipalities that run sloppy treatment operations. I think action taken previously to deal with municipal problems in Detroit and Milwaukee underscore our commitment. At the same time, we want to help those who need it to determine why the system is not performing as it was intended; not only to protect the taxpayers' investment, but also to protect the health and welfare of all the people in this Basin."

Mr. Max Hanok, U.S. Co-Chairman of the Workshop.

The following are remarks made by Mr. Hanok of the U.S. EPA, who was U.S. Co-chairman of the Workshop, on behalf of himself, the Canada Co-chairman, Mr. Alex Redikopp, and the Workshop Steering Committee.

> "You, the invited delegates to this Workshop, represent a prominent cross-section of all disciplines and interests involved in wastewater treatment in the Great Lakes Basin as well as from other parts of Canada and the United States. Included are consultants, municipal decision-makers, equipment manufacturers, regulatory officials, plant operators, environmentalists, research and development scientists, physical and management scientists, public sector representatives, training experts, and government officials.
>
> As we proceed through all of the deliberations in this Workshop, it is our opinion that we should ask ourselves a number of hard questions if we are to develop the most meaningful answers. Questions such as these should be asked:
>
> ° What is the quality of O&M that we are trying to achieve for the Great Lakes Basin?
>
> ° What is the impact of an improved O&M expected to be on the water quality of the Great Lakes? How long can we expect such an improved O&M to stay improved?
>
> ° What new and practicable approaches can we suggest for improving O&M while making it more cost-effective?
>
> ° What management principles of efficient O&M can we formulate from successful experiences that could form a basis for improving other less efficient wastewater treatment plants in the Great Lakes?"

Background Papers

The purpose of the Workshop was to develop strategies and recommendations necessary to improve operation and maintenance of municipal wastewater treatment plants in the Great Lakes Basin to a level mutually desired by both the United States and Canada. The proceedings of this Workshop are to provide valuable assistance to municipal, State, Federal and provincial agencies in improving their own O&M programs.

Over 60 persons, representing various disciplines and responsibilities were invited to participate at the Workshop. They included design engineers, equipment suppliers and manufacturers, plant operators and managers, municipal officials, administrators and officials from regulatory agencies, environmentalists and public interest groups. An official from the General Accounting Office also attended as an observer. The participants and advisors and observers and their affiliations are presented in the Appendix.

Six background papers were presented at the Workshop by speakers from the U.S. EPA, the Ontario Ministry of the Environment, consulting engineers, municipal officials and representatives from the public sector. Mr. Robert Fuller was the luncheon speaker at the Workshop. Some of the highlights are given below:

° Mr. Bob Hegg, consulting engineer, presented the results of a U.S. EPA research study[6] on the O&M factors limiting municipal wastewater treatment plant performance. The study ranked 70 different potential operations factors in order of severity and frequency of occurrence. The highest ranking cause of poor plant performance was "operator application of concepts and testing to process control." The second highest factor was "sewage treatment understanding." The study showed that plant personnel are an untapped resource for achieving improved plant performance. The third highest factor was improper technical guidance which the plant operator

received from "authoritative sources" such as design engineers, State and Federal regulatory personnel, plant O&M manuals, operator training programs, other plant operators, and equipment manufacturers.

Many of the present O&M problems were found to be process design oriented. These problems are: sludge wasting capability, process flexibility, process controllability, secondary clarifier, sludge treatment and aerator capability.

This EPA study showed that in order to improve O&M, existing training programs must provide operators with a basic level of sewage treatment understanding. Once that is achieved, an operator's skill will then be developed through proper technical guidance from qualified personnel. To ensure proper technical guidance and improved plant design, "authoritative sources" must also receive special training.

° Dr. Peter Seto of the Ontario Ministry of Enviornment presented a paper[7] on Ontario's experiences with O&M. The paper included an overview of Ontario's administrative procedures as they related to sewage treatment plants' operators, statistics on plant sizes, sludge production and disposal practices, phosphorus removal programs, educational profiles of operators, costs of O&M, and some specific O&M problems.

° The other background papers were presented by Mr. Richard Dougherty[8] of the Metropolitan Waste Control Commission of Minneapolis/St. Paul, Dr. Robert Zeller[9] of the U.S. EPA, Mr. Joseph Hanlon[10], consulting engineer and Mr. Robert Fuller,

Milwaukee River Restoration Council. The key points made by the speakers from their respective points of view were:

° Current U.S. Federal funding program for new plant construction should encourage local concern for improving O&M of existing plants;

° EPA's construction grant process should provide adequate emphasis on O&M;

° A one time grant to correct operational deficiencies at existing plants may be a viable solution;

° The U.S. National O&M Inspection Program should provide more efficient feedback to design engineers and plant owners;

° There should be more stringent enforcement against municipal discharge permit violators by U.S. EPA and the State agencies. This would give incentives to local decision makers to scrutinize operations more closely;

° U.S. EPA has started development of private sector O&M expertise through seminars, on-site technical assistance demonstrations, fiscal incentives, technical guidance documents and regular meetings with national associations of public and private sectors;

° There should be extensive public awareness programs to encourage municipalities to accept ownership responsibilities.

Other comments were of a more general nature:

° A major contributing factor to poor plant performance is the design engineer's failure to select the proper equipment that will perform satisfactorily for long periods of time.

° Discussions with the chief plant operator at the early plant design stage as to space requirements, and accessibility of equipment for maintenance are very important.

° There is widespread apathy and lack of understanding about O&M among local elected and appointed officials. Many communities, particularly the smaller ones, are also faced with real fiscal and institutional constraints.

° There is an adequate appreciation and understanding of the importance of process controls in sewage treatment plants at the operator level.

° New plants are needed which depend less on the number and skills of operators.

° Municipalities need to recognize that well paid and well trained treatment plant personnel can be very cost effective.

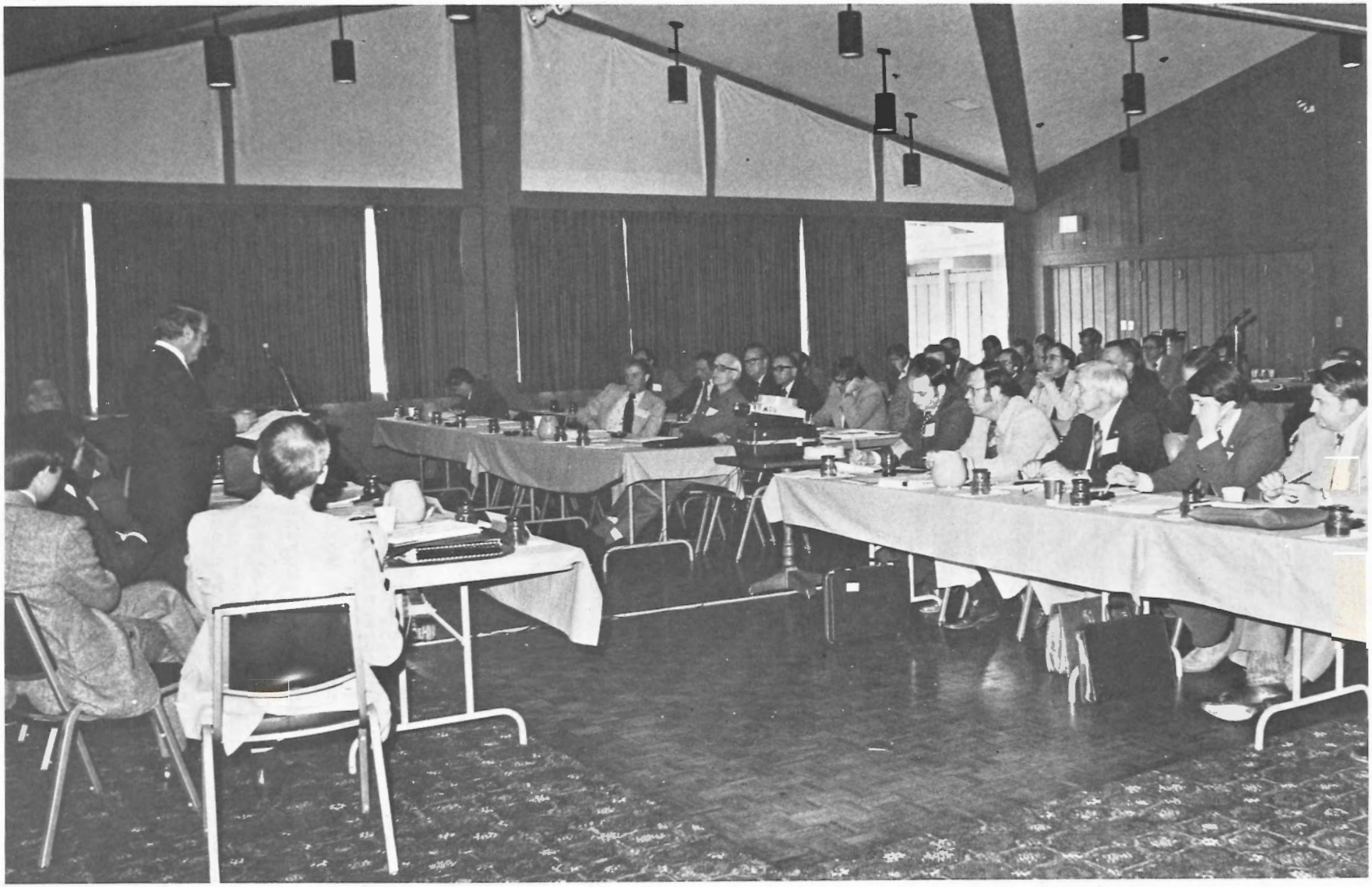
° Each community needs an O&M plan or a Plan of Operation.

° One of the persistent O&M issues is the need for professional development, training and certification of plant operators. Adequate funds are generally not available for professional development.

The background papers presented at the Workshop showed that there are certain basic O&M issues common to both Canada and the United States in the Great Lakes Basin.

There appeared to be a wider range of O&M problems in the United States. This is due mainly to the administrative complexity in the United States and the fact that there are a greater number of State and local governments involved in plant operation than in Ontario. Although Canada and the United States share the Great Lakes, there are differences in constitutional and administrative arrangements between the two countries.

The Province of Ontario expanded its municipal wastewater treatment plant construction program in the 1950's and experienced many of the problems identified at the O&M Workshop. A partial solution to these problems was the establishment by the province of a bid depository and a policy of preselecting major mechanical equipment. The province did experience a similar critical shortage of trained staff at all levels. This problem was lessened considerably by returning new staff to the universities for postgraduate training in sanitary engineering and instituting an operator training program.



Joseph Hanlon, a consulting engineer, addresses the Workshop Participants on Process Design and Equipment Selection and Performance.

CHAPTER 2: GROUP DELIBERATIONS BY THE WORKSHOP PARTICIPANTS

After the presentation of the background papers, the attendees were divided into six homogeneous discussion panels on the basis of their specialties and job responsibilities. The six homogeneous panels were:

1) operators and plant superintendents
2) consulting engineers
3) municipal decision makers
4) regulatory officials
5) equipment manufacturers and suppliers
6) public interest group representatives

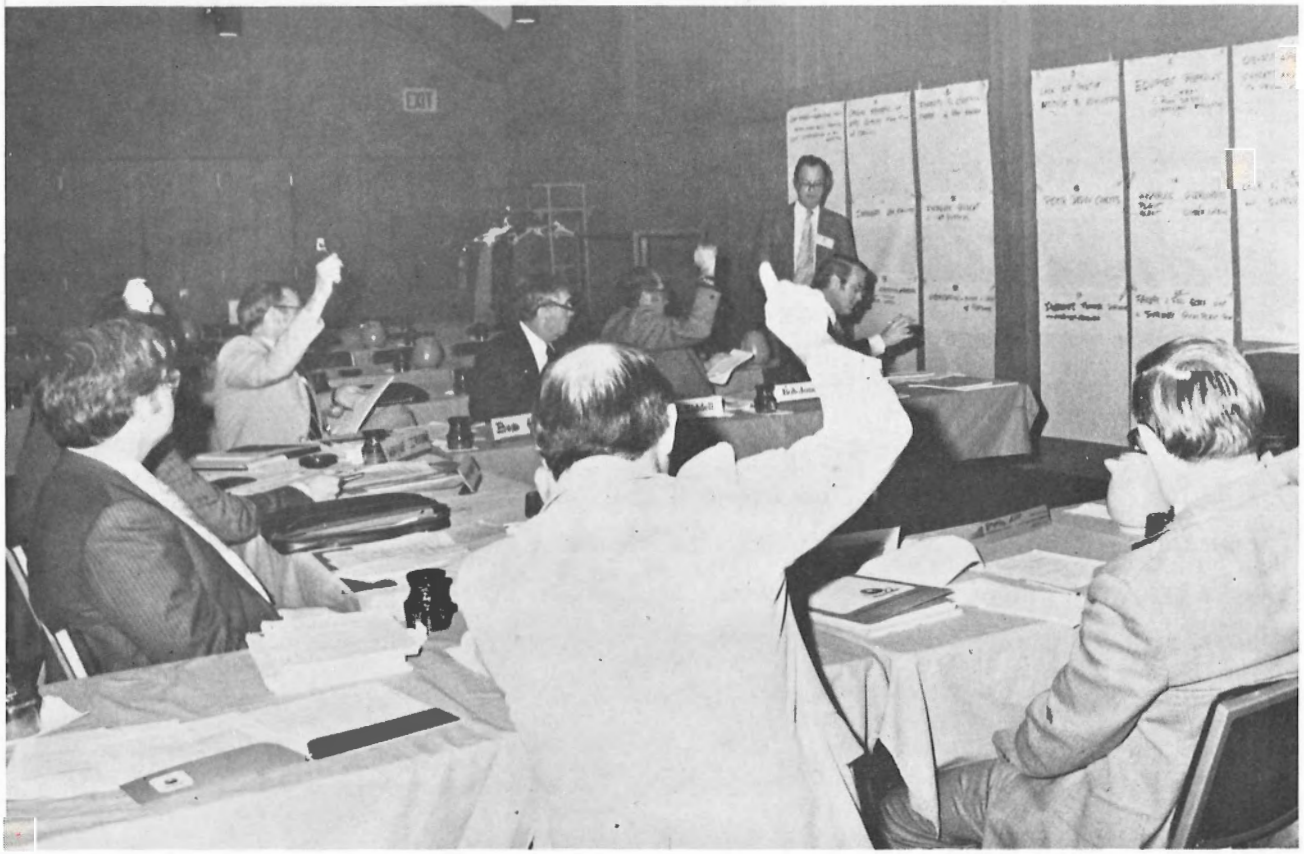
Each of these panels discussed the significant O&M issues and possible solutions from its own point of view. For example, the panel of consulting engineers discussed the various O&M problems and solutions as perceived by their own profession and experiences.

After the homogeneous panel discussions, the attendees were reorganized into five heterogeneous groups, each with a cross-section of different disciplines and job responsibilities. The O&M problems and possible solutions as developed by the homogeneous groups were then critically reviewed by the heterogeneous panels in terms of significance, priorities, solutions and recommended strategies for action.

The Great Lakes O&M Issues for Sewage Treatment Plants

The Workshop participants in group discussions identified a series of major O&M issues or problem areas encountered in municipal wastewater treatment plants in the Great Lakes Basin which require immediate attention. These problem areas are all related to the many different groups of people whose work is connected with wastewater treatment plants. These groups include plant superintendents and operators; consultants; municipal, State, provincial and Federal decision-makers; regulatory officials; equipment manufacturers and suppliers; public interest groups; and environmental research and management scientists.

Andy Ungar guides a group of decision makers toward arriving at O&M issues and solutions.



Consultants, directed by Sid Dutton, arrive at O&M issues.

Jerry Rupke directs a heterogeneous group to the definition of broader O&M issues and solutions.

The Workshop, in identifying the major O&M issies of immediate concern and their potential solutions, focused on the following problems. The O&M of municipal wastewater treatment plants in the Great Lakes Basin would be significantly improved if these problems were resolved:

1) Adequacy, Qualifications and Image of Plant Personnel

There is a need to provide adequate operator and plant management training. The public, plant owners, decision-makers, and operators must recognize that treatment plants require highly skilled and technically competent staff. The Workshop consensus was that there is an insufficient supply of competent management and staff to improve O&M. All interest groups can help to resolve this problem.

2) Improving the Administrative and Management System

There is currently no clear definition of roles and responsibilities for consultants, owners and government authorities.

3) Facility Design Flexibility

Many treatment plants are not adequately designed to allow for process flexibility, control, maintenance, safety and reliability. Faulty design is an expensive problem to correct once a plant has been constructed. Responsibilities for improved facility design and flexibility rest with the consultant who must work closely with all other groups.

4) Support of Adequate O&M Budgets at the Municipal, Administrative, Local, and Public Levels

A major need exists to develop support for adequate O&M budgets at the local levels and among the public. Plant performance frequently suffers due to inadequate or unbudgeted funds, such as in phosphorus removal.

5) Uncontrolled Discharge of Industrial Waste

Indiscriminate discharges of industrial wastes into treatment plants often cause serious O&M problems. Hydraulic overloading and variable discharges of non-conventional pollutants into the sewers are also contributing factors. Among the solutions recommended by the Workshop participants are better characterization of wastewater, design for pollutant surges and enforcement at sources. Industrial waste surveys should be prerequisite to the approval of facility design and prior arrangements be made between industrial dischargers and owners of wastewater treatment plants for treatability studies for new industrial wastes of unknown quality.

6) Improving Equipment Reliability

Inadequacies in equipment selection and the lack of trained personnel for installation are major O&M problems. There should be appropriate equipment specifications, over their life cycle, maintenance training by the equipment suppliers and an established maintenance program for plants. The equipment suppliers at the workshop recommended improved equipment quality control and consultant/owner approval of supplies after bids. A management mechanism is needed for owner/operator, consultants and equipment suppliers to improve procurement regulations and co-ordinate plant start-up. Regulatory officials should institute and co-ordinate the new methods.

7) Establishment of O&M Management Programs

Specific O&M programs for equipment are essential to effective plant operation. Certification of laboratory personnel and delegation of responsibility for proper, regular and preventative maintenance programs at the municipal levels are essential. It was also recommended that agencies such as EPA consider one-time O&M grants, and scrutinize O&M programs under existing permit systems.

8) O&M Experience in Setting EPA's Policies

EPA should utilize as much as possible appropriate technical expertise and experience when preparing guidelines for O&M. There should be more effective input of external expertise to EPA.

9) Improving the Utility of the NPDES Reporting System

Current EPA NPDES reporting system does not appear to encourage above average O&M performance and does not require reporting of non-conventional pollutants. The permit system should be developed to its full potential so that O&M problems can be readily identified.

10) Technological Developments and Applications

The Workshop took the position that available technologies for wastewater treatment did not present an obstacle to improvement of O&M. As a result, only one direct issue on phosphorus removal technology surfaced. However, the participants did explore interest in the automation of wastewater treatment plants as a possible aid in improving O&M. In addition, adequacy of technology as a factor was intimately associated with other issues such as training.

CHAPTER 3: A PLAN FOR ACTION

Many studies on the problems of operation and maintenance at sewage treatment plants have been carried out by pollution control agencies and other government institutions. Most of these studies reviewed the technical aspect of O&M and recommended specific remedial actions.

While it is true that the Great Lakes Workshop on O&M had confirmed what had been known for some time in the profession, it was unique in that it brought together for the first time all the different disciplines and groups in our society that are responsible for or have influence over the operation of wastewater treatment plants in the Great Lakes region. What sets the Great Lakes Workshop apart from the others is that it did not address the O&M issues from the point-of-view of one single group. The deliberations from the Workshop made it quite clear that resolution of all the well-known O&M problems requires action from many groups and professional disciplines. There is no one single action plan that can be implemented by any one group to solve all the problems. Actions are required from all levels of regulatory agencies, elected officials, design engineers, equipment manufacturers and supplies, municipal associations, and public-interest groups. Each group has a role to play. The Workshop synthesized a role for each discipline in the over-all complex management system which makes municipal wastewater treatment plants run effectively.

Municipal Officials

Most sewage treatment facilities in the Great Lakes Basin are owned and operated by municipalities. Elected officials at this local government level are directly responsible for the quality of effluent from their treatment plants. Several specific recommendations were made at the Workshop.

Municipal officials should require treatment plant operators to attend regular training sessions at regulatory agencies and local educational institutions in developing good operator training programs. Regulatory agencies should be urged to implement mandatory certification programs for treatment plant operators. Municipal officials can publicize the benefits of good O&M at treatment plants by informing their own citizens that effective O&M programs can save money in the long term. They can also offer operator incentives towards better O&M through recognition and monetary awards. Furthermore, the working conditions for treatment plant operators should be upgraded in recognition of their important work. This will help to improve the operator's public image and thus attract more competent people into the profession. Municipal officials should also enact and rigorously enforce municipal bylaws governing the discharge of industrial wastes into municipal treatment plants. Finally, municipalities should require consultants to develop O&M manuals and purchase equipment based on reliability, in addition to price.

Regulatory Agencies

This group includes regulatory agencies at the State, Federal and provincial levels. As enforcers of environmental control laws and financial sources for many publicly owned sewage treatment plants, regulatory agencies can help to improve O&M in many ways.

They can require municipalities to have O&M manuals for each of their treatment plants. This will necessitate close working relationships with equipment manufacturers, suppliers and consulting engineers. Adequate financial and technical support should be provided to the municipalities. The regulatory agencies should promote the benefits of good O&M with State, Federal, and provincial legislative bodies. Such action can result in continuous and increased funding support from elected officials.

The agencies should also establish a sewer charge system for industrial wastes where necessary to minimize overloading. They can

provide leadership to develop effective operational training programs by working with educational institutions, professional associations such as the Water Pollution Control Federation, design engineers and municipal governments. This may lead to compulsory certification of operators. Hiring of certified and trained laboratory personnel should also be encouraged.

The agencies must work with equipment manufacturers to ensure selection of proper equipment. This may take the form of prequalification of plant equipment. They should promote accelerated research and development programs to improve monitoring and automated control devices for treatment plants possibly through additional research and development funds. The agencies should also provide O&M improvement grants on a one-time basis.

The U.S. EPA should consider the following recommendations from the Workshop:

- Utilize more external technical input in the development of O&M policies and practices.

- Ensure that technical personnel in key decision-making positions have significant O&M experience.

- Use the NPDES compliance data as a basis for establishing incentives to plant owners and oeprators.

- Use the NPDES reporting system to identify O&M problems, implement control programs and set priorities for construction grants.

Equipment Manufacturers and Suppliers

The equipment manufacturers and suppliers must ensure that the best equipment is designed and manufactured for the plant. Engineers with O&M experience should be supervising equipment installations.

The suppliers should also provide training and technical assistance to plant personnel on their equipment. Several specific recommendations were suggested. There should be opportunities for equipment manufacturers and suppliers to gain first hand plant operation experience. This will enable the suppliers to provide well-trained personnel for plant start-ups and operator training. The manufacturers and suppliers should work with consultants, regulatory agencies and municipal officials to improve equipment specifications, procurement procedures, and equipment reliability.

Consultants

Consulting egineers have the on-site responsibility for planning O&M training. They should always be aware of the actual requirements for operations and maintenance resulting from their designs. They should work closely with the operating authority during all stages of the project. The operators should be encouraged to relate areas of good design features back to the consulting engineers. The consultants should encourage their clients to provide the necessary funds for O&M manuals. Technical and operational guidance from the consultants is essential after the construction start-up period. The design engineers can assist by suggesting to universities specific areas of an O&M awareness in treatment plant design. The consultants should ensure that all equipment faults and any differences between design data and operating results are brought to the attention of the manufacturers.

Public Interest Groups

The primary role of the public sector as represented by organizations such as the Water Pollution Control Federation, the League of Women Voters, Association of Cities and Towns, etc., is to engage in more active support of wastewater treatment as a significant profession. Specifically, the public interest groups should arrange trips to wastewater treatment plants to improve the awareness of citizens and their own members on the

importance of O&M. They can also publish information pamphlets on treatment plants for distribution to other citizens groups and assist regulatory agencies and municipal officials in obtaining support from legislative bodies for O&M funds. Provision of recognition certificates for noteworthy O&M and treatment plant performance can also serve to increase public awareness of the significance of the profession. Finally, public interest groups should promote proper O&M as a cost-effective management practice.

Plant Operators

The operators of municipal wastewater treatment plants are the most important group. They have the on-site responsibility for effective O&M. It is very important for experienced operators to have a voice in the selection of plant equipment. They must maintain working relationships with their consulting engineers and equipment suppliers. These operators can also advise municipal officials of new O&M initiatives and must establish a preventative maintenance program as a prerequisite for good O&M.

CHAPTER 4: PRINCIPLES FOR ACHIEVING EFFECTIVE OPERATION AND MAINTENANCE

The design, operation and maintenance of a wastewater treatment plant can be adversely affected by many problems that have been identified in the foregoing chapters. These difficulties can be resolved through the diligent efforts of the many different groups of professionals who are both directly and indirectly involved with the management system associated with treatment plants. These groups include consultants, equipment manufacturers and suppliers, elected officials, regulatory officials, public interest groups, plant managers and operators, and environmentalists.

This chapter contains a list of principles that should be recognized if effective O&M is to be achieved.

1. A municipal wastewater plant is similar to any manufacturing plant. It too has a product to sell, namely, clean water. Therefore, it it should be designed and operated in like fashion.

2. Equipment supply and performance will be significantly improved for municipal wastewater treatment plants if the suppliers and the users will involve the same kinds of design, training, and technical service programs that are in effect for other industrial plants.

3. The interest and understanding of elected officials and the general public in improving O&M of municipal wastewater treatment plants can best be enhanced through educational and public awareness programs and through incentives that instill a desire or need to emphasize the signifncance of O&M.

4. Certification of managers and operators is necessary to ensure high quality staffing at the treatment plants.

5. Review of the design of wastewater treatment plants at the initial stages with consultants and operating personnel is the most effective means of assuring optimum O&M design.

6. Public support is a necessary prerequisite to proper performance of treatment plants.

7. The construction grants and NPDES programs of the U.S. EPA can be made more effective in encouraging safe, reliable and efficient plant operation by shifting more emphasis on O&M priority.

8. An O&M program should be developed at the planning stage with all professional groups participating fully.

9. All O&M programs developed by regulatory agencies should be designed by professionals with practical O&M experience.

10. An important difference between the O&M of municipal wastewater treatment plants in the Great Lakes Basin and those associated with other bodies of water is their long-range impact on the water quality of the Great Lakes system.

The Workshop recommended these principles as rules for good O&M management together with the roles and other specific recommendations. These principles and recommendations should be used as a guide to <u>action</u> in improving O&M at wastewater treatment plants in the Great Lakes Basin.

BIBLIOGRAPHY

1. Research Advisory Board of the International Joint Commission. "Great Lakes Water Quality Research Needs 1976." July 1976

2. Gilbert, W.G., "Relation of Operation and Maintenance to Treatment Plant Efficiency." Journal of Water Pollution Control Federation, 48, 1922 (1976).

3. Comptroller General of the United States. "Report to the Congress-Continuing Need for Improved Operation and Maintenance of Municipal Waste Treatment Plants." April 11, 1977.

4. Olt, R.D. et al, Plant Operating Priorities. Paper presented at the WPCF meeting, Anaheim, California, October 1978. Available from Water and Wastewater Equipment Manufacturers Association, McLean, Virginia.

5. Azan, K.M. and Boyko, B.I., "Identification of Problem Areas in Water Pollution Control Plants." Canada-Ontario Agreement Research Report. No. 15. 1973.

6. Hegg, B.A., et al., "Evaluation of Operation and Maintenance Factors Limiting Municipal Wastewater Treatment Plant Performance." U.S. EPA (Contract #68 - 03 - 2224). In press.

7. Seto, P. and Van Fleet, G.L., "Experiences with O&M at STP's in Ontario." Paper presented to the Joint U.S.-Canada Workshop on O&M of Municipal Wastewater Treatment Plants in the Great Lakes Basin, Itasca, Illinois. March 15, 1978.

8. Dougherty, R.J. "Management of Wastewater Treatment Systems for Compliance on Environmental Benefits." Paper presented at the Joint U.S.-Canada Workshop. March 15, 1978.

9. Zeller, R., "Manpower Training and Plant Administration - A Government View." Paper presented at the Joint U.S.-Canada Workshop. March 15, 1978.

10. Hanlon, J., "Process Design and Equipment Selection and Performance." Paper presented at the Joint U.S.-Canada Workshop. March 15, 1978.

11. Fuller, R., "The Taxpayer's Stake." Luncheon address to the O&M Workshop, March 15, 1978.

THE WORKSHOP

The United States Environmental Protection Agency and the Review Board of the Canada/Ontario Agreement on Great Lakes Water Quality are jointly sponsoring this **Workshop on Operation and Maintenance (O&M) of Municipal Wastewater Treatment Plants in the Great Lakes Basin** in order to discuss the complexity and diversity of common problems and issues and to facilitate long-range solutions.

FORMAT: Participants will hear a series of short introductory presentations designed to give a broad overview of the current status of operation and maintenance of plants and the main issues dealing with them. This will be followed by task group and panel discussions, climaxing in several plenary sessions.

PURPOSE OF THE WORKSHOP: The purpose of the Workshop is to develop the strategy and recommendations necessary to improve operation and maintenance of municipal wastewater treatment plants in the Great Lakes Basin to a level mutually desirable by both the United States and Canada.

WHO IS ATTENDING? Attendance at the Workshop is by invitation only. An intense effort is being made to bring together persons from the many diverse areas which influense a plant's O & M proceedings. Persons participating will represent operators and plant superintendents, consulting engineers, municipal decision makers, equipment manufacturers and suppliers, regulatory officials, public interest groups, and environmental research and management scientists.

BACKGROUND INFORMATION: In March 1976, the Minister of Fisheries & Environment Canada, and the Administrator of the U.S. Environmental Protection Agency, under the sponsorship of the U.S. Department of State, and the Canadian Department of External Affairs, entered into a broad agreement providing for direct exchange of technical information between the two Governments. With the consumation of that agreement, it seemed to be more appropriate and in keeping with the responsibilities of the two Governments, to sponsor the workshop as a joint undertaking. Participation and input to the workshop was to be from a broad cross-section of interests involved in municipal waste treatment facility operation.

AGENDA

MARCH 14, 1978

8:00 pm	Registration: Main Lobby

MARCH 15

8:30 am	Registration
9:00 am	Opening Remarks and Welcome: GEORGE R. ALEXANDER, JR., Regional Administrator, Region V, U.S.E.P.A.
—	Workshop Directions and Charge: MAX HANOK, Workshop U.S. Co-Chairman, Region V, U.S.E.P.A.
—	Evaluation of O & M Factors Limiting Performance: ROBERT HEGG, M & I Consulting Engineers.
—	Experiences with O & M at STP's in Ontario: GORDON VAN FLEET, Ontario Ministry of the Environment.
	Coffee Break
—	Management of Wastewater Facilities for Compliance or Environmental Benefits: RICHARD DAUGHERTY, Metropolitan Waste Control Commission of Minneapolis/St. Paul.
—	Process Design and Equipment Selection and Performance: JOE HANLON, Camp, Dresser & McKee.
—	Manpower Training and Plant Administration—A Government View: ROBERT ZELLER, Water Program Operations, U.S.E.P.A.
Noon	Luncheon Guest Speaker: ROBERT FULLER, Milwaukee River Restoration Council, speaking on • The Taxpayers' Stake. •
2:00 pm	Homogeneous Groups Discussion Sessions: Six working panels in concurrent session establish O & M issues, significance, priorities and solutions. • Operators and Plant Superintendents • Consulting Engineers • Municipal Decision Makers • Regulatory Officials • Equipment Manufacturers and Suppliers • Public Interest Representatives
7:00 pm	Dinner
8:30 - 9:00 pm	Homogeneous Groups Session; Each panel completes preparation of reports. Deliver to U.S. and Canada Workshop Co-Chairmen.
9:00 pm	Steering Committee Review and Decision Meeting

AGENDA

MARCH 16

8:30 am	Plenary Session—MAX HANOK presiding. Overview of homogeneous groups' findings. Assignment of panelists to heterogeneous groups.
9:00 am - 12:30 pm	Heterogeneous Groups Discussion Sessions. Four working panels in concurrent session deliberate on homogeneous groups' opinions. Finalize O & M issues, significance, priorities, solutions, and recommended strategies for action. Indicate desired uses of workshop product. Members of each heterogeneous panel representing a cross-section of all O & M disciplines.
12:30 - 2:00 pm	Lunch
2:00 - 5:30 pm	Heterogeneous Groups Complete Deliberations.
5:30 pm	Work Adjourns for the Day.
6:30 pm	Dinner
8:00 pm	Steering Committee and Advisors Meeting: Review Workshop Status and Recommendations.

MARCH 17

9:00 am	Plenary Session: Workshop Issues/Solutions Recap, MAX HANOK.
9:30 - 11:30 am	Plenary Session: JOHN CONVERY, U.S.E.P.A., Presiding, with PAUL FOLEY, Ontario Ministry of the Environment. • Representatives of each of the heterogeneous working panels present their respective panel's position. • Final discussion of Workshop findings by all participants.
11:30 am	Plenary Session: Closing Statements and Subsequent Actions - MAX HANOK, U.S.E.P.A. and ALEX REDEKOPP, Environmental Protection Service, Canada, Presiding. • Major Uses for Workshop Output. • Directions to the Workshop Report Development Committee and Steering Committee.
Noon	Workshop Adjournment
2:00 - 4:00 pm	Analysis and Decision Meeting. Workshop Report Development Committee and Steering Committee: ALEX REDEKOPP and MAX HANOK, Co-Chairmen.

APPENDIX II: MEMBERSHIP OF THE STEERING COMMITEEE AND ADVISORS: GREAT LAKES O&M WORKSHOP

STEERING COMMITTEE

CANADA

Canada Co-Chairman. ALEX REDEKOPP
Environment Canada, Ottawa

PAUL FOLEY
Ontario Ministry of the Environment, Toronto

J.W.C. RUPKE
Regional Municipality of York

S. DUTTON
Proctor & Redfern Ltd., Toronto

STEVE BLACK
Ontario Ministry of the Environment

UNITED STATES

U.S. Co-Chairman. MAX HANOK
Region V, U.S. EPA, Chicago

JOHN CONVERY
U.S. EPA, Cincinnati

ANDREW T. UNGAR
Cleveland Regional Sewer District, Cleveland

ROBERT FULLER
Milwaukee River Restoration Council, Milwaukee

EUGENE CHAIKEN
Region V, U.S. EPA, Chicago

ADVISORS

MRS. LEE BOTTS
Region V, U.S. EPA, Chicago

THOMAS HARRISON and ALVIN LIEBLING
Region V, U.S. EPA, Chicago

CLARENCE LASKOWSKI
Region V, U.S. EPA, Chicago

N.W. SCHMIDTKE
Environment Canada, Ottawa

JOSEPH TYNSKY
Region V, U.S. EPA, Chicago

APPENDIX III: WORKSHOP PARTICIPATION

PARTICIPANTS

George R. Alexander, Jr.
Regional Administrator
U.S. EPA, Region V
Chicago, USA

Earl Baldock
Dept. of Works
Municipality of Metro Toronto
Toronto, Ontario

Ernie Bennett
Certification & Training
Illinois EPA
Springfield, IL, USA

Steve Black
Pollution Control
Ontario Ministry of the Environment
Toronto, Canada

Paul Blakeslee
Water Quality
Michigan Dept. of Natural Resources
Lansing, MI, USA

James Brooker
Environmental Sales
Door-Oliver-Long Limited
Orillia, Ontario, Canada

James Bryant
Environmental Resources Training Center
Southern Illinois University
Edwardsville, IL, USA

Eugene Chaiken
Construction Grants
Region V, U.S. EPA
Chicago, IL, USA

John Convery
Wastewater R&D
U.S. EPA
Cincinnati, OH, USA

Guy Cnoop-Koopmans
James F. MacLaren Limited
Consulting Engineers
London, Ontario, Canada

Bill Cross
City of Peterborough
Peterborough, Ontario, Canada

Art Doran
Asdor Limited, Consultants
Downsview, Ontario, Canada

Richard Dougherty
Metropolitan Waste Control Commission
St. Paul, MN, USA

Sid Dutton
Proctor & Redfern Ltd.
Consulting Engineers
Toronto, Ontario, Canada

Lawrence A. Ernest
Jones Island Plant
Milwaukee Sewerage Commission
Milwaukee, WI, USA

Paul Foley
Research Coordinator
Ontario Ministry of the Environment
Toronto, Ontario, Canada

Bob Forhan
Town of Newmarket
Newmarket, Ontario, Canada

Robert Fuller
Milwaukee River Restoration Council, Inc.
Grafton, WI, USA

PARTICIPANTS

Walt Gilbert
National Training Center
U.S. EPA
Cincinnati, OH, USA

Joseph Hanlon
Camp Dresser & McKee
Consulting Engineers
Boston, MA, USA

Max Hanok
Great Lakes Office
Region V, U.S. EPA
Chicago, IL, USA

Blair Hansler
Utility Operation
Ontario Ministry of the Environment
Stoney Creek, Ontario, Canada

Thomas Harrison
Regional Counsel
Region V, U.S. EPA
Chicago, IL, USA

Bob Allen Hegg
M & I Consulting Engineers
Ft. Collins, CO, USA

William Hill
Floyd Browne & Associates
Consulting Engineers
Marion, OH, USA

Bob Jones
Donohue & Associates, Inc.
Sheboygan, WI, USA

William Konrad
Marketing Development
Envirex, Inc.
Waukesha, WI, USA

Earl W. Knight
Engineering
Metro Sanitary Dist. of Chicago
Chicago, IL, USA

Tom Komline
Komline-Sanderson Engineering Corp.
Peapack, NJ, USA

Robert M. Krill
Water Supply & Pollution Control
Wisconsin Dept. of Natural Resources
Madison, WI, USA

Clarence Laskowski
Construction Grants
Region V, U.S. EPA
Chicago, IL, USA

Peter Laughton
R. V. Anderson & Assoc. Ltd.
Willowdale, Ontario, Canada

Walter Mardis
Planning & Evaluation
U.S. EPA
Washington, DC, USA

Joel Margolis
Manpower Development
Region V, U.S. EPA
Chicago, IL, USA

Andy Matwichuk
Training and Certification - Pollution Control
Ministry of the Environment
Toronto, Ontario, Canada

Dr. Ross McKinney
University of Kansas
Dept. of Civil Engineering
Lawrence, KS, USA

Doug McTavish
Ontario Ministry of the Environment
London, Ontario, Canada

PARTICIPANTS

J.E. Meers
J.E. Meers & Associates
Chicago Heights, IL, USA

Jim Mshar
Williams and Works
Consulting Engineers
Grand Rapids, MI, USA

Bob Olt
Union Carbide Corp.
Engineering Dept.
Tonawanda, NY, USA

Dale Patrick
Operations
Cleveland Regional Sewer District
Cleveland, OH, USA

Alex Redekopp
Technology Transfer & Training
Environment Canada
Ottawa, Canada

Terry M. Regan
T.M. Regan, Inc.
Lexington, KY, USA

Ken Richards
Consoer, Townsend & Assoc.
Chicago, IL, USA

M.D.R. Riddell
Greeley and Hansen
Chicago, IL, USA

Louise Rome
League of Women Voters of Ill.
River Forest, IL, USA

Jerry Rupke
Engineering Department
Regional Municipality of York
Newmarket, Ontario, Canada

Carl M. Schwing
Municipal Utilities Department
City of Galveston
Gavelston, TX, USA

Dr. Peter Seto
Ontario Ministry of the Environment
Toronto, Ontario, Canada

Kim Shikaze
Environment Canada
Toronto, Ontario, Canada

Carol Small
Indiana Assn. of Cities & Towns
Indianapolis, IN, USA

John Smith
Wastewater R&D
U.S. EPA
Cincinnati, OH, USA

James H. Suddreth
Water Pollution Control Federation
Washington, DC, USA

Mike Thorne
South Peel Area System
Mississauga, Ontario, Canada

Joe Tynsky
Great Lakes National Program Ofc.
Region V, U.S. EPA
Chicago, IL, USA

Andy Unger
Cleveland Regional Sewer District
Cleveland, OH, USA

Kit Woods
Comm. of Works
City of Windsor
Windsor, Ontario, Canada

PARTICIPANTS

William Wankoff
Philsdelphia Water Department
Philadelphia, PA, USA

Chester A. Warner
Precision Scientific Company
River Forest, IL, USA

Dr. Robert Zeller
Municipal Operations & Training
U.S. EPA
Washington, DC, USA

OBSERVERS

Carlton Edmonson
U.S. General Accounting Office
Washington, DC, USA

Wayne Irlan, President
M & I Consulting Engineers
Ft. Collins, CO, USA

Raymond Kadukis, President
Cleveland Regional Sewer District
Cleveland, OH, USA

CONSULTANTS AND STAFF

Dr. John Masterson, Consultant
Dept. of Communications
DePaul University
Chicago, IL, USA

Jan Pickett, Consultant
The E Company
Chicago, IL, USA

John Squires
The E Company
Chicago, IL, USA

Cindy Tirrell
Catalyst Marketing Team
Villa Park, IL, USA

Marti Velasco
Public Affairs Office
Region V, U.S. EPA
Chicago, IL, USA

GPO 825-354

United States
Environmental Protection
Agency

Region V
230 South Dearborn Street
Chicago, Illinois 60604

Official Business
Penalty for Private Use
$300

Postage and
Fees Paid
Environmental
Protection
Agency
EPA 335

prepared by USEPA Region V Graphic Arts Section.