



# **Operation, Maintenance and Management of Wastewater Treatment Facilities**

## **A Bibliography of Technical Documents**





OPERATION, MAINTENANCE  
AND MANAGEMENT OF  
WASTEWATER TREATMENT  
FACILITIES

A Bibliography of Technical  
Documents

by

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Municipal Operations Branch  
Office of Water Program Operations  
U.S. Environmental Protection Agency  
Washington, D.C. 20460

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Chicago, Illinois 60604

ENVIRONMENTAL AGENCY

## F O R E W O R D

The Municipal Operations Branch, under the direction of Mr. Lehn J. Potter, develops program strategies and related guidance documents on municipal wastewater treatment facilities in cooperation with the Environmental Protection Agency's ten Regions and the 50 States. A prime objective of the Branch is to assure adequate consideration of operation and maintenance characteristics in the planning, design and construction of new plants. The Branch is also responsible for action plans to assist States and municipalities in identifying and correcting wastewater treatment plant operational problems. Effective performance of these functions depends on a strong coordinated program involving Federal, State and local agencies, combined with the professional expertise of the consulting engineering communities.



## A B S T R A C T

Efficient operations and maintenance saves money! Since 1956, nearly \$20 billion has been spent through EPA's Construction Grants Program to build new wastewater treatment facilities or to upgrade existing plants. If a plant fails to do the job it's supposed to, or deteriorates, these tax monies are wasted. There is conclusive evidence that one-third to one-half of existing plants are not operating effectively and efficiently.

Under the sponsorship of the Municipal Operations Branch, the Operation, Maintenance, and Management manuals described on the following pages, were prepared by operations specialists with years of in-plant experience. The manuals were developed in cooperation with EPA regional technical staff, as well as State and local governmental personnel. This Bibliography presents a summary description of the data included in the manuals. It will be noted that a broad spectrum of key information is covered, ranging from descriptions of process components and guidelines for plant start-up, to troubleshooting, preventive maintenance and laboratory testing procedures. Aerobic and Anaerobic Sludge Digestion are addressed, and include case histories of operational experiences and problem-solving techniques. The materials are designed to assist the operators, plant owners, consulting engineers and educators.

Copies of the manuals may be obtained by writing direct to the U.S. Government Printing Office or the National Technical Information Service. Appropriate data for direct orders are included as Appendices I and V respectively.

Questions relating to any of these documents should be directed to the appropriate EPA Regional Office. A listing of these mailing addresses is shown on the inside back cover of this Bibliography. Inquiries may also be submitted to the Municipal Operations Branch (WH-596), Office of Water Program Operations, United States Environmental Protection Agency, 401 "M" Street, S.W., Washington, D.C. 20460.





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A PLANNED MAINTENANCE MANAGEMENT SYSTEM  
FOR MUNICIPAL WASTEWATER TREATMENT PLANTS

This information was developed and successfully demonstrated as a Planned Maintenance Management System (PMMS) at the 18-mgd Lower Potomac Wastewater Treatment Plant of Fairfax County, Virginia. It outlines a model maintenance management program for wastewater treatment plants throughout the United States.

Specifics of maintenance needs on each item of plant equipment are provided and instructions on the maintenance of complex equipment are reduced to simple procedures. For each procedure, the system includes details of the methods, materials, tools and personnel required; schedules the task, and provides for data recording and feedback.

During the 12-month demonstration of the PMMS, a steady downward trend was noted in the frequency of malfunctions in various mechanical equipment. In many cases, the early detection of danger signs led to positive corrective action in preventing breakdowns.

This report describes the system in technical detail; thoroughly explains the installation of the system, including acceptance by the mechanics and coordination with plant operations, and outlines an application of the system to other wastewater treatment facilities.

ASPECTS OF STATE-WIDE EMERGENCY RESPONSE PROGRAMS  
FOR MUNICIPAL WASTEWATER TREATMENT FACILITIES

The material provided in this document is designed to assist in the development of State emergency programs in responding to spills of raw or inadequately treated municipal wastewater. It emphasizes the legal aspects of spill reporting, the definition of a reportable spill and State-wide aspects of emergency response planning.

Preliminary steps in this work included a review of existing and proposed Federal statutes and current State water pollution control laws and regulations. Over 55 State and interstate agencies were asked to provide information on existing or future water pollution contingency plans; over 200 wastewater treatment facility managers provided data on emergency actions.

Each State response plan must, of course, be adapted to the local situation.

PROCESS CONTROL MANUAL FOR  
AEROBIC BIOLOGICAL WASTEWATER TREATMENT FACILITIES

This document will provide an on-the-job reference for operators of activated sludge and trickling filter wastewater treatment plants. It will also assist operators in establishing process control techniques and in optimizing the performance of these two aerobic biological treatment systems.

The manual, presented in three major divisions, includes: The Activated Sludge Process; The Trickling Filter Process, and Appendices. Major subject matters are divided into the following sections: Troubleshooting; Process Control; Fundamentals; and Laboratory Control. These sections emphasize the fundamentals of operating and controlling aerobic biological treatment processes. Each section is presented in sufficient detail to allow the reader to use them independently.

## OPERATIONS MANUAL

### ANAEROBIC SLUDGE DIGESTION

Included in this manual are comments solicited from treatment plant operators throughout the country on the operation, control and troubleshooting of anaerobic sludge digesters. Major contributions are also included from scientists and engineers.

Case histories of operational experiences and problem-solving form a section of the publication which will be useful to plant operators, designers and engineers who are interested in digester operation and theory.

The subject of anaerobic digester operation in municipal wastewater treatment plants is presented by covering the area of troubleshooting, general operation, safety, start-up of units, basic theory, sampling, laboratory testing and other subjects relevant to day-to-day operations. The document is intended for plant operators who have anaerobic digesters as part of their total treatment process. It is structured so that each section is complete within itself and indexed for quick reference.

CONSIDERATIONS FOR PREPARATION  
OF  
OPERATION AND MAINTENANCE MANUALS

This material provides basic considerations for the preparation of complete and adequate municipal wastewater treatment plant operation and maintenance (O&M) manuals. Proper utilization of these guidelines will assist the user in complying with the eligibility requirements of EPA's Construction Grant Program.

Some of the information included was extracted from the appendix of the "Federal Guidelines for Design, Operation and Maintenance of Wastewater Treatment Facilities", (1970). Information was gathered from individuals experienced in the preparation of plant O&M manuals and data compiled from existing O&M manuals.

The document contains separate sections on each major topic recommended for inclusion in an O&M manual and detailed discussions on the type of information to be included. A suggested manual outline is presented for treatment plants; another for pumping stations and pipelines. The guidelines are not intended to present a rigid format; each manual must be adapted to the local situation.

EMERGENCY PLANNING FOR  
MUNICIPAL WASTEWATER TREATMENT FACILITIES

Information provided in this document is designed to assist those responsible for developing comprehensive emergency operating procedures and systems for wastewater treatment facilities. It provides assistance for treatment plant staffs to use in explaining to local governing bodies the need for additional funds to remedy malfunctioning units at their plants. The material is also useful for municipal department heads and staff in developing plans suited to the peculiarities of their plants. It assists regulatory agencies in evaluating the emergency operating program sections of the O&M manuals.

Consulting engineers may use it as a guide for writing the emergency operating portion of an O&M manual for any municipal treatment system. Guidance is provided to ensure each plant's discharge of pollutants does not exceed the effluent limitations dictated by the facility's discharge permit.



ESTIMATING LABORATORY NEEDS FOR  
MUNICIPAL WASTEWATER TREATMENT FACILITIES

Because treatment processes and combinations of processes vary widely, laboratory needs must be specifically tailored to each installation. This manual provides data to make possible the rough estimation of laboratory needs for municipal wastewater treatment plants. Criteria for physical facilities, staffing and laboratory services are included. Considerations for sampling and testing needs are presented for individual processes, and include the minimum and the best testing requirements. The testing programs are designed to meet the needs of each process.

Guidelines for equipment and supplies are divided into six categories: Major Equipment; Miscellaneous Equipment; Expendable Supplies, Glass and Plasticware; Test Kits; and Chemicals. The guidelines for Major Equipment and Chemicals are based on testing requirements, while the others are usually general and indicate items needed at any laboratory.

Estimates for staffing needs are given as the annual base man-hours for laboratories serving the several types of treatment facilities, and include methods for adjusting the number of man-hours for local conditions. The manual describes two ways of optimizing laboratory services: regional laboratories serving several facilities, and local laboratories serving both water and wastewater facilities.

ESTIMATING STAFFING FOR  
MUNICIPAL WASTEWATER TREATMENT FACILITIES

Materials in this document are intended primarily for consulting engineers, plant management personnel, State regulatory agencies and the Environmental Protection Agency. The manual describes a four-step method for preparing staffing estimates for sewage treatment plants. It covers plants with capacities from 0.5 to 25 million gallons per day (mgd) of sewage, using primary, secondary and advanced treatment processes. The four steps described provide guidance to:

1. Develop, using a "Table of Adjustment for Local Conditions", factors for increasing or decreasing staffing needs relative to those required for an "average" plant.

2. Develop the staffing for an "average" plant using staffing curves showing annual man-hour needs. Items covered are:

- a. Supervisory, clerical, laboratory and yard tasks based on plant design capacity.
- b. Operation and maintenance work on the basis of both plant design capacity and types of process units or steps. The operation and maintenance man-hour needs for certain types of non-continuous processes on the basis of the time that the equipment for these processes is in operation.

3. Increase or decrease the annual manhour staffing for the above listed types of work using the factors taken from the "Table of Adjustment for Local Conditions".

4. Analyze and break-down staffing functions into specific tasks.

Note: Staffing estimates prepared according to this manual should not be used as rigid or final requirements. The ultimate decision on staff requirements for a particular plant should be determined by personnel familiar with similar plants under similar circumstances.

MAINTENANCE MANAGEMENT SYSTEMS FOR  
MUNICIPAL WASTEWATER FACILITIES

Basic information furnished in this document was obtained from individuals experienced in maintenance management systems at various-sized facilities. Existing systems were reviewed at different municipalities, the private sector and defense establishments.

The manual includes a number of recommendations covering each of the basic elements required to develop an effective maintenance management system. These recommendations may be tailored or modified to meet specific equipment and plant type requirements. The procedures are comprehensive and will assist in the development of effective systems.

## OPERATIONS MANUAL

### PACKAGE TREATMENT PLANTS

Package treatment plants were originally designed to serve areas not easily connected to existing sewage treatment plants. Such areas include the subdivisions developed in the "fifties" and commercial establishments such as restaurants, motels and parks. More recently, package plants have increased in size so they can serve small municipalities. Many were installed with the concept the plants would operate with little or no operator attention. However, to meet today's more demanding pollution discharge regulations, these plants do require daily attention by a knowledgeable and conscientious operator thoroughly familiar with the plant. Materials included in this manual are designed to give the operator an increased knowledge of the basic principles in the effective operation of a package treatment plant.

The document is also directed to the plant owner and the design engineer. The owner may be either the actual purchaser of the plant, if privately owned, or the individual(s) or group responsible for making policy decisions concerning the treatment plant, such as a city council. The owner is responsible for enlarging the treatment plant when necessary, controlling sewer construction practices in the service area, keeping supplies at the plant and supervising the operator. Most importantly, the owner, in the final analysis, is legally and administratively responsible for the performance of the treatment plant. Detailed descriptions are provided, which outline the duties and responsibilities of the owner.

Also, for the engineer, this manual provides information that can be used wholly or in part with an O&M manual, prepared for a specific plant. It may be valuable to the consulting engineer in plant selection, by alluding to various design problems inherent in previous package plant installations.

FIELD MANUAL FOR  
PERFORMANCE EVALUATION AND TROUBLESHOOTING AT  
MUNICIPAL WASTEWATER TREATMENT FACILITIES

This manual is considered useful as a technical field guide or reference document for improving the performance of municipal wastewater treatment plants. A primary objective of the document is to provide a troubleshooting guide for identifying, analyzing and solving operating problems. It is also useful in EPA and State training courses for plant inspectors and performance evaluations. Consulting engineers, designers, plant operators, educators and students may also find the information useful.

A description is provided on procedures to evaluate the performance of treatment processes and equipment commonly used in municipal wastewater facilities. The procedures also cover other items related to the effective operation of municipal wastewater treatment plants. Troubleshooting and performance evaluation material is provided for each unit process commonly used in wastewater treatment facilities.

The style, language and format of the manual are directed to the level and technical knowledge of a technician having some experience in plant operation, design, inspection or performance evaluation.

## OPERATIONS MANUAL

### SLUDGE HANDLING AND CONDITIONING

This manual was initiated with the overall objective of providing guidance to assist in the proper operation and maintenance of various sludge processing, conditioning and disposal systems at wastewater treatment plants. Emphasis is placed on the establishment of good operational procedures, proper testing, effective measures for detection and correction of operational problems. The style and format of the manual is tailored to the needs of the potential user.

The processing and disposal systems presented in the document include those designed to treat various types of sludge generated from primary, secondary and chemical wastewater treatment processes. The principal sludge processes and unit operations are included such as sludge thickening, stabilization and conditioning, chemical and heat dewatering, heat drying, and ultimate disposal systems.

Step-by-step operation and maintenance procedures are presented for the various systems. Each section contains explicit instructions on process control procedures for detecting and correcting operational problems. Plant type and size are considered where applicable to operational procedures. Useful troubleshooting guides, solutions to design shortcomings and descriptions of design variations of particular processes are also included.

OPERATIONS MANUAL  
STABILIZATION PONDS

Stabilization ponds for wastewater treatment were first used in the midwest for remote communities. They have since been used extensively in various parts of the country. In addition to domestic uses, ponds are now being used to treat various types of industrial wastes, including vegetable, oil refineries, slaughter houses, dairies, and rendering plants.

The manual is intended to:

- A. Supplement the specific operation and maintenance manual prepared for municipal ponds.
- B. Provide basic information on the theory of stabilization pond requirements for the entry-level operator.
- C. Provide operation and maintenance suggestions for operators based on current pond experiences.
- D. Provide a troubleshooting guide in handling various problems common to ponds.

The document is divided into six major divisions:

- I. The Basics
- II. Control Information
- III. Operation and Maintenance for Ponds
- IV. Troubleshooting for Ponds
- V. Safety
- VI. Appendices

START-UP OF MUNICIPAL  
WASTEWATER TREATMENT FACILITIES

This document serves as a guide for establishing the initial outline for the operation of a new municipal wastewater treatment plant, a new addition to an existing plant or a change in the mode of a plant's operation.

Information is provided in preparing for actual treatment plant start-up, including: staffing, developing standard operating procedures; establishing procedures when construction is continued during start-up; dry and wetrun testing of equipment; on-site operator training; and safety training.

Start-up procedures are described for some of the more common pre-treatment and primary treatment units. Methods are also provided for specific secondary treatment processes of activated sludge, trickling filters, stabilization ponds and aerated lagoons, as well as sludge handling units and the anaerobic digestion process.



INFORMATION FOR DIRECT ORDERS  
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|---|----------------------------|--------------|
| A Planned Maintenance Management System<br>for Municipal Wastewater Treatment<br>Plants                       | 5501-00756-6               | \$ 2.75      |
| Aspects of State-Wide Emergency Response<br>Programs for Municipal Wastewater<br>Treatment Facilities         | 055-001-01077-0            | 2.20         |
| Aerobic Biological Wastewater Treatment<br>Facilities, Process Control Manual                                 | 055-001-01071-1            | 4.75         |
| Anaerobic Sludge Digestion, Operations<br>Manual  | 055-001-01075-3            | 3.25         |
| Considerations for Preparation of Oper-<br>ation and Maintenance Manuals                                      | 5501-00644-6               | 3.10         |
| Emergency Planning for Municipal Waste-<br>water Treatment Facilities   | 5501-00778-7               | 1.25         |
| Estimating Laboratory Needs for Munici-<br>pal Wastewater Treatment Facilities                                | 5501-00651-9               | 1.45         |
| Estimating Staffing for Municipal Waste-<br>Water Treatment Facilities  | 5501-00569-5               | 1.75         |
| Maintenance Management Systems for Mu-<br>nicipal Wastewater Facilities                                       | 5501-00762-1               | 1.60         |
| Package Treatment Plants, Operations<br>Manual  | 055-001-01072-9            | 2.50         |
| Performance Evaluation and Trouble-<br>Shooting at Municipal Wastewater<br>Treatment Facilities, Field Manual | 055-001-01078-8            | 5.50         |
| Sludge Handling and Conditioning, Op-<br>erations Manual  | 055-002-00167-0            | 5.75         |
| Stabilization Ponds, Operations Manual  | 055-001-01076-1            | 2.30         |
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Appendix III



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|   |                  | <u>Paper</u> <u>copy</u> | <u>Microfiche</u> |
| A Planned Maintenance Management System for Municipal Wastewater Treatment Plants               | PB233111/AS      | \$ 6.50                  | \$ 3.00           |
| Aspects of State-Wide Emergency Response Programs for Municipal Wastewater Treatment Facilities | PB279551/AS      | 5.25                     | 3.00              |
| Aerobic Biological Wastewater Treatment Facilities  | PB279474/AS      | 12.00                    | 3.00              |
| Anaerobic Sludge Digestion  | PB250129/AS      | 9.00                     | 3.00              |
| Considerations for Preparation of Operation & Maintenance Manuals                               | PB227096/AS      | 9.50                     | 3.00              |
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| Start-Up of Municipal Wastewater Treatment Facilities   | PB256614/AS      | 6.00                     | 3.00              |

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