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Model Protocol for the Comprehensive Evaluation of Publicly Owned Treatment Works Performance and Operation

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MODEL PROTOCOL FOR THE COMPREHENSIVE EVALUATION OF PUBLICLY OWNED TREATMENT WORKS PERFORMANCE AND OPERATION

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16. ABSTRACT

This manual presents a systematic approach to conducting a comprehensive performance evaluation of municipal wastewater treatment plants. The objective of the evaluation is to identify and rank the causes of poor plant performance.

Five major problem areas are addressed. They are design, performance monitoring, operation, maintenance, and administration. By following this protocol an evaluation team will be able to identify deficiencies in each of the five categories, weight them with respect to adverse impact on plant performance, and rank them in order of severity of impact. The manual also addresses the preparatory steps to be completed before the actual plant visit and includes a section covering the preparation of the evaluation report. All required data and work sheets are included in the appendixes of the manual.

The evaluation protocol has been prepared as a user oriented field document that provides specific guidance for conducting comprehensive plant evaluations and identifying problems and solutions in order to improve plant performance.

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FOREWORD

The U.S. Environmental Protection Agency was created because of increasing public and government concern about the dangers of pollution to the health and welfare of the American people. Noxious air, foul water, and spoiled land are tragic testimonies to the deterioration of our natural environment. The complexity of that environment and the interplay of its components require a concentrated and integrated attack on the problem.

Research and development is that necessary first step in problem solution; it involves defining the problem, measuring its impact, and searching for solutions. The Municipal Environmental Research Laboratory develops new and improved technology and systems to prevent, treat, and manage wastewater and solid and hazardous waste pollution discharges from municipal and community sources, to preserve and treat public drinking water supplies, and to minimize the adverse economic, social, health, and aesthetic effects of pollution. This publication is one of the products of that research and provides a most vital communications link between the researcher and the user community.

Previous studies have documented performance and operation problems in POTWs, and cause and effect relationships have been developed for poor plant performance that results in noncompliance with NPDES permit requirements. It has been noted that a combination of design, operation, maintenance, and administrative management practices and procedures cause poor performance and therefore in order to evaluate and solve poor performance problems, a treatment plant evaluation procedure that addresses all potential performance limiting factors must be used.

This manual presents a systematic approach to conducting a comprehensive evaluation of municipal wastewater treatment plant performance and operation. By following the systematic guidance given, a team of investigators including an experienced sanitary engineer will be able to compile plant data in the areas of design, performance monitoring, operation, maintenance, and administration; identify deficiences; and weight and rank the deficiencies in order of severity of adverse impact on plant performance.

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ABSTRACT

Many studies and reports have documented that a large percentage of the country's wastewater treatment plants do not meet design expectations and are not in compliance with their NPDES permit standards. EPA studies have identified deficiencies in the areas of design, operation, maintenance and administration that adversely affect plant performance. The data indicated that at any one facility, a combination of factors limiting performance was always observed and that a single cause of poor performance at any one plant was never noted. The studies also documented that when the adverse factors are identified and ranked in order of severity of adverse impact on plant performance significant potential exists for improving the performance of treatment systems simply and inexpensively by upgrading operation and maintenance programs, improving attention to management procedures and administrative requirements, and by making low cost corrections of design deficiencies.

Because these circumstances are applicable to POTWs on a nationwide basis, a need exists for establishing a treatment plant performance survey protocol that provides consistency in conducting plant evaluations on a comprehensive basis that identifies performance problems and establishes cause and effect relationships in order to formulate solutions to those problems to improve plant performance.

This research program was undertaken to develop and prepare a protocol for the comprehensive evaluation of biological treatment plant performance and operation. The methodology is applicable to a wide range of plant sizes and types of attached growth and suspended growth biological systems. All unit process and interprocess configurations and appurtenant equipment for mainstream and side-stream treatment are addressed including major in-plant recycle streams and residuals handling and disposal systems. The protocol is designed for plant evaluations of from one to ten days duration which are conducted by a team of from one to three investigators including an experienced sanitary engineer and a trained plant operations professional.

In the evaluation methodology a systematic approach and detailed guidance are provided for all phases of the evaluation from initial contact with responsible municipal and plant personnel through presentation of findings and report preparation. Procedural recommendations are made for information and data collection for the following activities:

- Preliminary evaluation contacts and manpower and cost estimates
- Collection of performance monitoring data
- Documentation of basis of design and verification of process design information

- Documentation of quantitative and qualitative operational practices and procedures
- Examination of maintenance provisions
- Assessment of administrative policies and programs
- Weighting and ranking factors adversely affecting performance
- Preparing the evaluation summary report

The protocol has been formatted as a user oriented desk and field document. Through tables in the text and a series of eleven appendixes all data forms, checklists, and data evaluation summary forms that are required to conduct the comprehensive plant evaluations, identify problems, and submit reports are included. It is intended for use by EPA, State, or contract investigators who visit the facilities and submit reports.

This report was submitted in partial fulfillment of Contract No. 68-03-2571 by Gannett Fleming Corddry and Carpenter, Inc. under the sponsorship of the U.S. Environmental Protection Agency. This report covers the period June 11, 1979 to January 29, 1980, and the work was completed January 5, 1981.

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Section 1. INTRODUCTION

This manual presents a systematic approach to conducting a comprehensive performance evaluation of municipal wastewater treatment plants. The objective of the evaluation is to identify and rank the causes of poor plant performance. In the context of this evaluation procedure, plant performance is related to the consistency with which the effluent quality meets the provisions of the NPDES permit.

Five major problem areas are addressed in the comprehensive evaluation. They are design, performance monitoring, operation, maintenance, and administration. By following this protocol an evaluation team will be able to identify deficiencies in each of the five categories, weight them with respect to adverse impact on plant performance, and rank them in order of severity of impact. Other aspects of performance, such as energy utilization efficiency, will not be analyzed in this evaluation. Typically, the on-site investigations will require three to five days to complete, depending on the size and complexity of the subject plant.

In addition to setting forth procedures to be followed in conducting the field investigations, the manual addresses the preparatory steps to be completed before the actual plant visit. The purpose of these preevaluation activities is to insure that data collection will be productive, efficient, and complete. The manual also includes a section covering the preparation of the evaluation report. The report must clearly present the evaluation findings since these will be the basis for developing a composite correction program (CCP) to improve plant performance.

The findings of an EPA national survey have shown that poor performance of POTW's is usually the result of a combination of inhibitory factors. By properly performing the comprehensive plant evaluation the limiting factors and the severity of each will be determined. A corrective program can then be designed that provides an effective solution to the performance problem by considering all its facets. Formulation of the CCP is not covered in this manual.

The evaluation team that uses this manual should include at least one individual with wastewater treatment engineering expertise, and one individual with plant operation training and experience. In the case where the plant is small enough to be evaluated by one person, that individual should be a professional engineer who also holds operations certification.

Section 2. PRELIMINARY ACTIVITIES

In order to minimize time in the field and to maximize the quality of information gained, the necessary preliminary procedures should include:

1) Contacting cognizant regulatory officials to obtain all existing relative data.

2) Contacting responsible treatment authority or municipal officials to inform them of the proposed evaluation.

3) Contacting the treatment plant superintendent to inform him of the proposed evaluation, and to discuss the purpose and scope.

4) Estimation of time, manpower requirements, and materials needed to conduct the evaluation.

5) Formulation of field sampling and analytical program.

The guidelines for performing these preevaluation tasks are presented in the following paragraphs.

Regulatory Agency Contacts

The leader of the evaluation team should obtain all existing information on subject plant that may be on file with the EPA or state environmental control agency. Data to be acquired from the regional EPA office includes at least the STORET records for the subject facility and the EPA Form 7500-5 survey form, if one has been completed. The state regulatory agency should be accessed to obtain copies of recent (within the past year) monitoring records and any design related information that may be on file. These data are to be carefully reviewed to identify performance limiting problems that have been previously noted, and to observe past trends in effluent quality.

Notification of POTW Authority and Municipal Officials

The chairman of the POTW owning authority and the head of the municipal department responsible for plant operation, if the plant is operated on a leaseback basis, must be notified of the planned evaluation. Alternatively, if the plant is owned and administered by a municipality or other governmental unit, then the appropriate municipal official needs to be contacted. The responsible official is usually the head of the department of

public works or the municipal sanitation department. The NPDES permit can be checked to determine the responsible official. These officials must be notified in writing two weeks prior to the scheduled initiation of the evaluation. Written notification is to be followed with a telephone contact one week prior to the evaluation.

The written notification should indicate the reason for the evaluation; for example, to determine what factors are responsible for the failure of the treatment plant to meet its discharge permit. The scope of the evaluation should be briefly summarized, and the dates on which field work will be performed must be indicated. The responsible official must be told to have his plant superintendent available throughout the field study period to respond to questions raised by the evaluation team and to provide copies of operating records. Furthermore, the responsible official is to be notified that the budgetary information for the most recent fiscal year is to be made available for review by the evaluation team, and that an individual should be designated as a contact for the evaluation team regarding budgetary and other administrative information. Names of the evaluation team personnel and the designated team leader should be included in the notification.

The administrative officials should be made aware of the positive aspect and tangible benefit that can result from the undertaking such as the identification of areas where O & M programs can be improved. Such improvements may involve minimal investment when compared to structural upgrading, but significant performance improvement may be achieved. The concept that should be communicated is that the evaluation is the first step in maximizing the return on the investment represented by the pollution control plant. If these ideas are clearly communicated, negative attitudes will be reduced and cooperation from the plant staff and administrators will facilitate the evaluation process.

Notification of the POTW Superintendent

Contact with the plant superintendent should not be made until the responsible authority or municipal official has discussed the scope and purpose of the evaluation with the plant superintendent. Then the team leader should call the superintendent to explain the nature of the evaulation to the superintendent, inform him of how much of his or his staff's time may be required, and answer his questions concerning the type and extent of information he will be asked to provide. The team leader should indicate the specific operating records and technical references he will inspect during the field investigation. The intent of contacting the plant superintendent is both to solicit his cooperation and to allow him some time to prepare so that information retrieval is expedited. No written contact need be made. Again, the concept that the evaluation team's findings may benefit his plant's performance is to be communicated to the superintendent.

Contacting Consulting Engineer of Record

When the plant administration is notified, the name and address of the design engineering firm should be obtained. The administrator may refer

the evaluation team leader to his consultant engineer to answer plant specific questions. In any case, the administrative official should be asked to give clearance to his engineer to release information regarding plant design to the evaluation team. The team leader should then directly contact the consultant and request to be given a copy of the basis of design, which may be returned to the consultant at the conclusion of the evaluation. Also, at this time, the scope and purpose of the evaluation should be discussed with the consultant. He should be asked for his suggestions concerning areas or facets of plant operation that should be specifically observed during the evaluation.

Estimation of Evaluation Time

Field time required for a comprehensive evaluation is a function of size of plant, complexity of treatment process, and the amount of cooperation provided by the plant operating staff. A minimum of three days in the field is to be allowed for plants with design capacities of 11,355 cu m/d (3.0 mgd) or less and a minimum of five days field evaluation time must be allowed for larger plants. The cutoff point between three and five day field studies is somewhat arbitrary and based on average conditions. Judgment must be exercised in making adjustment in time allotments for plants where unusual or extenuating circumstances exist. It is better to overestimate the time required to conduct a comprehensive evaluation than plan for too tight a schedule. The slower pace will allow the evaluation team to better observe plant operations and to converse at some length with the operators. Such conversations can provide additional insight into problems which would otherwise be missed in the rush of a tight schedule. Also, the slower evaluation pace can result in an atmosphere in which the operating staff feels the evaluation team is providing some technical assistance to them. Under such circumstances, a good attitude and the cooperation of the plant staff increases the quality of the evaluation.

Estimation of Required Manpower

The provision of proper staffing of a comprehensive evaluation involves two considerations. The number of individuals required to accomplish all tasks within the three to five day time frame must be determined. Just as important, however, is that the evaluation team include individuals with appropriate training and experience to gather all performance, design, operational, maintenance and administrative information, and to perform necessary sampling and field analysis. The number of individuals required to perform these tasks is a function of the size and complexity of the treatment plant. Since complexity of the treatment facility normally increases with design flow, manpower requirement can be related to plant size. Table 1 shows the recommended number of staff for an evaluation team as a function of plant design flow. This staffing guide should be viewed as a minimal allocation of manpower.

TABLE 1

GUIDE TO STAFFING REQUIREMENTS FOR COMPREHENSIVE EVALUATIONS

Plant Design Flow		
cu m/d	mgd	No. of Investigators
<11,355	<3	1
11,355-94,625	3-25	2
94,625-227,100	25-60	3
>227,100	>60	3 or more

Every evaluation team must include two categories of technical expertise; plant design and process operations. In the case of small plant evaluations where only one individual is involved, that individual must be an engineer who has had experience in treatment plant design or review of such designs, and has been involved in facets of plant operations. He should also be a registered professional engineer and hold state certification as operator, in states where certification programs exist. Although an individual with this dual certification is not always available, experience and a working knowledge in both areas is absolutely necessary. In the case where an evaluation team is comprised of two or more individuals, at least one sanitary engineer and one certified operator should be included. Other individuals on the team may be technicians familiar with sampling, analysis, and field measurement techniques. These personnel would perform field data collection tasks under the supervision of one of the senior team members.

One of the senior team members should be designated as the evaluation team leader. The duties of the team leader include: (1) making all preliminary contacts, (2) collecting and coordinating review of previously available data, (3) overseeing scheduling, transportation, and lodging arrangements, (4) reviewing and approving of field sampling program, (5) coordinating field work, and (6) preparation of the evaluation report.

Determination of Required Equipment and Materials

To enhance efficiency and organization of the field data collection effort, several forms have been developed. Sample copies are included in this manual. As part of the preliminary activities, copies of these forms should be reviewed so that the evaluation team understands the data requirements and format before proceeding into the field. All available preevaluation information should be entered on the forms prior to the field study and confirmed during the field investigation.

The Field Analysis Requirement Form, shown in Appendix A, is a guide to be used to design the sampling and analysis program portion of the evaluation. It should be completed prior to the on-site work so that proper

sample containers, reagents, and instruments can be obtained. However, a process flowsheet and some plant design information is needed to complete the form. If this information is not available, then sampling program decisions will necessarily be made in the field, in which case the team must be sure to bring sufficient sample containers and reagents to cover any contingency.

The following items are to be obtained, cleaned and calibrated prior to conducting the field study:

1. Sample Bottles - Approximately 1/2 liter capacity, sufficient number to sample plant influent, effluent, and interprocess streams at least daily during the 3-5 day survey. One hundred sample bottles will normally be sufficient.

2. Automatic Composite Samplers - To be used for sampling all wastewater flows including influent, primary effluent, secondary clarifier effluent, and final discharge.

3. Reagents for Sample Preservation - Sulfuric acid, nitric acid, mercuric chloride.

4. 50 Liter Cooler - For sample storage and transport.

5. Field pH Meter

6. Field D.O. Meter

7. Tape Measure - 30.5 m (100 ft.)

8. Bucket and Rope

9. Stop Watch

10. Dye Tablets

11. Protective clothing including boots and wet weather gear

12. Calculator

13. Clipboards

Laboratory Analyses

The extent of laboratory analysis to be performed on collected samples depends on several factors. Of primary importance are the analyses for parameters required to quantify the process control indicators, which will vary with the treatment process flowsheet. Also, analyses for all discharge permit parameters should be performed on influent, effluent, and unit process flows so that removal of these pollutants may be profiled through the facility. Table 2 presents a general guideline indicating analyses to be performed on samples obtained from various points in the treatment process. Daily samples are to be obtained at each indicated

TABLE 2. SUGGESTED SAMPLING AND ANALYSIS PROGRAM

Analyses / Sampling Points	Plant influent	Primary effluent*	Aeration zone(s)*	Return activated sludge*	Trickling filter effluent*	Secondary effluent	Tertiary effluent*	Plant effluent	Raw sludge	Primary digester sludge*	Secondary digester sludge*	Secondary digester supernatant*	Thickened sludge*	Dewatered sludge*
BOD_5 (total)	x	x			x	x	x					x		
BOD_5 (soluble)	x											x		
Settleable solids	x							x						
Suspended solids (total)	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Suspended solids (volatile)			x	x					x	x	x	x		
Dissolved oxygen			x					x						
Phosphate*	x							x						
Ammonia nitrogen*	x							x						
Alkalinity										x				
pH	x		x					x		x				
Chlorine residual								x						
Fecal coliform								x						
Metals*	x													

*Where applicable

sampling point. Where possible, composite samples should be collected. Whether these should be time proportioned or flow proportioned, depends on the flow characteristics at the particular sampling point. Use of automatic samplers, wherever possible, is strongly recommended. This will reduce manpower requirements while improving sample integrity. Samples for solids analysis must be collected manually, but several samples per day should be combined into one composite. For all samples collected, careful judgment must be used in determining the actual point where a unit process will be sampled to assure that a timely representative sample is obtained.

Table 3 shows recommended sampling locations for the various plant unit processes. In the case of multiple parallel units, each unit should be individually sampled in order to isolate problems. There are many unusual or specialty processes that are not specifically covered in Table 3. In deciding where to sample such processes, the evaluator must exercise careful judgment. Every effort must be made to obtain the most representative sample in light of the purpose for sampling at the point in question.

Since no person is more familiar with access to the various plant units than the operator, Table 3 should be reviewed with him at the start of the field survey. The operator will be able to indicate where sampling ports, free discharges, or other appropriate sampling points can be found. If there is a serious problem with accessing a particular flow, and it is critical to the evaluation, alterations such as inserting a valve or tap in a line must be discussed with the supervisory operator. The long-term advantages of having complete sampling access for purposes of process control should be explained at that time. It may be necessary to postpone the evaluation for several days to allow any necessary modifications to be made.

TABLE 3

RECOMMENDED SAMPLING POINTS

Plant Influent	Wet well, after bar screen, comminutor and raw sewage pumps
Grit Removal	Near effluent weirs, approximately 2 feet beneath surface
Primary Clarifier	Free discharge into effluent launder (over weir)
Trickling Filter	Effluent junction box, beneath surface (or manhole if no junction box exists)
Aeration Tank	Near center of tank, 2 feet beneath surface (D.O. should be run at several depths)
Sludge Return	Free discharge into aeration tank, return sludge distribution box, sampling valve on return pump
Secondary Clarifier	Free discharge at weir into effluent launder
Disinfection Unit	Near effluent weir (if chlorine residual is to be run, sample should be fixed)
Plant Effluent	At outfall discharge
Raw Sludge	Sampling port on sludge transfer line (or lines), free discharge into aerobic digester
Primary Digester	Tap on line between primary and secondary digester
Secondary Digester	Supernatant - at collection sump or port on recycle line, free fall discharge at plant headworks Sludge - free discharge to drying beds, influent line to thickener, influent line to holding tank for dewatering equipment

TABLE 3 (Cont'd)

Thickener	Dewatering holding tank, influent line to holding tank
Polishing Pond	Near effluent weir or other discharge device
Polishing Filters	Tap on filter effluent line, discharge to chlorine contact tank

Estimating the Cost of an Evaluation

A budget for the comprehensive evaluation must be prepared during the planning stage. The variables that impact the cost of an evaluation include: duration of the survey, number of team members, extent of sampling and analysis program, and transportation, lodging and subsistence costs. A guide for estimating the funds to be budgeted for an evaluation is given in Table 4. Table 5 shows typical ranges for costs of laboratory analyses. Experience indicates the costs of comprehensive evaluations typically fall in the range of $3,000 to $8,000, including all field work and the preparation of an evaluation report.

TABLE 4

A Guide To Estimating The Cost Of A Comprehensive Evaluation

Cost Center	Variable No. 1		Variable No. 2		Variable No. 3	Constant	Subtotal
A. Pre-Evaluation Activities							
1. Make contacts and prepare correspondence	No. man-hours	x	Average payroll rate ($/hr)				
2. Review existing data	No. man-hours	x	Average payroll rate ($/hr)				
3. Prepare field sampling and analytical plan	No. man-hours	x	Average payroll rate ($/hr)				
4. Mobilization	No. man-hours	x	Average payroll rate ($/hr)				
Subtotal							
B. Field Investigations							
1. Labor	No. of investigators	x	Duration of survey	x	Average payroll rate ($/hr)	8-hours/day	
2. Analytical	Cost per analysis (See Table 4)					No. of Samples for each analysis	
3. Lodging	No. of investigators	x	Duration of survey	x		Per diem ($/day)	
4. Transportation	(Round trip mileage + at-site mileage		estimated	x		Vehicle rate ($/mile)	
5. Subsistance	No. of investigators	x	Duration of survey	x		Per diem ($/day)	
Subtotal							

TABLE 4 (Cont'd)

Cost Center	Variable No. 1		Variable No. 2	Variable No. 3	Constant	Subtotal
C. Report Preparation						
1. Data Reduction and analysis	No. man-hours	x	Average payroll rate ($/hr)			
2. Writing and editing	No. man-hours	x	Average payroll rate ($/hr)			
3. Typing and assembling	No. man-hours	x	Average payroll rate ($/hr)			
4. Printing and reproduction	No. of pages				Reproduction rate ($/page)	
Subtotal						
Total Evaluation Cost						

TABLE 5

COST RANGES FOR TYPICAL

DOMESTIC WASTEWATER ANALYSES

PARAMETER	COST RANGE ($ Per Test)
BOD_5	10 - 17
Suspended Solids	3 - 15
Fecal Coliform	10 - 20
pH	3
Phosphorus	10 - 15
Ammonia Nitrogen	10 - 12
Nitrate Nitrogen	10 - 12
Total Kjeldahl	15 - 20
Dissolved Oxygen	3 - 6
Chlorine Residual	30 - 40
COD	10 - 17
Settleable Solids	3 - 5

Section 3. MONITORING DATA COLLECTION

Three potential sources of monitoring data exist by which the performance of a treatment plant and its individual unit processes should be evaluated. First, there are the plant operating reports that document all analyses performed at the facility. The results of analyses performed on samples collected as part of the evaluation are the second source of monitoring data. The third source is the sampling and analysis information maintained by the regulatory agency in certain states.

Plant Monitoring Data

A member of the survey team should obtain copies of all monitoring data and reports maintained by the plant staff during the previous 12 months. Such information would include overall plant performance data such as flow records, influent and effluent BOD_5, suspended solids, phosphorus, nitrogen, and pH analyses. As a minimum, such information should include results of all tests performed in accordance with the NPDES monitoring requirements, set forth in the plant's permit. Other available monitoring data maintained at the plant may include: primary effluent BOD_5 and suspended solids, MLSS, MLVSS, and aeration basin dissolved oxygen (D.O.) and pH, and digester performance indicators, including alkalinity, volatile acids, temperature, and pH. Results of analyses on side streams such as return sludge, digester supernatant, thickener overflow, and dewatering filtrate should also be requested.

Evaluation Monitoring Data

One of the tasks performed by the evaluation team during a survey is the collection of samples for the purpose of monitoring process performance. Table 2; as shown in the preceding section, Preliminary Procedures, presented the inter-unit streams and process contents which should be sampled during the evaluation. The typical analyses to be performed on these samples were also indicated. Recommendations for volume of sample required and sample preservation are given in Appendix B. This information was extracted from the EPA publication entitled, "Manual of Methods for Chemical Analysis of Water and Wastes". For detailed answers to more specific questions regarding sampling and analytical techniques, the use of that document is recommended.

Regulatory Agency Data

Certain state water pollution control agencies periodically conduct sampling and analysis studies at treatment plants within their jurisdiction as a check on performance. By contacting the respective state agencies,

such data may be available for evaluation purposes or for confirming evaluation monitoring data. Appendix C presents a list of the state water pollution control agencies, grouped by EPA region.

Computation of Operational Parameters and Performance Indicators

Using available data and those generated by the field sampling and analysis activities, the evaluation team can compute operational parameters and pollutant removal efficiencies for the overall plant and for individual unit processes. Appendix D shows some basic computations. The team should deliver any samples collected during the evaluation directly to the laboratory where the analyses are to be performed. Complete written instructions must be left with the supervisor of the laboratory with respect to the analyses to be performed, expected concentration ranges, specific reporting requirements for results, and any deadlines for completion of the tests. Calculations are required to obtain averages and other statistical data (ie, maximum value, minimum value, standard deviation, etc.) for analytical results and operating parameters for the entire year, as well as to compute 7- and 30-day average concentrations and loadings for evaluating performance in terms of NPDES permit compliance. Analytical test results from field collected samples are easily reduced by hand computation but reduction of a year of plant operating data is a bit more complex. The final section of this manual, "Report Preparation and Distribution", discusses how the results of these computations can be used to assess the quality of plant performance.

Section 4. DESIGN ANALYSIS

The framework on which any process control program must be based is the plant design. An important part of the comprehensive evaluation, therefore, is to evaluate the basis of design and to compare the plant construction with the basis of design. The objectives of this portion of the comprehensive evaluation are to (1) discern any facts of design which may limit the ability of the plant to meet its permit conditions, (2) determine the limitations on operations imposed by design, and (3) identify minor design deficiencies that may be easily and inexpensively corrected. This analysis will include examination of process design parameters, such as detention times, hydraulic and organic loadings, recirculation rates, and sludge age. Also, a visual comparison of plans and specifications to existing equipment and layout must be made to determine if changes have been made either at the time of construction or afterwards. The adverse impact of some design errors or omissions, such as undersized unit processes, is easily perceived. However, the evaluation team must also establish the extent to which more subtle design problems adversely impact the performance of the treatment plant. Examples of such problems could be inadequate sludge return or wasting capacity, or poor control over recycle flows. Inadequate process flexibility is another potential design problem that may not be readily apparent on initial review of the basis of design.

General Design Information

General design information can be obtained from several sources. These include: the preliminary engineering report or 201 Facilities Plan prepared for the plant, the plant basis of design, the O&M manual, as-built drawings retained by owner, design drawings retained by the consultant engineer, and permit applications on file with the state regulatory agency. In addition to all unit process design information, design wastewater characteristics and flows must also be determined. As a minimum the general background information that must be obtained to evaluate the treatment plant design includes:

- Average design flow
- Peak design flow (rate)
- Design BOD_5 and suspended solids loadings
- Design service population
- Design year
- Age of existing facility
- Present average flow
- Present peak flow (rate)
- Present BOD_5 and suspended solids loadings
- Present service population

- Volume of industrial wastewater
- Character of industrial wastewater (BOD_5, suspended solids, heavy metals, toxics, etc.)
- Volume of infiltration/inflow

In addition, review of recent operating records, or regulatory agency inspection records, must be accessed to obtain information on current wastewater flows and characteristics. Records of any infiltration/inflow analyses that have been performed are available from the plant owner or the consulting engineer.

Process Design Information

The major portion of the design evaluation phase is devoted to the analysis of individual unit process designs. This analysis consists of determination of process design parameters and loadings, comparison of these parameters with good engineering practice, and comparison of design parameters with actual values realized in the process under actual operating conditions. Thorough evaluation of unit process design will provide the necessary information to establish the existence and degree of the following potential plant performance limiting conditions:

1. Poor process design which subverts the ability of a process to meet design intent. For example: excessive solids loading on a secondary clarifier, inadequate detention time in an aeration tank, etc.

2. Construction or installation which does not conform to design. An example would be clarifier weirs installed out of level, causing short circuiting in the unit.

3. Inadequate process flexibility. This situation interferes with the operator's ability to adjust the process to variations in wastewater conditions. An example of this would be an activated sludge return line for which flow cannot be adjusted.

4. Poor process selection. An example would be the use of the contact stabilization mode of the activated sludge process to treat wastewater which is highly variable in organic strength.

5. Incompatibility of unit process with the constituent removal requirements. An example of this would be the use of a secondary clarifier to achieve effluent suspended solids concentrations of less than 20 mg/l. All unit process design evaluations must be conducted with the above five potential problem areas being carefully considered.

When applicable, the following unit processes must be evaluated at any biological treatment facility:

Raw sewage pumping
Screening
Shredding
Grit removal
Flow measurement
Primary sedimentation
Trickling filters
Aeration (activated sludge)
Rotating biological contactors (RBC)
Secondary sedimentation
Disinfection
Filtration
Microscreening
Carbon adsorption
Land application (wastewater)
Thermal sludge conditioning
Sludge thickening
Anaerobic digestion
Aerobic digestion
Sludge dewatering
Land application (sludges)

Design and present loading parameters must be collected for each of these unit processes. Appendix E, "Design Information Summary Form" can be used to record and organize pertinent design information. Though the collection of design data is a somewhat routine undertaking, the evaluation team must be continually aware that these data must be complete to definitely determine whether unit process design is in any way placing limitations on the plant's performance.

The following paragraphs offer some guidelines on collection and manipulation of the data. The parameters to be investigated and the raw data needed to calculate them are specified for each unit process. Recommended design values should be obtained from the various design references. Such references include: Manual of Practice No. 8, "Wastewater Treatment Plant Design", published by the WPCF and ASCE, texts such as those authored by Fair, Geyer, and Okun or Metcalf and Eddy, and the EPA Technology Transfer series.

Raw Sewage Pumping

Pumping capacity and pumping head are the criteria that define the capacity of the raw sewage pumping station. This information may be obtained from the pump manufacturer whose pump curves may be compared to the engineer's operating curves to determine design pumping rates and total dynamic head. By measuring water levels at the wet well surface and the discharge water surface the required pump horsepower may be calculated for the design flow rate. Such a procedure is set forth in another EPA publication, EPA/430/9-79-010, "Inspectors Guide for Evaluation of Municipal

Wastewater Treatment Plants". Thus it can be determined whether the raw sewage pumps are sufficiently sized to meet the load placed on them.

The dimension of the wet well should be measured, and based on flow records, the average detention time of raw sewage in the wet well is determined. This will point out if septicity of the raw sewage, which can cause problems in downstream unit processes, is a potential problem.

Screening

The major design parameter to be checked for this unit process is the flow velocity through the channel containing the screening device (usually a bar screen). Cross sectional channel dimensions and flow data are used to check this velocity. A low velocity will cause undesirable deposition of smaller particulate matter in the screen channel, causing odor and maintenance problems. Also, provisions for cleaning the screen must be checked because insufficient cleaning can cause flow backup and eventual surges to the treatment plant.

Shredding

The dimension of the approach channel must be checked to assure sufficient approach velocity so that solids deposition does not occur. If a comminutor or macerator is employed the diameter must be checked to determine if the unit is sufficiently sized for the design flow. Also the evaluator must determine the accessibility of moving parts for required maintenance.

Grit Removal

Grit removal is accomplished in a grit chamber for which various designs and configurations exist. The critical design parameters are overflow rate, velocity through the chamber, detention time, grit removal facilities, and in some cases, aeration. Therefore, the evaluator must check the length, width, and depth dimensions of the chamber and calculate the above design parameters based on actual average daily flow to the plant. Excessive overflow rates or low detention time will cause incomplete grit removal. However, excessive detention time will allow some organic solids to settle in the grit chamber and objectionable odors may result. Facilities for removal of grit from the chamber may be manual or automatic, but, in either case, the design evaluator must determine that grit removal is efficient and not limiting to the performance of the unit process. Storage of grit on the plant premises can contribute to odor problems. The evaluator should investigate the grit loading facility and trucking schedule to ascertain the existence of potential problems in this regard.

In the case of an aerated grit chamber the diffused air is used as a method of velocity control, and the spiral pattern moves grit along the tank bottom to the removal hopper. For such a design the hydraulics in the sedimentation zone are critical. The evaluator must check that sufficient baffling exists so that short circuiting cannot occur. Also, the air rate should be controllable in response to variations in flow and/or grit loading.

Flow Measurement

Measurement of influent flow rate is a more important process than is often realized. Process control for biological systems requires knowledge of influent and recycle flows, so reliable and accurate measurement devices are paramount to process controllability. There are many types of devices in use, each based on some hydraulic parameter that is directly relatable to volumetric flow rate. Examples are measurement of discharge head over a weir or measurement of average fluid velocity. Selection of the proper device should be based on the compatibility of flow meter scale with influent flow variations, placement of flow meter, location of sensing devices, and ease of calibration. The flow meter should be sized such that it is not required to operate near maximum or minimum scale for extended periods of time, since this is the region in which relative errors will be the greatest. Level or pressure sensing equipment should not be located where clogging or fouling with grease or other matter will frequently occur. The evaluator should determine if and how the flow monitoring system can be calibrated, and the likelihood that calibration will be practiced at the recommended interval. Where possible, the evaluation team is to measure flow directly at the monitoring device (by measuring depth in a Parshall flume, for example) and compare this measurement to that shown on the instrument readout and chart recorder. Finally, the evaluator must note which plant recycle streams are monitored, or included in the influent flow monitoring, and which recycles are not measured.

Primary Sedimentation

Design parameters to be checked for this unit process include surface overflow rate, hydraulic detention time, weir loading rate, and sludge detention time. Dimensions to be determined to calculate the above are length, width (or diameter), side water depth, and weir length. The volume of any conical bottom compartment must also be determined. The average sludge holding time can be determined from the total solids loading, including waste activated sludge or other recylces, and recent sludge pumping records.

The evaluator must be especially cognizant of the possible short circuiting of flows through the primary clarifier. In this regard careful attention should be paid to the baffle design, and to the possibility of installation errors in placing effluent launders and/or weirs. Where short circuiting seems a possibility, dye testing should be done.

Trickling Filters

Design evaluation of trickling filters involves investigations of at least the following factors: hydraulic loading (surface), organic loading (volumetric), recirculation rate and control, ventilation, and media type. Thus, filter surface area and volume must be determined. Trickling filters fall into one of five design categories: (1) low-rate, (2) intermediate-rate, (3) high-rate, (4) super-rate, and (5) roughing filter. The evaluator must be certain, therefore, as to the design intent of the filters under evaluation. Each type of filter is associated with a specific set of

recommended design criteria. Most trickling filters employ rock media, but super-rate filters usually employ plastic media. One must also keep in mind that trickling filters are normally designed for BOD_5 removal in the 65 to 85 percent range, but roughing filters should only be expected to realize 40 to 65 percent BOD_5 removal. Also, careful attention must be directed to the recirculation system. Sufficient control of the recirculation ratio should be available so that this parameter can be optimized with respect to the two major functions of recirculation, namely to improve hydraulic distribution over the filter surface and improve BOD_5 removal through increased contact time of organic material with the biological growth.

Aeration (activated sludge)

The design information that must be obtained to evaluate the aeration process in the activated sludge system includes: organic loading (volumetric), detention time, number of stages, configuration of units (series or parallel), process type (contact stabilization, plug flow, complete mix, extended aeration), food to microorganism ratio, mean cell residence time, mixing input, and air transfer capacity. Sludge recycle ratio and control range must also be determined. To enable these design parameters to be calculated, tank dimensions and other fixed data such as aerator horsepower and recirculation pump capacity must be obtained. In addition, certain analytical data will be needed. These include primary effluent BOD_5, aeration tank dissolved oxygen, and mixed liquor suspended solids. If these are not available from recent operating records then data obtained during the field evaluation must be used.

Rotating Biological Contactors (RBC)

The design information to be obtained for RBC systems principally relates to the organic and hydraulic loading per unit of disc surface area. Also of importance is the detention time in the wastewater tank. This requires determination of appropriate disc and tank dimensions. Also, disc rotational velocity, media material, and type and power of drive should be checked for design adequacy.

Secondary Sedimentation

Secondary clarifiers are designed for the dual functions of clarification and thickening. The solids loading per unit surface area (solids flux) controls thickening, and the surface overflow rate controls clarification. Therefore, both of these parameters must be checked against acceptable design values. Data that must be obtained include surface and depth dimensions, and weir length and placement. Hydraulic and sludge detention times must be determined. The type of clarifier should be noted (i.e., center feed or peripheral feed). If the clarifier contains chemical feed facilities and a flocculation compartment, the design of these must be evaluated. The sludge withdrawal mechanism is also a critical design feature. Design problems with sludge removal mechanisms usually involve the inability of the unit to remove sludge at a fast enough rate or from all areas of the clarifier bottom. As a result, sludge pockets are formed which can become septic and cause gasification in the clarifier.

Disinfection

The great majority of plants use chlorination for disinfection. The major system components consist of the contact tank and the chlorine feed device. The evaluator should check the contact tank design for minimum contact time at peak flows. The capacity of the chlorine feed device must be checked to determine that adequate capacity exists to deliver the necessary chlorine dosage to achieve disinfection and maintain a chlorine residual at peak flow. Chlorination control is also an important design feature. Because of the flow and chlorine demand variations characteristic of municipal sewage, manual control is nearly impossible and usually wastes chemicals. An automatic control system should be provided. This system may detect flow and chlorine residual, or only residual, and pace the dosage according to feedback from this detention system.

Disinfection systems must be designed to operate without interruption. Four design features are necessary to assure continuity of chlorine feed. These are: (1) adequate reserve supply of chlorine to bridge delivery delays, (2) chlorine container seals, (3) a header system that allows switchover of chlorine containers without interruption of feed, and (4) an automatic device for switching to a full chlorine container when the one in use becomes empty. If all of these features are not present, the evaluator can be reasonably sure that interruption in the disinfection process occurs from time to time.

Filtration

Granular media filtration is found in use as a polishing step at some biological treatment plants. Design evaluation is complicated by the fact that there are many types of deep bed filters available. These include gravity or pressure filters, single media or multimedia, upflow or downflow, and manual or automatic backwash. The general design features to be checked include surface loading (hydraulic), the depth of media, the particle size gradation for the media, the distribution and collection systems, and the backwash and cleaning system. Filter backwash systems may be manual or automatic based on a maximum head loss through the filter bed. The evaluator must be satisfied that sufficient capacity exists for filtration to proceed within allowable loading ranges while a unit is off line for backwash. Also the backwash water is recycled to other plant unit processes. The impact of this recycle must be investigated.

Sludge Thickening

The critical design parameter for a gravity sludge thickener is the loading in terms of weight of total solids per area per day. The allowable loading varies widely depending on the type of sludge to be thickened. Various ratios of primary sludge to secondary sludge will be encountered. Acceptable design solids loading will be a function of the sludge composition. Normally a higher ratio of activated to primary sludge reduces the allowable design loading. In the case of continuous thickeners, overflow rate must also be checked as this will impact supernatant quality. Thickener detention time is another important design variable. Appurtenances to be

checked include any mixing mechanism and surface skimming devices. Also, the underflow piping design should be checked. These are subject to high head losses so suction lines should be short. In cases where the sludge has a tendency to foul or plug a line, dual underflow piping should be present.

To evaluate thickener design the evaluator must obtain all dimensions and must know the total daily primary and secondary sludge quantities generated. This latter information is obtained from plant operating records. If the records are inadequate in this respect, estimates must be made using previously cited references.

Flotation thickeners are employed at some treatment plants. The critical design parameters to be evaluated for these units are the surface loading rate (solids per area per time) and the air to solids ratio. In many cases chemical addition is used to enhance flotation thickening. The chemical feed and mixing facilities must then be evaluated.

Anaerobic Digestion

The most important design factor is organic loading rate which is expressed as mass of volatile solids per unit time per unit of digester volume. Hydraulic loading and detention time are also design parameters to be checked. Heating provisions are included in many anaerobic digestion systems. These can consist of digester gas storage and burning systems coupled to heat exchangers. This design feature must be evaluated as to heat transfer capacity and reliability. The sludge and supernatant pumping and metering systems are also to be scrutinized.

Aerobic Digestion

Aerobic digestion design, like the anaerobic process, is also based on the organic loading and retention time considerations. The aeration aspect, however, is also an important design consideration. Air transfer capacity must be determined from the characterization of the aeration device. This must be compared against the digester oxygen demand. A dissolved oxygen profile to determine the minimum oxygen concentration in the digester should be run. It is noted that oxygen requirements of an aerobic digester will be increased significantly as the ratio of primary to secondary sludge is increased. To analyze the design of an aerobic digester the sludge composition, total daily sludge flow, digester dimensions, type and capacity of aerators, and sludge and supernatant withdrawal provisions must be documented.

Sludge Dewatering

Design of mechanical dewatering devices must be evaluted because these units can control the rate at which sludge can be wasted from the process, and recycle streams produced can impact other unit processes. Vacuum filters and centrifuges are the most common sludge dewatering units. The major design factor with respect to vacuum filters is the loading rate, expressed as dry weight of solids per unit of filter area. Filter area and sludge feed rate must be determined to check the loading parameter. The

design loading rate should be consistent with the sludge filterability. Filterability information may be available from the consultant engineer. Another design consideration is chemical conditioning. Chemical feed and mixing units must be evaluated with respect to dosing capability. Filtrate pumping and recycle systems should be checked; and the point of reentry to the treatment process established. Frequency and duration of filtrate pumping must be documented.

Centrifuges fall into two design categories, the continuous feed, solid bowl type, and the batch basket type, of which the former is more commonly in use. The primary design factor is sludge feed rate. Capacities of single units range from 4 gpm to 20 gpm. The feed rate must be compatible with the waste sludge volumes to be handled. As with vacuum filtration chemical conditioning is generally employed. Thus design of chemical feed and mixing systems must be evaluated.

Land Application of Wastewater

Evaluating the design of wastewater land application systems is basically a matter of determining that the type of application system is compatible with the land and climatological conditions, and that proper loadings are used. The soil conditions of interest include soil depth and type, permeability, and depth to seasonal high water table. The geologic parameters of concern are depth of rock, type of rock, extent of fracturing, water table elevation, groundwater gradient and flow direction, and proximity of wells. Topography and physical features of the land are important for determining the head loss from the pumping plant to the distribution areas.

The process design parameters to be evaluated include daily flow rates and quality, number and capacity of storage units, weekly loading depth, daily and hourly application rates, hydrologic and renovation capability, sprinkler spacing, and nozzle operating pressure.

Evaluation of wastewater land application systems design must take into consideration the relationship between wastewater characteristics and the vegetation that is part of the treatment system. Certain wastewater parameters may be toxic to the vegetation if present in sufficient concentrations. Examples of substances that could impair the crop bearing capacity of soil include sodium, calcium, magnesium, nitrate, heavy metals, total dissolved solids, and pathogenic organisms.

Loading rates to land application systems are highly variable depending on climate, crops grown, soil type, geology, previous wastewater treatment, and treatment objective. This makes objective evaluation difficult. As a minimum, however, the evaluator must be satisfied that the system includes adequate application area, adequate wastewater storage capacity, and adequate distribution capacity. It is recommended that the EPA process design manual "Land Treatment of Municipal Wastewater" be consulted as a guide to reasonable design parameters.

Section 5. OPERATIONAL INVESTIGATIONS

The evaluation of operational capabilities and limitations comprises an extremely important segment of a thorough comprehensive evaluation of a treatment facility. This area historically has not been given adequate consideration in plant evaluations. Operational factors affecting plant performance range from qualitative factors such as the personal characteristics and traits of operators (e.g., process knowledge and general aptitude), to more quantitative physical constraints placed on the staff, such as deficiencies in laboratory equipment or a lack of reference materials. The evaluation team must be objective but diplomatic during all of its fact-finding activities, but this is especially true in relation to operations. The operators may be very sensitive to question in this area, because they may interpret the evaluator's questions as an attempt to assess their job performance. To some degree, operator job performance must be assessed in this section of the comprehensive evaluation.

In this evaluation protocol, plant operational practices are divided into four major categories: operating personnel, plant monitoring, process control, and operations references. The information to be obtained during this part of the evaluation is described in this section. Also, for comparison purposes, baseline capabilities are given wherever possible which will assist the evaluator in determining the adequacy or acceptability of plant operational procedures and resources. The form shown in Appendix F can be used to evaluate the major factors affecting plant operations and assessing operational capabilities.

Operating Personnel

The best engineered plant would not perform to its potential without the management provided by a capable operator. Conversely, many poorly designed plants can and do perform satisfactorily with respect to effluent criteria due to conscientious and capable operators. Through discussions with the plant superintendent the evaluation team must establish the abilities and limitations of the operating staff. At small plants this may involve in-depth discussions with only one operator. At larger facilities, the investigations should be directed toward the chief operator for each shift or the individuals in charge of overall operations, those in charge of specific process operations (i.e., digester control operator), and those responsible for laboratory functions.

The evaluator should determine the level of education of each of the responsible operating personnel. For individuals in supervisory positions and in situations where there is only one operator the equivalent of a high school graduate would be considered baseline. The evaluation team

must assess the level of knowledge that the plant operators have regarding wastewater treatment. The aptitude of the operating personnel in this regard must be assessed through question-and-answer sessions in which treatment theory and process control techniques are discussed. Careful analysis of the operators responses is the best way to determine his ability to comprehend and apply the concepts of wastewater treatment. Specific questions to be asked depend on the type and complexity of treatment process involved. For example, in the case of an activated sludge plant the operator might be asked if he has ever encountered a bulking problem and, if so, what action he took in response. He might further be asked if he feels his process can be controlled by F/M or mean cell residence time techniques and how this might be accomplished. The operator of a trickling filter plant might be asked about his plant's recirculation control capabilities. Questions concerning sludge handling and disposal, and laboratory techniques should also be posed.

Operator attitude has an important bearing on the overall performance of a plant. A good attitude toward operating the plant is an indication that the personnel are at least expending the effort to produce a high quality effluent. Evaluation of operator attitude is necessarily subjective. Often a poor attitude is evidenced by excessive complaining about working conditions; an antagonistic reaction to the evaluation; placing all culpability for performance problems on the engineer, plant administration, or regulatory entities; an inability to get along with others; high rate of absenteeism; or (of most importance) indifference toward the problems at the plant. This last manifestation of poor attitude is usually accompanied by poor records keeping, poor condition of equipment, and inadequate laboratory testing. It is recognized that in many instances operators complaints are justified by the circumstances. The evaluator must judge the degree to which the operator is offering constructive criticism, and conversely, the degree to which negativism and attitude problems prevail.

Plant Monitoring

Monitoring activities conducted at a treatment facility by the operatating personnel are a good indication of the emphasis placed on operations, and the operator's understanding of process control. Factors affecting a plant's monitoring capabilities are described in this section. The evaluation team is responsible for making value judgements in each of these areas.

The sampling program followed at a treatment plant must be compared with recommended or required procedures. Performance sampling (i.e., that sampling of the plant influent and effluent required under the NPDES or other permit) should conform with permit requirements. Such requirements may include composite sampling. The frequency of sampling may also be specified. If samples are going to be held for any period longer than a few hours before beginning the laboratory analyses, preservation techniques (as described in Appendix B) are to be employed.

In the case of performance testing, the evaluation team must determine whether the plant operators are analyzing the influent and effluent according to permit requirements. Are all the required performance tests

(BOD_5, suspended solids, fecal coliform, pH, etc.) being run? Does the operator or laboratory technician perform the tests at the frequency stipulated in the NPDES permit? Are any tests performed by an outside laboratory? Are all tests performed in accordance with accepted references, specifically EPA's "Methods for Chemical Analysis of Water and Wastes" or "Standard Methods." With respect to this last point, the evaluation team should directly observe the operator's or technician's laboratory techniques. This will enable the evaluator to identify any improper techniques (such as in handling, weighing, and calculating suspended solids), and also afford him the opportunity to discuss laboratory procedures with the analyst. This discussion will provide some insight into the capabilities and attitudes of laboratory personnel. If direct observation is not possible, the evaluation team should request that the operator or laboratory individual briefly describe the techniques that he uses in a step-by-step manner for each analysis. Information obtained on sampling and laboratory capability should be recorded in the format shown in Appendix G, Laboratory Testing Capability and Performance. This information should (at that time) be compared with the approved methods presented in the references.

Process testing should be evaluated in a manner similar to performance testing. Although these tests are not required by permit, effective process control of certain unit processes, such as the activated sludge system or the anaerobic digester, requires such tests be conducted in order that appropriate control adjustments may be made.

Unlike the performance testing case, process testing scope and frequency will not be set forth in regulatory permits. Therefore, the evaluator must use judgement and references in setting a framework of acceptable process testing at a given plant. Table 6 presents a guide for evaluating the acceptability of process control testing for various processes and interprocess streams, for plants in the small, medium, and large design categories. The table may be used as a general guide, but specific conditions at each plant should be taken into consideration when applying the table in the field.

TABLE 6

Guide for Evaluating Process Testing

	BOD_5	Suspended Solids	Volatile Suspended Solids	D. O.	pH	Alkalinity	Volatile Acids
PRIMARY EFFLUENT							
Less than 1 mgd	1/wk	1/wk	-	-	Daily	-	-
1 to 5 mgd	2/wk	2/wk	-	-	Daily	-	-
Greater than 5 mgd	2/wk	2/wk	-	-	Daily	-	-
TRICKLING FILTER EFFLUENT							
Less than 1 mgd	1/wk	1/wk	-	Daily	-	-	-
1 to 5 mgd	2/wk	2/wk	-	Daily	-	-	-
Greater than 5 mgd	2/wk	2/wk	-	Daily	-	-	-
MIXED LIQUOR							
Less than 1 mgd	-	2/wk	1/wk	Daily	Daily	-	-
1 to 5 mgd	-	4/wk	2/wk	3/day	Daily	-	-
Greater than 5 mgd	-	Daily	4/wk	3/day	Daily	-	-
RETURN SLUDGE							
Less than 1 mgd	-	1/wk	1/wk	-	-	-	-
1 to 5 mgd	-	2/wk	1/wk	-	-	-	-
Greater than 5 mgd	-	4/wk	2/wk	-	-	-	-
THICKENED SLUDGE							
Less than 1 mgd	-	1/wk	1/wk	-	-	-	-
1 to 5 mgd	-	2/wk	2/wk	-	-	-	-
Greater than 5 mgd	-	2/wk	2/wk	-	-	-	-
PRIMARY DIGESTER							
Less than 1 mgd	-	-	1/wk	-	2/wk	1/wk	1/wk
1 to 5 mgd	-	-	2/wk	-	Daily	2/wk	2/wk
Greater than 5 mgd	-	-	2/wk	-	Daily	2/wk	2/wk
DIGESTED SLUDGE (Aerobic and anaerobic)							
Less than 1 mgd	-	1/mo	1/mo	-	-	-	-
1 to 5 mgd	-	1/wk	1/wk	-	-	-	-
Greater than 5 mgd	-	2/wk	2/wk	-	-	-	-
DEWATERED SLUDGE							
Less than 1 mgd	-	1/mo	1/mo	-	-	-	-
1 to 5 mgd	-	1/wk	1/wk	-	-	-	-
Greater than 5 mgd	-	2/wk	2/wk	-	-	-	-
RETURN STREAMS (Thickener overflow, secondary digester supernatant, filtrate)							
Less than 1 mgd	1/mo	1/mo	1/mo	-	-	-	-
1 to 5 mgd	1/wk	1/wk	1/wk	-	-	-	-
Greater than 5 mgd	2/wk	2/wk	2/wk	-	-	-	-

The evaluation team should document the plant's analytical capabilities. Does the operator or his designated staff know how to perform the previously mentioned performance and process tests? Is the laboratory properly equipped with the required apparatus, reagents, and equipment described in the previously cited analytical references? The condition of the laboratory should also be evaluated. Broken or inoperable equipment should be noted. Are chemicals and reagents properly stored? Is all glassware clean? The overall organization of the laboratory should also be assessed. Does the laboratory appear "cluttered" or disorganized?

Maintaining adequate records of plant monitoring is an important aspect of operations. Records should include copies of NPDES monitoring reports dating back at least two years and complete records of all process monitoring for the current and previous year. As a minimum, annual summary sheets of all performance and process monitoring should be filed at the plant for all previous years. Neatness and organization of monitoring records should be assessed. Entries of laboratory results should be scrutinized. Evidence of repetitive results within allowable effluent criteria, not consistent with the statistical nature of the laboratory procedure, may indicate poor laboratory techniques or even falsification of monitoring reports.

Process Control

An effective process control program is essential if a biological treatment plant's performance is to be optimized. This is especially true in the case of activated sludge systems. However, process control is not something that will be easily quantified by the evaluation team. In most cases, the evaluators will have to rely on discussions with the plant superintendent and/or operators to supplement available records and observations.

The evaluation team must determine how knowledgeable the operator is with respect to process control methods. Are the typical process control parameters, such as food to microorganism ratio (F/M) and mean-cell residence time (MCRT), familiar to the operator? Does the operator understand how to calculate these parameters and does he know what reasonable values are? Is he aware of the process control monitoring (i.e., influent BOD_5, MLSS, volume of sludge wasted, etc.) which must be performed to determine such control parameters?

The rational basis for any existing process control should be determined. For activated sludge plants some control methods in use include maintaining a constant MLSS or MLVSS concentration, maintaining a constant sludge age, or maintaining a constant F/M ratio. Controlled sludge wasting is critical to all of these procedures and thus should be carefully investigated by the evaluation team. In the case of trickling filter plants the use of recycle flow as a means of controlling the hydraulic loading on the units should be checked and discussed with the operator.

Previous plant performance surveys have shown that at some plants, the operator performs the recommended process tests, but makes no effective

use of the information. For example, MLSS levels may be monitored daily, although no attempt is ever made to adjust sludge wasting routines in order to maintain an optimum MLSS concentration. Through discussions with the operator, the evaluation team must determine whether the process monitoring data is being used to control the facility's performance or simply being compiled.

The evaluators must assess the emphasis placed on process control. Do the operators seem convinced that there is some utility in process control? Is process control a high-priority item in terms of manpower and time commitments?

Records of process control activities must be examined. The objective is to determine what actions were taken when control parameters were not within desired limits. For example, if the recycle volume to the trickling filter was increased during low flow periods, do the records indicate this action? Also, the records should indicate responses to implementation of process control adjustments. If the volume of sludge wasted from the system was increased to eliminate a bulking problem, for example, do the records indicate the success of this action?

Operations References

Good technical references are a significant asset to the operator with respect to efficient plant operation. The operations manual prepared specifically for the plant is the most important reference. Other reference materials relating to operations include manufacturer's literature, publications by professional organizations such as the Water Pollution Control Federation, and EPA documents.

The evaluation team should judge the adequacy of the operations manual at each plant. A comprehensive operations manual will address all aspects of the plant including laboratory functions, testing, process control, and safety. Start-up and shutdown procedures for all equipment should be presented in a stepwise fashion. The control center or panel should be described in detail with particular emphasis on the features of automatic control systems (i.e., what happens when certain buttons are pushed?). The manual should include detailed schematics of the plant piping that show all pumps, valves, and similar control devices. Troubleshooting procedures should be described in detail. For example, if a pinfloc were to develop in the final clarifier (resulting in increased effluent suspended solids concentrations), the manual should describe these symptoms and recommend corrective actions to be taken. The manual should contain a detailed process control procedure. This procedure should include all process testing requirements as well as centerlines and ranges for key process control parameters. The evaluation team should discuss the adequacy of the manual with the operator. To what extent has the manual assisted the staff in conducting operations? Is the manual written in a style that is readily understandable to the operator? In which areas should the manual be expanded (i.e., process control, laboratory techniques, troubleshooting procedures, etc.)?

Operational literature is frequently supplied to the treatment plant by equipment manufacturers. These references provide operators with specific information on equipment and unit processes that is intended to supplement the comprehensive operations manual. The evaluation team should first assess the availability and extent of such information at the plant itself. The evaluators should also determine whether the manufacturer's information fills any voids in the comprehensive manual. Organization of such literature should also be assessed (i.e., is there a filing system for manufacturer's literature or is the information scattered?).

Operations publications from professional organizations include Manuals of Practice (MOP) prepared by the WPCF and various state association handbooks. Examples of such documents are "Operation of Wastewater Treatment Plants" (MOP 11) and the "Manual of Wastewater Operations" prepared by the Texas Water Utilities Association. Such publications provide the operator with additional insight regarding items such as process control techniques and troubleshooting. Those reference materials are particularly important if the plant lacks a detailed comprehensive manual. The evaluation team should note the presence or absence of such publications. Do the operators find these references helpful? Are these publications frequently consulted? The contents and scope of these references should be discussed with the operator.

Another reference source for treatment plant operations is made available by EPA under the Technology Transfer Series. The evaluation team should note the availability of these references at the plant site, and should inquire as to their value to the plant staff. Do plant operators find these publications understandable? Have the manuals been used or merely stored on site.

In summary, thorough evaluation of operational factors is critical to the comprehensive evaluation. Successful investigation of this area requires in-depth conversations with the operating staff as well as careful analysis of operating records and observed process control and testing techniques. The evaluation team should be prepared to devote at least 50 percent of its field time to this effort.

Section 6. MAINTENANCE INVESTIGATIONS

Maintenance of the treatment plant is a primary responsibility of the staff. Maintenance duties typically range from performing simple routine maintenance functions, such as lubrication, to on-site repair of equipment. The plant maintenance program and its degree of success are a function of design and construction methods, as well as staff capabilities. In this section, various aspects of plant maintenance which must be examined by the evaluation team are discussed.

Units Out of Service

The evaluators should note all process units or equipment which are inoperable at the time of the evaluation. Through discussions with the operator, the team should determine the length of downtime for each unit, the performance and maintenance history of the unit, and estimate the level of effort that would be required to put the unit back in operation. If the reason for the unit being out of service is beyond the control of the operator (i.e., waiting for a special part to be manufactured and shipped), such reason should be noted. The evaluation team must assess the impact of out of service units on plant reliability and performance. The evaluation team should also document which major plant processes are provided with multiple units to provide backup capabilities or partial treatment during maintenance periods. The evaluators must question, in depth, the plant operators and maintenance staff with respect to which processes or equipment are the major problems from the maintenance viewpoint and where they feel additional preventive procedures or spare parts inventory are warranted.

Units Needing Repairs

Any units in operation but in need of repair should be noted. Symptoms of such needed repairs are noisy bearings in motors, seal and gland water leaking from pumps, oil leaking from mechanical parts (other than minor drippage), and excessive digester fuel consumption for heating purposes. The evaluation team should review with the plant maintenance personnel each of the units determined to be in need of repair or servicing; noting their comments regarding the reasons for such conditions, any proposed repair schedules, and any long-range programs for eliminating such conditions in the future.

Routine Maintenance Procedures

The evaluation team should assess the scheduling of routine or preventive maintenance. Such maintenance includes: lubrication, periodic draining and cleaning of tanks, repairing sludge scraping and skimming

mechanisms, repacking pumps, replacing bearings, cleaning diffusers on air headers and nozzles on trickling filter distributors, and cleaning flow measuring devices and monitoring equipment. Is such maintenance performed on schedule or only when time permits? Are adequate records of all such maintenance kept? Such records for each piece of equipment requiring maintenance should include the date and cost of repairs, time to repair, manpower expenditures, materials, and outside contractor costs. Generally, the evaluation team should determine whether the emphasis at the plant is placed on preventive or corrective maintenance.

Spare Parts and Equipment Availability

On the basis of discussions with the plant staff, it should be noted whether commonly needed spare parts (bearings, seals, etc.) are inventoried at the facility. If not, are these parts readily available from local suppliers? Does the plant include uncommon or obsolete equipment which makes it difficult or impossible to obtain parts when needed?

With respect to major equipment items, such as motors, mixers, or pumps, the evaluation team should determine their availability. Instances where excessive delivery times on such units have been encountered should be documented.

Chemical Supplies

The evaluation team should assess inventories of chemical supplies maintained at the plant. Through discussions with the plant staff, the reliability of chemical deliveries should also be determined. Do chemical supplies ever exhaust before deliveries? Are inventory records kept up to date, and are requests for deliveries made on the basis of those records?

Housekeeping

Visual observations should be made for the purpose of assessing housekeeping practices. Do equipment items appear clean and painted? Are the plant grounds well maintained? Are screening devices regularly cleaned? Is the control building neat and orderly? Is snow removal adequate? Are pumping station dry wells clean and dry? These are examples of various items which the evaluation team members should address regarding the staff's housekeeping practices.

Emergency Provisions

To effectively deal with emergency situations the plant must maintain certain baseline capabilities or provisions. An alternate power source (i.e., gasoline- or diesel-powered generators, or a second power service line from a separate substation) should be provided. Audible alarms should alert failures of major equipment items, such as pumps, chemical feeders, mixers, or aerators. Also, portable pumps should be readily available in case of flooding. The manpower resources available to the plant in times of emergency must be assessed. Such manpower includes permanent staff and personnel from other departments or private contractors that may be

brought in on short notice. Are emergency communication chains established? Does a contingency plan exist whereby sludge can be transported to another plant for handling and disposal? Records of such emergency actions indicating parts suppliers or contractors should also be maintained for reference, in case of repeat emergencies.

A checklist is shown in Appendix H that can be completed by the evaluation team to document the quality or regularity of various aspects of plant maintenance. In completing this checklist maintenance shortcomings and problem areas will become evident.

Maintenance References

Plant maintenance personnel must occasionally refer to written instructions, illustrations, or diagrams in performing their duties. The evaluation team should assess the availability of such maintenance references. The most likely source of such information is the operation and maintenance manual prepared specifically for the plant. Maintenance related items that should be covered in the manual include: routine maintenance procedures, equipment lubrication schedules, procedures for disassembling and reassembling major equipment items, and suggested spare parts inventory and recommended parts suppliers. The evaluators should assess the availability of supplementary maintenance information sources, such as might be supplied by the manufacturers of specific equipment items or processes. The extent and effectiveness of the use of such information by maintenance personnel must be assessed. The organization and accessibility of maintenance information must be evaluated.

Section 7. ADMINISTRATION INVESTIGATIONS

Administration of a treatment facility plays an important role in the overall performance. Administrative policies and procedures may directly result in operation or maintenance deficiencies that are noted during the evaluation. Administrative problems adversely impact plant performance in a subtle or indirect manner and their relationship to effluent quality may be difficult to discern. In this section of the manual, four key aspects of plant administration are discussed: plant staffing, budgeting, staff training, and use of consultant services. Each of these items and their effect on plant performance must be examined by the evaluation team.

Plant Staffing

It is unrealistic to expect any treatment facility to produce an effluent which consistently meets permit requirements and design performance standards if the plant does not have a sufficient number of employees to provide needed operation and maintenance. In an evaluation, plant staff responsibilities are grouped according to the following classifications: management, operations, maintenance, laboratory, and clerical. Unfortunately, labor breakdown at treatment facilities is not always in accordance with these classifications. For example, at small plants, a single employee may be responsible for all five labor categories. Even at large plants, an individual may be called an operator, although his duties include laboratory or clerical work. If an employee's time is divided between two or more labor categories, an estimate of the fraction of total time devoted to each category should be made. This should be accomplished by discussing the responsibilities and duties of each plant employee with the superintendent, and with his help, establishing the percentage of working time which each employee devotes to each of the five categories. The evaluation team should also note the number and specific days of the week that the plant is attended, the number of shifts staffed and the duty hours, and the types of personnel staffing and the categories of activities undertaken during the various shifts.

After the staffing information is gathered, the evaluation team must assess the adequacy of: 1.) the number of plant employees, 2.) the distribution of manpower among the five labor categories, and 3.) shift coverage. To do this, the evaluators must examine each of the labor categories in an overview manner with respect to the quality and completeness of activities. Where deficiencies have been noted, the team must discuss with the superintendent the extent to which these deficiencies have affected the performance of the plant. Also, the evaluation team must determine how successfully the present plant staff could respond to any noted deficiencies, and assess the need for additional personnel. For example, if a deficiency

is evident in the area of process control, the evaluator must determine (in this example) whether the currently employed personnel can handle the additional responsibilities to correct the deficiency.

One reference for roughly checking the adequacy of existing staff levels and the need for additional personnel is the EPA technical report entitled, "Estimating Staffing for Municipal Wastewater Treatment Facilities". Because all plant specific contingencies could not possibly be covered, the staffing estimates prepared according to guidelines given in this document are not to be considered absolute requirements. However, the EPA publication can be used as a source for determining baseline staffing needs to which adjustments reflecting specific plant requirements may be made by the evaluation team. The results of this procedure would be an estimate of required manpower for each labor category against which the actual plant manpower situation could be compared.

Budgeting

Budgeting is one aspect of plant administration which is often cited as being responsible for deficiencies in other areas of plant management, such as maintenance or staffing. However, a large number of facilities are operated effectively on tight budgets and are able to meet performance standards. Therefore, the evaluator must discern when funding is used as an excuse for poor performance when it is not the true cause. Also, the team must determine not only the adequacy of the operating budget, but the impact that budget has on performance.

The evaluation team must obtain a copy of the most recent operating budget and records of expenditures. Although it is recognized that accounting practices will vary from one municipality to the next, for purposes of standardizing data as much as possible the information should be documented in a form similar to that present in Appendix I.

The adequacy of funds provided for the operation, maintenance and administration of a particular installation is something that can be measured indirectly by certain plant characteristics, such as the condition of the facility, the adequacy of staffing, and the morale of the employees. The evaluators must determine for example, if poor performance is attributed to the inappropriate use of existing maintenance labor forces or to insufficient maintenance personnel, spare parts, or replacement equipment due to an inadequate budget. The budget amounts for the various maintenance categories must then be checked in order to be able to answer the following questions. Have deficiencies in available funds impeded operational or maintenance practices? Do the plant personnel convey extreme dissatisfaction with salary levels? Are there salary inequities within the current staffing? In what specific areas does the plant superintendent feel that additional funding must be provided? Have requests to fund specific areas of operation and maintenance been repeatedly turned down?

If the adequacy of budgeting is suspect or the inadequacy is documented, the evaluation team should estimate the needed improvements in budget amounts and categories. Such estimates would be developed on the

basis of changes in the staffing mix or pattern, additional personnel requirements, spare parts inventory improvements, chemical supply increases, laboratory improvements, and other expenditures required to achieve optimum performance levels. For reference purposes, the publication, "Analysis of Operation & Maintenance Costs for Municipal Wastewater Treatment Systems", published by EPA in 1978 can be used. It presents the results of comprehensive cost surveys for plants of various types, sizes, and geographical locations and can be used to compare operating costs at a particular facility with the costs at similar facilities within the same geographic area. The drawback to using the document to develop standards of comparison is that it is not known how many plants included in the data base may have been inadequately funded.

Staff Training

In the context of this comprehensive evaluation, staff training is considered to be an administrative matter, because the opportunity to participate in training courses is usually made available to the operators by those individuals with administrative responsibility for the plant. Discussions should be held with the plant operators to determine the extent of training received. Standardized courses in wastewater treatment which are typically available to plant operators are the Sacramento and Clemson series. These training sessions have been offered through local community colleges and through correspondence. Similar training courses and seminars are normally sponsored and presented by state environmental agencies, water pollution control organizations, and vocational-technical schools or community colleges. In addition, EPA's "Operational Control Procedures for the Activated Sludge Process" has been offered to select plants at no cost.

The team should determine the number and level of certified operators on the plant staff. State certification is often an indication of a basic background knowledge of waste treatment fundamentals. How helpful has the staff found the information gained from preparing for state certification examinations? As certified operators, do they periodically receive information or training from the state such as, refresher courses?

In some instances, plants have instituted relatively sophisticated on-the-job training programs, in which the more experienced, better trained, senior operators convey their knowledge to new or inexperienced employees through formal hands-on training seminars or programs. Also, in many cases, consultants are retained to provide training during start-up of new or upgraded facilities. Whenever programs such as these are encountered, the evaluators should determine their relative effectiveness. Are all operators, especially newer ones, familiar with aspects of operations specific to the plant including unusual or old pieces of equipment? Have the individual operators found specific on-site training programs to be helpful in comparison to other training programs?

In all cases, the team should determine the extent to which the plant personnel have retained the training received. Were laboratory testing and process control techniques actually learned or memorized and soon

forgotten? If training was not retained, was it because of a lack of use of learned principals?

Use of Consultant Services

The evaluation team should discuss with the plant superintendent or administrative official the extent of their use of consultants or other technical experts. How does the plant make use of consultants? Is a technical assistance only called upon when problems develop? Is an engineer retained to regularly monitor the plant performance? Does the consultant have a thorough knowledge of the plants historical performance problems? Do the superintendent and invididual operators feel that the consultant provides a useful service that is responsive to specific plant needs? Is local availability of technical assistance a problem? What impact does cost have on the extent of use of outside technical expertise.

In addition to the four aspects of administration discussed in this section, other administrative policies and attitudes can also have an adverse impact on plant performance. If the municipal administrators feel that the management of the treatment plant is a low priority item, such an attitude could be reflected by the plant's condition and performance. If administrative policy is such that no additional funds are available unless absolutely necessary (i.e., no funds for replacing old or worn equipment), the condition of the facility would be expected to reflect this attitude. Also, salaries of the plant staff may be kept low as a result of the attitude of administrators that wastewater treatment is not as important as other municipal services. The plant superintendent and operators should be questioned concerning their perception of such attitudes or policies on the part of the administration. If it is the intent of the evaluation team to discuss such matters with the administration representative, the plant staff should be so informed prior to initiating any questioning in these areas. Plant personnel may not want those responsible for administration to be made aware of their attitudes or grievances in these areas.

On the basis of the investigations described in this section, the team should be capable of evaluating administrative practices and identifying any administrative shortcomings. A form that will help to summarize administrative characteristics for a particular facility is given in Appendix J.

Section 8. PLANT EVALUATION SUMMARY

The ultimate objective of the treatment plant evaluation procedure described in this manual is to identify and rank all factors that adversely impact the plant's performance. Although the weighting procedure involves quantifying professional judgments and subjective evaluations, the factors must be ranked if a rational and comprehensive correction program is to be formulated.

To organize and streamline the weighting and ranking process a plant evaluation summary form is used. The numerical weighting procedure used to complete the summary form and the form itself are discussed in this section, and a sample PLANT EVALUATION SUMMARY form is given in Appendix K. The form should be completed as much as possible during the field survey. However, because certain factors cannot be weighted until the results of laboratory analyses are available, some of the form will be completed following field work.

The PLANT EVALUATION SUMMARY form consists of three parts. Part 1 records general plant identification information. Part 3 is the Weighting Table in which all factors evaluated are rated numerically from zero (0) to three (3) in order to reflect the degree of adverse impact each factor has on plant performance. Part 2 is the Ranking Table on which the most significant problems are listed in order of importance. The procedures to follow to complete the three sections of the SUMMARY are described in the following paragraphs.

Part 1. General Information

This brief section of the summary form records general background data used to describe the treatment plant. Basically the plant is categorized with respect to size (design flow), age, most recent modifications, and biological process type. Also, space is provided for the evaluator to comment on plant performance. This should be a brief assessment of performance as observed by the evaluator during the field studies. For example, a continuously turbid effluent or major equipment breakdown during the survey should be noted in the space provided.

The terms used in Part 1 are defined as follows:

Plant Name	Name of the plant as noted on the NPDES permit.
Plant Type	Specific description of type of plant (e.g. two stage trickling filter with anaerobic digestor or extended

	aeration activated sludge with polishing pond and without sludge digestion.
Design Flow	Plant design flow rate as of most recent upgrade.
Actual Flow	Sewage flow rate for current operating condition (e.g., for past one to two months). Also significant seasonal variation in flows will be noted.
Year Plant Built	Year initial units were put into operation that are still functioning.
Year of Most Recent Upgrade	Year last additional major units were put into operation (e.g., digester, chlorine contact chamber, etc.).
Plant Performance	Brief description of plant performance as related to present and anticipated treatment requirements.

Part 3. Weighting Table

The Weighting Table presents a listing of approximately 70 factors which could contribute to performance problems in a biological treatment process. Others may be added to suit specific situations. For each factor identified at a facility, the evaluation team must weigh the impact of each of these factors on performance and assign it a numerical weighing scale value of 0, 1, 2, or 3, in accordance with the following definitions.

Weighing Scale	Effect of Factor on Plant Performance
0	No significant effect on plant performance. No apparent deficiencies exist. Capability appears adequate. No problems are apparent.
1	Minor effect on plant performance. Plant may be deficient in this area. Capability is marginally adequate. Little or no problems result.
2	Minimum indirect effect on plant performance on a continuous basis or major direct effect on plant performance on a periodic basis. Plant may be deficient in this area. Capability is inadequate. Some problems result.
3	Plant is deficient in this area. Capability is required but nonexistent. Major direct effect on plant performance. Considerable problems result.

Good judgement must be used in applying weighing values because the final ranking of problem factors depends on results of the weighting procedure. The evaluator must be as consistent as possible in determining effect on performance and assigning one of the above numerical values. Each member of

the evaluation team may independently assign weighting factors. However, when the results are compared and discussed, the responsibility for assigning the final value to each factor belongs to the team leader. An explanation of terms and factors to be considered when assigning scale values for each factor in the weighting table are given in Table 7.

TABLE 7

WEIGHTING TABLE

CATEGORY	EXPLANATION
A. ADMINISTRATION	
1. Plant Administrators	
a. Policies	Do the appropriate staff members have the authority to make required decisions regarding operations (e.g., valve adjustment), maintenance (e.g., hire electrician), and/or administration (e.g., purchase critical piece of equipment) decisions or do the administration policies require a strict adherence to a "chain of command" that has caused critical decisions to be delayed, which in turn affected plant performance and reliability? Does an established administrative policy limit plant performance?
B. Familiarity with Plant Needs	Do the administrators have a first hand knowledge of plant needs through plant visits, discussions with operators, etc. and if not, has this been a cause of poor plant performance and reliability through poor budget decisions, poor staff morale, poor O&M procedures to be continued, poor design decisions to be made, etc.?
2. Plant Staff	
a. Manpower	
1. Number	Does a limited number of people employed have a detrimental effect on plant operation through not getting the necessary work done?
2. Plant Coverage	Does the time period of plant operation influence process adjustments? Does inefficient usage of the number of people on the staff cause the operators to "get into each others way?"
b. Morale	
1. Motivation	Is the plant staff motivated to do a good job by self satisfaction?

2. Pay	Does a low pay scale discourage more highly qualified persons from applying for operator positions or cause operators to leave after they are trained?
3. Supervision	Does the plant superintendent - (or supervisor) operator working relationship cause adverse operator incentive?
4. Working Conditions	Does a poor working environment create a condition for poor work habits and lower operator morale?
c. Productivity	Does the plant staff conduct the daily operation and maintenance tasks in an efficient manner? Is time used efficiently?
d. Personnel Turnover	Does a high personnel turnover rate cause operation and/or maintenance problems which affect process performance or reliability?

3. Financial

a. Insufficient Funding	Does the lack of available funds cause poor salary schedules, insufficient spare parts and equipment repair, insufficient capital outlay for improvements, etc.?
b. Unnecessary Expenditures	Does the manner in which available funds are dispersed cause problems in obtaining needed equipment, staff, etc.? Is the money spent wisely?
c. Bond Indebtedness	Does the annual bond debt payment limit the amount of funds available for other needed items like equipment, staff, etc.? Does a disproportionate amount of the total budget go for bond debt retirement?

B. MAINTENANCE

1. General

a. Housekeeping	Has a lack of good housekeeping procedures (e.g., grit chamber or bar screen cleaning; unkept, untidy, or cluttered working environment) caused an excessive equipment failure rate?
b. Equipment Age	Has the age or obsolescence of critical pieces of equipment caused excessive equipment downtime and/or inefficient process

	performance and reliability (due to unavailability of replacement parts)?
c. Scheduling and Recording	Has the absence or lack of an effective maintenance scheduling and recording procedure created a condition for a sporadic preventive maintenance program that has caused unnecessary equipment failure?
d. Manpower	Has the lack of adequate maintenance manpower prevented or delayed maintenance functions?
2. Preventive	
a. Lack of Program	Has the lack of an effective maintenance program caused unnecessary equipment failures or excessive downtime that has degraded plant performance or reliability?
b. Reference Available	Has the absence of good equipment references caused unnecessary equipment failure or downtime for repair (includes maintenance portion of O&M manual)?
c. Spare Parts Inventory	Has a critically low or nonexistent spare parts inventory caused unnecessary delays in equipment repair reducing process performance?
3. Emergency	
a. Staff Expertise	Does the plant staff have the necessary expertise to keep the equipment operating, and to make smaller equipment repairs when necessary?
b. Critical Parts Procurement	Have delays in getting replacement parts caused extended periods of equipment downtime?
c. Technical Guidance	If technical guidance for repairing or installing equipment is necessary to decrease equipment downtime, is it retained?
C. DESIGN	
1. Plant Loading	Has the presence of "shock" loading characteristics over and above what the plant was designed for (or what is thought to be tolerable) reduced process performance by one or more of the listed loadings (a-e)?

a.	Organic	
b.	Hydraulic	
c.	Industrial	
d.	Toxic	
e.	Seasonal Variation	
f.	Infiltration/Inflow	Does excessive infiltration or inflow reduce process performance?
g.	Return Process Streams	Does an excessive volume of highly organic or toxic return process flow stream cause adverse effects on process performance, equipment problems, etc.)?
2.	Unit Design Adequacy	
a.	Preliminary Treatment	Have the design features of any preliminary treatment unit reduced plant performance?
b.	Primary Treatment	Have the design features of any primary treatment unit reduced plant performance?
c.	Secondary Treatment	
(1)	Process Flexibility	Does the lack of valves, piping, etc., limit plant performance and reliability when other modes of operations <u>of the existing plant</u> could be utilized to improve performance (e.g., operate activated sludge plant in plug, step, or contact stabilization mode; operate trickling filter with constant hydraulic loading or recirculation ratio; discharge good secondary treatment effluent as opposed to a degraded "polishing pond" effluent; etc.)?
(2)	Process Controllability	Do the existing process control features provide adequate adjustment and measurement over the appropriate flows (e.g., return sludge) in the range necessary to optimize process performance, or, is the flow difficult to adjust, variable once adjusted, not measured and recorded, not easily measurable, etc.?

	(3) Aerator	Does the type, size, shape, or location of the aerator impair treatment?
	(4) Clarifier	Does the size of the clarifier, placement of the weir, length of the weir, type of clarifier, or other miscellaneous problems impair treatment?
d.	Advanced Waste Treatment	Have the design features of any process which upgrades water quality to meet specific effluent limits which cannot be met by conventional primary and secondary treatment process (e.g., nitrification tanks, chemical treatment, multi-media filters) reduced plant performance? (Space has been provided for in the table to accommodate all advance processes encountered during the research project.)
e.	Disinfection	Have the design features of any disinfection unit reduced plant performance (e.g., proper mixing, detention time, feeding rates proportional to flow, etc.)?
f.	Sludge Wasting Capability	Does the plant have sludge wasting facilities? If so, can a known volume of sludge be wasted? Can sludge wasting be adequately controlled?
g.	Sludge Treatment	Does the type or size of sludge treatment process hinder sludge stabilization (once sludge has been removed from the wastewater treatment system) which in turn affects process operation (e.g., causes odor problems, causes limited sludge wasting, etc.)?
h.	Ultimate Sludge Disposal	Are the ultimate sludge disposal facilities of sufficient size and type to adequately handle the sludge? Are there any specific areas that limit ultimate sludge disposal, such as seasonal weather variations, crop harvesting, etc.?
3.	Miscellaneous	The miscellaneous design section covers areas of design inadequacy not specified in the previous design categories. (Space has been allowed to accommodate additional items not listed.)
a.	Plant Location	Does a poor plant location cause it to be inaccessible during certain periods of the year (e.g., winter) for chemical deliveries, equipment service, or routine operation?

b.	Unit Process Layout	Does the arrangement of the unit processes cause the inefficient utilization of operator time for checking various processes, collecting samples, making adjustments, etc.?
c.	Lack of Unit Bypass	Has the lack of unit bypass caused plant upset and long-term poor treatment, caused necessary preventive maintenance items to be cancelled or delayed; caused more than one unit to be out of service when maintaining only one unit?
d.	Hydraulic Profile	
	(1) Flow Backup	Does an insufficient hydraulic profile cause ground flooding or flooding of upstream units except clarifiers? Does periodic release of backed-up flow cause hydraulic surge?
	(2) Submerged Weirs	Does an insufficient hydraulic profile cause flooding of clarifiers and submerged clarifier weirs?
	(3) Flow Proportioning to Units	Has inadequate flow proportioning (or flow splitting) to duplicate units caused problems which degraded effluent quality or hindered achieving optimum process performance?
e.	Alarm System	Has the absence or inadequacy of a good alarm system for critical pieces of equipment caused unnecessary equipment failure or in any way caused degraded process performance?
f.	Alternate Power Source	Does the absence of an alternate power source cause problems in plant operation and/or plant performance?
g.	Process Automation	
	(1) Monitoring	Has the lack of needed automatic monitoring devices (D.O. meter, pH meter, etc.) caused excessive operator time to watch for slug loads or process upset to occur because of slug loads? Has a breakdown or malfunction of automated process monitoring features caused disruption of automated control features and subsequent degradation of process performance?
	(2) Control	Has the lack of needed automatic control devices caused excessive operator time to make process control changes or necessary changes to

		be cancelled or delayed? Has the breakdown or the improper workings of automatic control features caused degradation of process performance?
h.	Lack of Stand-by Units for Key Equipment	Has the lack of stand-by units for key equipment caused degraded process performance during breakdown, or cancelled or delayed necessary preventive maintenance?
i.	Laboratory Space and Equipment	Does the absence of an adequately equipped laboratory indirectly limit plant performance by the lack of operational testing and performance monitoring?
j.	Process Accessibility For Sampling	Has the inaccessibility of various process flow streams (e.g., recycle streams) for sampling caused needed information to not be obtained?
k.	Equipment Accessibility For Maintenance	Has the inaccessibility of various pieces of equipment caused extensive downtime or difficulty in making needed repairs or adjustments.
l.	Plant Inoperability Due to Weather	Are certain units in the plant extremely vulnerable to weather changes (e.g., cold temperature) and, as such, do not operate or do not operate as efficiently as necessary to achieve the required performance?

D. OPERATION

1. Staff Qualifications

a. Ability

(1)	Aptitude	Has the lack of capacity for learning or undertaking new ideas by staff members or cricical staff members caused poor O&M decisions to be made, causing poor plant performance or reliability?
(2)	Level of Education	Does a low level of education cause poor O&M decisions to be made?

b. Certification

(1)	Level of Certification	Does the lack of adequately certified operators result in poor process control decisions being made?

	(2) Training	Does the operators' nonattendance of available training programs result in poor process control decisions being made?
c.	Sewage Treatment Understanding	Has the operators' lack of understanding of Sewage Treatment been a factor in poor operational decisions and poor plant performance and reliability?
d.	Insufficient Time on Job (Green Crew)	Has a short time on the job caused improper process control adjustments to be made because of opening or closing a wrong valve, turning on or off a wrong pump, etc.?

2. Testing

a.	Performance Monitoring	Are the required monitoring tests being completed in compliance with the discharge permit?
b.	Process Control Testing	Has the absence or inadequacy of process control testing caused improper operational control decisions to be made?

3. Process Control Adjustments

a.	Operator Application of Concepts and Testing to Process Control	Has the operator been deficient in the application of his knowledge of sewage treatment and the interpretation of his process control testing, to process control adjustments?
b.	Technical Guidance	Does the plant lack guidance from a recognized expert (design engineer, operations consultant, etc.)? Has false operational information received from an equipment supplier, or from a paid technical consultant, caused improper operation decisions to be continued?

4. O&M Manual

a.	Adequacy	Has a poor O&M manual resulted in the operator making poor or improper operational decisions?
b.	Use by the Operator	Has lack of use of the O&M manual caused poor process control and poor treatment that could have been avoided?

5.	Miscellaneous	The miscellaneous operations category deals with any pertinent operational information not covered in the previous operational sections. (Space has been provided to accommodate additional items not listed.)
a.	Equipment Malfunction	Does malfunctioning equipment cause deteriorated process performance?
b.	Shift Staffing Adequacy (operations)	Has the improper distribution of adequate manpower delayed needed process control adjustments which in turn have caused poor plant performance?

Part 2. Ranking Table

In this part of the form, the specific factors that were weighted in Part 3 of the summary form are now ranked in order of severity of adverse impact on plant performance and reliability. An explanation of the terms used in the Ranking Table is as follows:

Ranking	The descending order of major causes that were detrimental to plant performance and reliability.
Problem Area	General category from Weighting Table (Administration, Maintenance, Design, or Operation).
Specific Problem	Causes of problem or deficiency as noted in Weighting Table (e.g., Plant Administrators - Policies).
Severity	Points assigned to specific problem in Weighting Table.

To complete Part 2, the 10 most serious problems are ranked in order of decreasing severity. It is likely that several problem areas will be given equal numerical ratings on the weighting table; that is, there may be five factors having the most severe rating of 3. In this situation the team leader must make a decision as to the order of ranking. In essence, this decision is a matter of asking the question "which of the highly weighted factors most directly impedes and most seriously interferes with plant performance?"

The care and thought that must be used in working through the weighting and ranking procedures, and the importance of the Plant Evaluation Summary cannot be overemphasized. The summary form is the culmination of all the extensive field, laboratory and office work performed and presents the results in a readily usable format. Inadequate treatment plant performance usually results from a combination of numerous factors. By identifying, weighting, and ranking these factors the most efficient and effective correction activity can be pursued. The Ranking Table then becomes the basis for a comprehensive program to correct problems, improve plant performance, and ultimately to achieve compliance.

Section 9. REPORT PREPARATION

Upon completion of all on-site investigations, a report must be prepared. This report must present the conclusions resulting from analyses of the field studies data and the related computations and comparisons. More importantly, the report must make specific recommendations for improving the plant's performance if such improvement is judged possible. Although all members of the evaluation team should become involved in the report preparation stage, the writing of the Plant Evaluation Report is the responsibility of the evaluation team supervisor. The other team members, at this stage of the evaluation, should contribute to sections of the report concerning their specific assignments, noting their observations made during the evaluation. All members of the evaluation team should review and comment on the conclusions and recommendations section. The following paragraphs will discuss the recommended organization of the comprehensive evaluation report, and procedures to be followed in preparing the report.

Analysis of Results

After all laboratory analyses are performed and monitoring data have been reduced, the unit process performance information should be compared to intended design standards and permit requirements. Overall removals and effluent concentrations of BOD_5 and suspended solids should be compared with the requirements of the NPDES permit. If the actual removals or effluent concentrations do not meet permit or design standards, a performance problem exists that may be remedied by a composite correction program.

The evaluation team must exercise extreme caution in identifying the cause of a performance problem. As noted throughout this manual, performance problems result from a combination of factors attributable to design, operation, maintenance and administrative deficiencies. Evaluators must be careful not to be unduly influenced by the obvious problems or to prejudge the causes of performance problems. All required data should be available first, and then thoroughly analyzed. Unless this restraint is practiced an investigator might, for example, attribute an effluent suspended solids problem to bulking sludge when in reality short-circuiting in the clarifier was the cause.

At this point in the evaluation, the team must assess all factors noted adversely affecting performance and determine which are the significant causes at the plant being evaluated. The Plant Evaluation Summary, discussed in the previous section is critical in this respect. The evaluators should review the overall performance and unit process parameters at the plant in light of the information contained in the Plant Evaluation Summary. Each

identified performance problem (ie, excessive effluent suspended solids concentrations) must be cross-referenced with each highly ranked factor (ie, inadequate sludge wasting, clarifier design, etc.) in the Plant Evaluation Summary. In this manner the actual causes of performance problems can be accurately identified. Similarly, those deficiencies which were noted during the survey that have no apparent adverse impact on performance will also be identified.

General observations of the evaluation team must also be considered in identifying causes of performance problems. The evaluation team supervisor should review with each team member the performance problems and non-standard operational parameters that were identified. Each team member should be asked to indicate any on-site observations that were made that would help substantiate these findings. For example, if a very dark mixed liquor was noted, such an observation would support an apparent long MCRT determined from data reduction. Similarly, if (as a result of data reduction) it was determined that volatile solids reduction in the digestion process was less than expected, an observation that the temperature in the primary digester was too low would help to confirm this finding.

Reporting Procedures and Format

Although rigid reporting guidelines cannot be followed in all situations, the format of the comprehensive evaluation reports should be sufficiently standardized to assure that the same type of information is presented in each report in similar format. The forms included in this manual are recommended for use in the presentation of data. As a minimum, each comprehensive evaluation report should be structured in accordance with the following:

Section 1. Summary - This section of the report briefly summarizes the performance of the facility and identifies the major problems or deficiencies noted during the survey.

Section 2. Description of Plant - This section describes the plant's location and presents a general description of the plant as set forth in the Plant Evaluation Summary. A process flow schematic should be included. Permit criteria should be recorded. Additional information to be presented includes: age of facility, date of most recent upgrading, and point of discharge.

Section 3. Design Evaluation - This section presents a unit-by-unit analysis of the entire treatment facility, addressing all major unit processes. The process design evaluation should include the completed Design Information Summary form. A discussion of design errors, deficiencies, and overloads should be included, along with their impact on plant and process performance.

Section 4. Performance Evaluation - This section summarizes the plant's actual performance as it relates to both design intent and

optimum capabilities. Performance should also be described statistically in terms of its compliance with NPDES limitations over the 12-month period. Annual average flows, influent and effluent pollutant concentrations, pollutant loadings, and percent removals should be documented.

Section 5. Operations Evaluation - This section summarizes the findings based on investigations of plant operational practices as described in Section 5. The completed forms, Laboratory Testing Capability and Performance and Summary of Operations Performance Indicators should be included in this section. All observations with respect to operating practices and procedures should be reported. This section should identify in detail potential operationally oriented causes of performance problems. Where program improvements are necessary, such needs should be stated.

Section 6. Maintenance Evaluation - This section summarizes the results of investigations conducted as discussed in Section 6 of this document. The completed form, Summary of Maintenance Performance Indicators should be included. The section should include observations made concerning maintenance programs. Areas of plant maintenance that can be cited as potential causes of performance problems should be identified. Additional maintenance needs should be noted.

Section 7. Administration Evaluation - This section summarizes the findings based on investigations performed as described in Section 7 of this protocol. The completed forms, Wastewater Treatment Facility Annual Operating Budget and Summary of Administrative Practices and Policies should be included in this section. Administrative shortcomings should be reported, as well as their apparent impact on other plant areas. Needed improvements in plant administrative procedures are to be noted.

Section 8. Plant Evaluation Summary - The Plant Evaluation Summary should be presented, including a brief discussion on how to interpret the information contained in the summary.

Section 9. Conclusions and Recommendations - This section presents all relevant conclusions regarding plant design, performance, operation, maintenance, and administrative factors adversely affecting plant performance. Causes of performance problems should be summarized. Actions to correct shortcomings should be classified as either:

1. Improvements needed to correct deficiencies that have been directly correlated with performance problems (first priority), or

2. improvements needed to correct deficiencies, although performance problems cannot be directly correlated with such deficiencies (second priority).

Each corrective action should also be classified with respect to being either:

1. A non-capital expenditure improvement, which is any action not involving the construction or modification of major physical facilities (first priority), or

2. a capital expenditure improvement, which is any action involving the construction or extensive modification of major physical facilities (second priority).

Wherever possible, the costs of implementing the corrective actions should be estimated. Specific recommendations should be presented. With few exceptions, recommendations must be limited to those corrective actions classified as "first priority" in both of the categories above. Exceptions would include any improvement that would require no (or minimal) cost. This section should also include a statement of the best effluent quality believed by the evaluator to be achievable if all non-capital intensive recommendations were to be implemented.

APPENDIX A

FIELD ANALYSIS REQUIREMENT FORM

SCHEMATIC OF FACILITY:

	A	B	C	D	E	F	G	H	I	J	K	L	M
FLOW													
TEMPERATURE													
SETTLEABLE SOLIDS													
SETTLEABILITY													
DISSOLVED OXYGEN													
pH													
CHLORINE FEED & RESIDUAL													
DRY SLIDE													
TURBIDITY													
TOTAL SOLIDS													
VOLATILE SUSP. SOLIDS													
SUSPENDED SOLIDS													
BOD													
ALKALINITY													
VOLATILE ACIDS													
ORGANIC NITROGEN													
AMMONIA													
NITRATE													
TOTAL PHOSPHATE													
ORTHO PHOSPHATE													
MICROSCOPIC EXAMINATION													
JAR TEST													
SLUDGE VOLUME LAB CENTRIFUGE													
FECAL COLIFORM													

NOTE: LETTERS INDICATE MONITORING POINTS.
FILLED BLOCKS IN TABLE INDICATE TEST;
1 = MON, 2 = TUES, ETC.

APPENDIX B

RECOMMENDATION FOR SAMPLING AND PRESERVATION
OF SAMPLES ACCORDING TO MEASUREMENT (1)

Measurement	Vol. Req. (ml)	Container	Preservative	Holding Time (6)
Acidity	100	P,G(2)	Cool, 4°C	24 Hrs.
Alkalinity	100	P,G	Cool, 4°C	24 Hrs.
Arsenic	100	P,G	HNO_3 to pH<2	6 Mos.
BOD	1000	P,G	Cool, 4°C	6 Hrs.(3)
Bromide	100	P,G	Cool, 4°C	24 Hrs.
COD	50	P,G	H_2SO_4 to pH<2	7 Days
Chloride	50	P,G	None Req.	7 Days
Chlorine Req.	50	P,G	Cool, 4°C	24 Hrs.
Color	50	P,G	Cool, 4°C	24 Hrs.
Cyanides	500	P,G	Cool, 4°C NaOH to pH 12	24 Hrs.
Dissolved Oxygen				
Probe	300	G only	Det. on site	No Holding
Winkler	300	G only	Fix on site	No Holding
Fluoride	300	P,G	Cool, 4°C	7 Days
Hardness	100	P,G	Cool, 4°C	7 Days
Iodide	100	P,G	Cool, 4°C	24 Hrs.
MBAS	250	P,G	Cool, 4°C	24 Hrs.

APPENDIX B

RECOMMENDATION FOR SAMPLING AND PRESERVATION
OF SAMPLES ACCORDING TO MEASUREMENT (1) (Continued)

Measurement	Vol. Req. (ml)	Container	Preservative	Holding Time (6)
Metals				
Dissolved	200	P,G	Filter on site HNO_3 to pH<2	6 Mos.
Suspended			Filter on site	6 Mos.
Total	100		HNO_3 to pH<2	6 Mos.
Mercury				
Dissolved	100	P,G	Filter HNO_3 to pH<2	38 Days (Glass) 13 Days (Hard Plastic)
Total	100	P,G	HNO_3 to pH<2	38 Days (Glass) 13 Days (Hard Plastic)
Nitrogen				
Ammonia	400	P,G	Cool, 4°C H_2SO_4 to pH<2	24 Hrs.(4)
Kjeldahl	500	P,G	Cool, 4°C H_2SO_4 to pH<2	24 Hrs.(4)
Nitrate	100	P,G	Cool, 4°C H_2SO_4 to pH<2	24 Hrs.(4)
Nitrite	50	P,G	Cool, 4°C	24 Hrs.(4)
NTA	50	P,G	Cool, 4°C	24 Hrs.
Oil & Grease	1000	G only	Cool, 4°C H_2SO_4 to pH<2	24 Hrs.
Organic Carbon	25	P,G	Cool, 4°C H_2SO_4 to pH<2	24 Hrs.

APPENDIX B

RECOMMENDATION FOR SAMPLING AND PRESERVATION
OF SAMPLES ACCORDING TO MEASUREMENT (1) (Continued)

Measurement	Vol. Req. (ml)	Container	Preservative	Holding Time (6)
pH	25	P,G	Cool, 4°C Det. on site	6 Hrs.(3)
Phenolics	500	G only	Cool, 4°C H_3PO_4 to pH<4 1.0 g $CuSO_4$/l	24 Hrs.
Phosphorus				
Orthophosphate, Dissolved	50	P,G	Filter on site Cool, 4°C	24 Hrs.(4)
Hydrolyzable	50	P,G	Cool, 4°C H_2SO_4 to pH<2	24 Hrs.(4)
Total	50	P,G	Cool, 4°C	24 Hrs.(4)
Total, Dissolved	50	P,G	Filter on site Cool, 4°C	24 Hrs.(4)
Residue				
Filterable	100	P,G	Cool, 4°C	7 Days
Non-Filterable	100	P,G	Cool, 4°C	7 Days
Total	100	P,G	Cool, 4°C	7 Days
Volatile	100	P,G	Cool, 4°C	7 Days
Settleable Matter	1000	P,G	None Req.	24 Hrs.
Selenium	50	P,G	HNO_3 to pH<2	6 Mos.
Silica	50	P only	Cool, 4°C	7 Days
Specific Conductance	100	P,G	Cool, 4°C	24 Hrs.(5)
Sulfate	50	P,G	Cool, 4°C	7 Days

APPENDIX B

RECOMMENDATION FOR SAMPLING AND PRESERVATION
OF SAMPLES ACCORDING TO MEASUREMENT (1) (Continued)

Measurement	Vol. Req. (ml)	Container	Preservative	Holding Time (6)
Sulfide	50	P,G	2 ml zinc acetate	24 Hrs.
Sulfite	50	P,G	Cool, 4°C	24 Hrs.
Temperature	1000	P,G	Det. on site	No Holding
Threshold Odor	200	G only	Cool, 4°C	24 Hrs.
Turbidity	100	P,G	Cool, 4°C	7 Days

1. More specific instructions for preservation and sampling are found with each procedure as detailed in this manual. A general discussion on sampling water and industrial wastewater may be found in ASTM, Part 23, p. 72-91 (1973).

2. Plastic or Glass.

3. If samples cannot be returned to the laboratory in less than 6 hours and holding time exceeds this limit, the final reported data should indicate the actual holding time.

4. Mercuric chloride may be used as an alternate preservative at a concentration of 40 mg/l, especially if a longer holding time is required. However, the use of mercuric chloride is discouraged whenever possible.

5. If the sample is stabilized by cooling, it should be warmed to 25°C for reading, or temperature correction made and results reported at 25°C.

6. It has been shown that samples properly preserved may be held for extended periods beyond the recommended holding time.

APPENDIX C

STATE WATER POLLUTION CONTROL AGENCIES

Region I

Connecticut

Dept. of Environmental Protection
Room 117, State Office Bldg.
165 Capitol Avenue
Hartford, Connecticut 06115
PHONE: 203-566-2110

Maine

Dept. of Environmental Protection
Ray Office Building
Hospital Street
Augusta, Maine 04333
PHONE: 207-289-2591

Massachusetts

Div. of Water Pollution Control
Dept. of Environmental
Quality Engineering
100 Cambridge Street
Boston, Massachusetts 02202
PHONE: 617-727-3855

New Hampshire

NH Water Supply & Pollution
Control Commission
P.O. Box 95 - 105 Loudon Rd.
Concord, New Hampshire 03301
PHONE: 603-271-3505

Rhode Island

Dept. of Health
75 Davis Street
Providence, Rhode Island 02908
PHONE: 401-277-2235

Vermont

Environmental Engineering Division
Agency of Environmental Conservation
State Office Building
Montpelier, Vermont 05602
PHONE: 802-828-2761

Region II

New Jersey

Public Wastewater Facilities Element
Division of Water Resources
Dept. of Environmental Protection
P.O. Box 2809
Trenton, New Jersey 08625
PHONE: 609-292-7762

New York

Bureau of Sewage Program
Division of Pure Waters
Dept. of Environmental Conservation
50 Wolf Road
Albany, New York 12233
PHONE: 518-457-7498

Puerto Rico

Air and Water
Environmental Quality Board
P.O. Box 1148
Santurce, Puerto Rico 00910
PHONE: 809-725-8692

Virgin Islands

Div. of Natural Resources Management
P.O. Box 578
St. Thomas, Virgin Islands 00801
PHONE: 809-774-6880

APPENDIX C

STATE WATER POLLUTION CONTROL AGENCIES (Continued)

Region III

Delaware

Div. of Environmental Control
Dept. of Natural Resources &
Environmental Control
Tatnall Building
Dover, Delaware 19901
PHONE: 302-678-4765

District of Columbia

Bureau of Air & Water Quality
Control
Dept. of Environmental Services
Environmental Health Admin.
614 H St., N.W.
Washington, D.C. 20002
PHONE: 202-629-3748

Maryland

Environmental Health Admin.
P.O. Box 13387
201 W. Preston Street
Baltimore, Maryland 21203
PHONE: 301-383-2740

Pennsylvania

Bureau of Water Quality Management
Dept. of Environmental Resources
P.O. Box 2063
Harrisburg, Pennsylvania 17120
PHONE: 717-787-2666

Virginia

State Water Control Board
Commonwealth of Virginia
2111 N. Hamilton Street
Richmond, Virginia 23230
PHONE: 804-786-1411

West Virginia

Div. of Water Resources
Dept. of Natural Resources
1201 Greenbrier Street
Charleston, West Virginia 25311
PHONE: 304-345-2107

Region IV

Alabama

Water Improvement Commission
State Office Building
Montgomery, Alabama 36133
PHONE: 205-832-3370

Florida

Div. of Environmental Programs
Dept. of Environmental Regulation
2562 Executive Center Circle, East
Tallahassee, Florida 32301
PHONE: 904-488-4807

Mississippi

Air & Water Pollution Control
Commission
P.O. Box 827
Jackson, Mississippi 39205
PHONE: 601-354-2550

North Carolina

Div. of Environmental Management
Dept. of Natural & Economic Resources
P.O. Box 27687
Raleigh, North Carolina 27611
PHONE: 919-829-4740

APPENDIX C

STATE WATER POLLUTION CONTROL AGENCIES (Continued)

Georgia

Water Protection Branch
Environmental Protection Div.
Dept. of Natural Resources
270 Washington St., S.W.
Room 820
Atlanta, Georgia 30334
PHONE: 404-656-6593

Kentucky

Div. of Water Quality
Dept. for Natural Resources &
Environmental Protection
U.S. 127 South
Frankfort, Kentucky 40601
PHONE: 502-564-3410

South Carolina

Environmental Quality Control
Dept. of Health & Environmental
Control
2600 Bull Street
Columbia, South Carolina 29201
PHONE: 803-758-5631

Tennessee

Div. of Water Quality Control
Dept. of Public Health
621 Cordell Hull Bldg.
Nashville, Tennessee 37219
PHONE: 615-741-2275

Region V

Illinois

Environmental Programs
Illinois Environmental Protection
Agency
2200 Churchill Road
Springfield, Illinois 62706
PHONE: 217-782-2027

Indiana

Stream Pollution Control Board
1330 West Michigan Street
Indianapolis, Indiana 46206
PHONE: 317-633-5467

Michigan

Bureau of Environmental Protection
Water Resources Commission
Stevens T. Mason Building
Lansing, Michigan 48926
PHONE: 517-373-2682

Minnesota

Div. of Water Quality
Minnesota Pollution Control Agency
1935 West County Road B2
Roseville, Minnesota 55113
PHONE: 612-296-7354

Ohio

OH Environmental Protection Agency
P.O. Box 1049
361 East Broad Street
Columbus, Ohio 43216
PHONE: 614-466-6686

Wisconsin

Dept. of Natural Resources
P.O. Box 450
Madison, Wisconsin 53701
PHONE: 608-266-2747

APPENDIX C

STATE WATER POLLUTION CONTROL AGENCIES (Continued)

Region VI

Arkansas

Dept. of Pollution Control
& Ecology
8001 National Drive
Little Rock, Arkansas 72209
PHONE: 501-371-1701

Louisiana

Health & Human Resources
Administration
P.O. Box 60630
New Orleans, Louisiana 70160
PHONE: 504-527-5112

New Mexico

Environmental Improvement Agency
P.O. Box 2348
Santa Fe, New Mexico 87503
PHONE: 505-827-5271, ext. 201

Oklahoma

Water Quality Services
State Dept. of Health
P.O. Box 53551
Oklahoma City, Oklahoma 73105
PHONE: 405-271-5205

Texas

Water Quality Board
P.O. Box 13246
Capitol Station
Austin, Texas 78711
PHONE: 512-475-3926

Region VII

Iowa

Water Quality Management Div.
Dept. of Environmental Quality
P.O. Box 3326
3920 Delaware Street
Des Moines, Iowa 50316
PHONE: 515-265-8134

Kansas

Water Quality Program
Div. of Environment
Dept. of Health & Environment
Building 740
Topeka, Kansas 66620
PHONE: 913-296-3825

Missouri

Clean Water Commission
Div. of Environmental Quality
P.O. Box 1368
Jefferson City, Missouri 65101
PHONE: 314-751-3241

Nebraska

Water Pollution Control
Dept. of Environmental Control
P.O. Box 94563
State House Sta.
Lincoln, Nebraska 68509
PHONE: 402-471-2186

APPENDIX C

STATE WATER POLLUTION CONTROL AGENCIES (Continued)

Region VIII

Colorado

Water Quality Control Div.
Department of Health
4210 E. 11th Avenue
Denver, Colorado 80220
PHONE: 303-388-6111

Montana

Water Quality Bureau
Dept. of Health & Environment Sciences
Cogswell Building
Helena, Montana 59601
PHONE: 406-449-2406

North Dakota

Div. of Water Supply & Pollution Control
Dept. of Health
State Capitol
Bismarck, North Dakota 58505
PHONE: 701-224-2386

South Dakota

Water Quality Control
Dept. of Environmental Protection
State Office Building #2
Pierre, South Dakota 57501
PHONE: 605-224-3351

Utah

Bureau of Water Quality
Bureau of Environmental Health
44 Medical Drive
Salt Lake City, Utah 84113
PHONE: 801-328-6146

Wyoming

Water Quality Division
Dept. of Environmental Quality
Hathaway Building
Cheyenne, Wyoming 82002
PHONE: 307-777-7781

Region IX

Arizona

Bureau of Water Quality Control
Room 200
1740 West Adams Street
Phoenix, Arizona 85007
PHONE: 602-271-5453

California

State Water Resources Control Board
Division of Water Quality
P.O. Box 100
Sacramento, California 95801
PHONE: 916-445-7972

Nevada

Department of Human Resources
Environmental Protection Services
201 So. Fall Street, Room 120
Capitol Complex
Carson City, Nevada 89710
PHONE: 702-885-4670

American Samoa

Environmental Quality Commission
Government of American Samoa
Office of the Governor
Pago Pago, American Samoa 96799
PHONE: 633-4116

APPENDIX C

STATE WATER POLLUTION CONTROL AGENCIES (Continued)

Guam

Environmental Protection Agency
Government of Guam
P.O. Box 2999
Agana, Guam 96910
PHONE: 646-8863

Trust Territory of the Pacific Islands

Div. of Environmental Health
Dept. of Health Services
Trust Territory of the Pacific Islands
Saipan, Mariana Islands 96950
PHONE: Via 00-0422

Hawaii

Dept. of Health
P.O. Box 3378
Honolulu, Hawaii 96801
PHONE: 808-548-6410

Region X

Alaska

Division of Air & Quality Control
Dept. of Environmental Conservation
Pouch O
Juneau, Alaska 99801
PHONE: 907-586-5371

Idaho

Dept. of Health & Welfare
Division of Environment
Statehouse
Boise, Idaho 83720
PHONE: 208-384-2390

Oregon

Water Quality Division
Dept. of Environmental Quality
1234 S.W. Morrison Street
Portland, Oregon 97205
PHONE: 503-229-5324

Washington

Office of Water Programs
Washington State Dept. of Ecology
Olympia, Washington 98504
PHONE: 206-753-3893

APPENDIX D

OPERATIONAL PARAMETER AND PERFORMANCE INDICATOR COMPUTATIONS

PARAMETER	UNITS	COMPUTATION	STREAM/PROCESS APPLICABILITY
Pollutant Removal	%	$\frac{\text{Influent conc. (mg/l)} - \text{Effluent conc. (mg/l)}}{\text{Influent conc. (mg/l)}} \times 100$	B, C, D
Pollutant Loading	lb/day	Waste flow (mgd) x conc. (mg/l) x 8.34	A, B, C, D
Detention Time	days	$\frac{\text{Unit Volume (ft}^3\text{)} \times 7.48\ \text{(gal/ft}^3\text{)}}{\text{Flow (gpd)}}$	E, G, H, I
Surface Loading (Overflow Rate)	gpd/ft^2(1)	$\frac{\text{Flow (gpd)}}{\text{Surface Area (ft}^2\text{)}}$	E, F, H
Weir Loading	gpd/ft	$\frac{\text{Flow (gpd)}}{\text{Weir Length (ft)}}$	E, H
Organic (Volumetric) Loading	$\frac{\text{lb BOD}_5\text{/day}}{1000\ ft^3}$	$\frac{\text{Flow (mgd)} \times \text{Unit Influent BOD}_5\ \text{(mg/l)} \times 8.34 \times 1000}{\text{Unit Volume (ft}^3\text{)}}$	F, G
F:M	$\frac{\text{lb BOD}_5\text{/day}}{\text{lb MLSS}}$	$\frac{\text{Flow (mgd)} \times \text{Unit Influent BOD}_5\ \text{(mg/l)}\ (10^6\ \text{gal/mg})}{\text{Unit Volume (ft}^3\text{)} \times 7.48\ \text{(gal/ft}^3\text{)} \times \text{Unit MLSS (mg/l)}}$	G
Sludge Volume Index (SVI)	-	$\frac{\text{Unit Settleable Solids conc. (\%)}}{\text{Unit Suspended Solids conc. (\%)}}$	G
Mean Cell Residence Time (MCRT)	days	$\frac{\text{Unit Volume (ft}^3\text{)} \times 7.48\ \text{(gal/ft}^3\text{)} \times 10^6\ \text{gal/mg} \times \text{Unit MLVSS (mg/l)}}{[(\text{Effluent Flow (mgd)} \times \text{Effluent VSS (mg/l)}) + (\text{Waste Sludge Flow (mgd)} \times \text{Waste Sludge VSS (mg/l)})]}$	G

A - Plant Influent
B - Plant Effluent
C - Primary Effluent
D - Secondary Effluent
E - Primary Clarification
F - Trickling Filter
G - Aeration Tank (Activated Sludge)
H - Secondary Clarification
I - Chlorination

(1) For trickling filters this is commonly expressed in terms of mgd/acre.

APPENDIX E

DESIGN INFORMATION SUMMARY FORM

A. Influent Characteristics

Average Daily Flow:	Design	_____ mgd	_____	m^3/day
	Current	_____ mgd	_____	m^3/day
Maximum Hourly Flow:	Design	_____ mgd	_____	m^3/day
	Current	_____ mgd	_____	m^3/day
Average Daily BOD_5:	Design	_____ lb	_____	kg
	Current	_____ lb	_____	kg
Average Daily TSS:	Design	_____ lb	_____	kg
	Current	_____ lb	_____	kg

Infiltration/Inflow:

Seasonal Variation:

Major Industrial Wastes:

Known Inhibitory Wastes:

Collection System:

Comments:

APPENDIX E

DESIGN INFORMATION SUMMARY FORM (Continued)

B. Unit Processes

Preliminary Treatment

Bar Screen:

Method of Cleaning (Manual or Mechanical) _____

Name _____

Model _____ Horsepower _____ Number of Screens _____

Bypass Capability _____ Dimensions of Screen (m) _____

Dimensions of Openings (cm) _____

Dimensions of Channel (m): Length _____ Width _____ Height _____

Cleaning Frequency _____

Daily Volume of Screenings (m^3) _____

Flow Through Velocity (m/s) _____

Within Building? _____ Heated? _____

Description of Operation:

Spare Parts Inventory:

Comments:

Screenings Disposal:

APPENDIX E

DESIGN INFORMATION SUMMARY FORM (Continued)

B. Unit Processes (Continued)

Preliminary Treatment

Shredding:

Type of Shredding Device _____ No. of Units _____

Name _____ Model _____ Horsepower _____

Size of Each Unit (m): Length _____ Width _____ Diameter _____

Hydraulic Capacity of Each Unit _____ Within Building? _____

Heated? _____

Maintenance:

Spare Parts Inventory:

Comments:

Grit Removal:

Type of System _____ No. of Units _____

Hydraulic Capacity of Each Unit _____

Dimensions of Each Unit (m): Length _____ Width _____

Depth _____ Diameter _____ Daily Volume of Grit (m^3) _____

Unit Volume of Grit ($m^3/10^6$ liters) Detention Time _____

Flow Through Velocity _____

Disposal of Grit:

Spare Parts Inventory:

Comments:

APPENDIX E

DESIGN INFORMATION SUMMARY FORM (Continued)

B. Unit Processes (Continued)

Flow Measurement

Flow Stream Measured _____

Control Section:

Type and Size _____

Location _____

Comments: (Operational problems, maintenance problems, unique features, preventive maintenance procedures, etc.)

Recorder:

Name _____ Model _____

Flow Range _____

Calibration Frequency _____

Date of Last Calibration _____

Relative Error (±%) _____

Location _____

Totalizer _____

Comments: (Operation and design problems, unique features, etc.)

APPENDIX E

DESIGN INFORMATION SUMMARY FORM (Continued)

B. Unit Processes (Continued)

Pumping

Flow Stream Pumped	Pump Type	Variable or Constant Speed	No. Pumps	Name	Model	HP	Capacity

Comments: (Flow control, suitability of installed equipment, etc.)

Comments:

Comments:

No. of Wet Wells	Wet Well Dimensions	Wet Well Det. Time	Alarm Systems	Ventilation Facilities
	Length (m)		High Water	
	Width (m)		Power Failure	
	Depth (m)		Pump Failure	

APPENDIX E

DESIGN INFORMATION SUMMARY FORM (Continued)

B. Unit Processes (Continued)

Primary Treatment

Primary Clarifier:

Number _____ Surface Dimensions _____

Water Depth (Shallowest) _____ ft _____ m

Water Depth (Deepest) _____ ft _____ m

Weir Location _____

Weir Length _____ ft _____ m

Total Surface Area _____ ft^2 _____ m^2

Total Volume _____ ft^3 _____ m^3

Flow (Design) _____ gpd _____ m^3/day

(Operating) _____ gpd _____ m^3/day

Weir Overflow Rate

(Design) _____ gpd/ft _____ m^3/day/m

(Operating) _____ gpd/ft _____ m^3/day/m

Surface Settling Rate

(Design) _____ gpd/ft^2 _____ m^3/day/m^2

(Operating) _____ gpd/ft^2 _____ m^3/day/m^2

Hydraulic Detention Time (Design) _____

(Operating) _____

Collector Mechanism Name _____

Model _____ Horsepower _____

Size of Sludge Pumps (l/min) _____ Sludge Pump _____

APPENDIX E

DESIGN INFORMATION SUMMARY FORM (Continued)

B. Unit Processes (Continued)

Primary Treatment

Control (Manual or Automatic) _____ Type of Alarm System _____

Scum Collection and Treatment:

Maintenance:

Spare Parts Inventory:

APPENDIX E

DESIGN INFORMATION SUMMARY FORM (Continued)

B. Unit Processes (Continued)

Secondary Treatment

ABF (Activated Bio Filter):

Name _____ No. Cells _____

Model _____ Freeboard _____

Surface Dimensions _____

Total Surface Area _____ ft^2 _____ m^2

Hydraulic Loading (Ml-d/hectare) _____

Media Depth _____ ft _____ m

Total Media Volume _____ ft^3 _____ m^3

Type of Media _____

Organic Loading $\left(\frac{kg\ BOD_5/day}{1000\ m^3}\right)$ _____

Recirculation Tank: Dimensions _____

Volume _____ gal _____ m^3

Capacity of Recirculation Pumps (l/min) _____

Recirculation Ratio:

Maintenance:

Comments:

APPENDIX E

DESIGN INFORMATION SUMMARY FORM (Continued)

B. Unit Processes (Continued)

Secondary Treatment

Rotating Biological Contactor (RBC):

No. Shafts _____ Length of Shafts _____ ft _____ m

Type of Media _____

No. Cells _____ Cell Volume _____ ft^3 _____ m^3

Name _____

Disc Diameter _____ ft _____ m

RPM _____

Peripheral Velocity _____ ft/sec _____ m/sec

Type of Drive _____

Total Surface Area _____ ft^2 _____ m^2

Percent Submergence _____

Flow (Design) _____ gpd _____ m^3/day

(Operating) _____ gpd _____ m^3/day

Hydraulic Loading:

(Design) _____ gpd/ft^2 _____ m^3/day/m^2

(Operating) _____ gpd/ft^2 _____ m^3/day/m^2

Temperature (Design) _____ (Operating) _____

Organic Loading

(Design) _____ kg BOD/day/1000 m^2 _____

(Operating) _____

Total Detention Time (Design) _____ hr (Operating) _____ hr

APPENDIX E

DESIGN INFORMATION SUMMARY FORM (Continued)

B. Unit Processes (Continued)

Secondary Treatment

Covered?_____ Heated? _____

Type of Alarm System:

Maintenance:

Spare Parts Inventory:

Comments:

APPENDIX E

DESIGN INFORMATION SUMMARY FORM (Continued)

B. Unit Processes (Continued)

Secondary Treatment

Trickling Filter:

No. Filters _____ Covered? _____

Surface Dimension _____

Type of Media _____

Media Depth _____ ft _____ m

Surface Area _____ ft^2 _____ m^2

Media Volume _____ ft^3 _____ m^3

Flow (Design) _____ gpd _____ m3/day

(Operating) _____ gpd _____ m^3/day

Organic Loading (Design) _____ lbs/ft^3

_____ gm/m^3

(Operating) _____ lbs/ft^3

_____ gm/m3

Hydraulic Loading (Design) _____ gpd/ft^2

_____ $m^3/day/m^2$

(Operating) _____ gpd/ft^2

_____ $m^3/day/m^2$

Capacity of Recirculation Pumps (gpm) _____

Recirculation Ratio:

Mode of Operation:

Maintenance:

Spare Parts Inventory:

Comments:

APPENDIX E

DESIGN INFORMATION SUMMARY FORM (Continued)

B. Unit Processes (Continued)

Secondary Treatment

Aeration Basin:

No. Basins _____ Surface Dimensions _____

Water Depth _____

Flow (Design) _____ gpd _____ m^3/day

(Operating) _____ gpd _____ m^3/day

Sewage Detention Time (Design) _____

(Operating) _____

BOD_5 Loading

(Design) _____ lb/ft^3 _____ gm/m^3

(Operating) _____ lb/ft^3 _____ gm/m^3

Food: Microorganism Ratio $\left(\frac{kg\ BOD_5/day}{kg\ MLSS}\right)$ _____

Covered? _____

Total Volume _____ ft^3 _____ m^3

Type of Aeration _____ No. Aerators _____

Name _____ Model _____ Horsepower _____

Oxygen Transfer Rate (kgO_2/hp-hr):

Mode of Operation:

Safety Provisions (For High-Purity O_2 Systems):

Type of Diffusers:

APPENDIX E

DESIGN INFORMATION SUMMARY FORM (Continued)

B. Unit Processes (Continued)

Secondary Treatment

Oxygen Transfer:

Type Aeration _____ No. Aerators _____ Name _____

Model _____ Horsepower _____

Capacity _____ cfm _____ m^3/min

No. Compressors _____ Name _____ Model _____

Horsepower _____ Capacity _____ cfm _____ m^3/min

Location _____

Spare Parts Inventory:

Maintenance:

Comments:

APPENDIX E

DESIGN INFORMATION SUMMARY FORM (Continued)

B. Unit Processes (Continued)

Secondary Treatment

Contact Basin:

Surface Dimension _____

Water Depth _____ ft _____ m

Volume _____ ft^3 _____ m^3

Flow (Design) _____ gpd _____ m^3/day

(Operating) _____ gpd _____ m^3/day

Sewage Detention Time (Design) _____ min (Operating) _____ min

Covered? _____

Comments:

Reaeration Basin:

Surface Dimension _____

Water Depth _____ ft _____ m

Volume _____ ft^3 _____ m^3

Hydraulic Detention Time at 100% Return

(Design) _____ hr (Operating) _____ hr

Flexibility to Operate as Conventional _____

Covered? _____

Comments:

APPENDIX E

DESIGN INFORMATION SUMMARY FORM (Continued)

B. Unit Processes (Continued)

Secondary Treatment

Number Compressors _____ Name _____

Model _____ Horsepower _____

Air Capacity (m^3/min)_____ Location _____

Type of Alarm System:

Maintenance:

Spare Parts Inventory:

Comments:

APPENDIX E

DESIGN INFORMATION SUMMARY FORM (Continued)

B. Unit Processes (Continued)

Secondary Treatment

Secondary Clarifiers:

No. _____ Dimension(s) _____

Water Depth (Shallowest) _____ ft _____ m

(Deepest) _____ ft _____ m

Volume (ft^3) _____ (m^3)

Weir Location _____

Weir Length _____ ft _____ m

Surface Area _____ ft^2 _____ m^2

Solids Loading Rate (lbs./day - ft^2) _____

Volume _____ ft^3 _____ m^3

Flow (Design) _____ gpd _____ m^3/day

(Operating) _____ gpd _____ m^3/day

Weir Overflow Rate (Design) _____ gpd/ft

_____ m^3/day/m

(Operating) _____ gpd/ft

_____ m3/day/m

Surface Settling Rate (Design) _____ gpd/ft^2

_____ m^3/day/m^2

(Operating) _____ gpd/ft^2

_____ m^3/day/m^2

APPENDIX E

DESIGN INFORMATION SUMMARY FORM (Continued)

B. Unit Processes (Continued)

Secondary Treatment

Hydraulic Detention Time (Design) _____ hr (Operating) _____ hr

Return Sludge Pump Capacity (l/min.):

Waste Sludge Pump Capacity (l/min.):

Return Sludge Pump Control (Manual or Automatic):

Type of Alarm System:

Collector Mechanism Name _____ Model _____ HP _____

Scum Collection and Removal:

Spare Parts Inventory:

Comments:

APPENDIX E

DESIGN INFORMATION SUMMARY FORM (Continued)

B. Unit Processes (Continued)

Disinfection

Contact Basin:

Number of Units _____

Surface Dimensions _____

Water Depth _____ ft _____ m

Volume _____ ft^3 _____ m^3

Detention Time (Design) _____ min (Operating) _____ min

Comments:

Disinfection:

Type of System (Chlorination, Ozonation, Etc.)

Name _____ Number _____

Capacity _____ lbs/day _____ kg/day

Type Injection _____

Feed Control System _____

Feed Rate (Operating) _____ lbs/day _____ kg/day

Dosage (Operating) _____ mg/l

Diffusers _____

Type of Alarm System _____

Spare Parts Inventory:

Maintenance:

Comments:

APPENDIX E

DESIGN INFORMATION SUMMARY FORM (Continued)

B. Unit Processes (Continued)

Filtration:

Type of Filter (Gravity, Pressure) _____ Number of Units _____

Size of Units (m) _____ Type of Media _____

Surface Loading Rate (l/sec-m^2) _____ Backwash Rate (l/sec-m^2) _____

Surface Wash Rate (l/sec-m^2) _____

Surface Wash Pressure (Pa) _____

Type of Control System (Constant Flow, Headloss, Time, etc.):

Type of Coagulant Addition System:

Backwash Cycle Control (Automatic, Manual):

Type of Alarm System:

Spare Parts Inventory:

Comments:

APPENDIX E

DESIGN INFORMATION SUMMARY FORM (Continued)

B. Unit Processess (Continued)

Land Application (Wastewater)

Number of Storage Units _____ Hydraulic _____

Loading Rate (m^3/hectare-day) _____

Organic Loading Rate (kg BOD_5/hectare-d) _____

Nitrogen Loading Rate (kg N/hectare-d) _____

Phosphorus Loading Rate (kg P/hectare-d) _____

Suspended Solids Loading Rate (kg SS/hectare-d) _____

Type of Distribution System (Irrigation, Sprinkler, Etc.) _____

Sprinkler Spacing _____ Nozzle Pressure (Pa) _____

Mode of Operation:

Spare Parts Inventory:

Comments:

APPENDIX E

DESIGN INFORMATION SUMMARY FORM (Continued)

B. Unit Processes (Continued)

Sludge Handling

Anaerobic Digestion:

No. of Units _____ Type of Units (Primary, Secondary) _____

Size of Each Unit: Diameter (m) _____ Depth (m) _____

Volume (m^3) _____ Flow (Design/Operating, m^3/day) _____

Detention Time (days): Design _____ Operating _____

Solids Loading (kg/day) _____

Influent Volatile Solids Content (%) _____

Effluent Volatile Solids Content (%) _____

Hydraulic Loading (l/m^3-day) _____

Organic Loading (kg VS/m^3-d) _____

Solids Retention Time (days) _____

Type of Digestion Mixing Device (Impeller, gas, pumping) _____

Type of Digestion Cover (Fixed, Floating) _____

Type of Heating Device _____ Digester Supernatant Return Point _____

Supernatant Flow (m^3/day) _____

APPENDIX E

DESIGN INFORMATION SUMMARY FORM (Continued)

B. Unit Processes (Continued)

Type of Alarm System:

Type of Safety Equipment:

Spare Parts Inventory:

Maintenance:

Mode of Operation:

Comments:

APPENDIX E

DESIGN INFORMATION SUMMARY FORM (Continued)

B. Unit Processes (Continued)

Sludge Handling

Aerobic Digestion:

No. of Units _____ Size of Units: Length _____ Width _____

Depth _____ Volume (m^3) _____ Solids Retention _____

Time (days) _____ Covered? _____ Heated? _____

Type of Aerator _____

Number of Aerators _____ Name _____

Model _____ Horsepower _____ Type of Diffuser _____

No. of Compressors _____ Name _____ Model _____

Horsepower _____ Air Capacity _____

Oxygen Transfer Rate (kgO_2/hp-hr.) _____

Influent Sludge Flow (m^3/day) _____

Influent Solids and Volatile Solids Content (%) _____

Effluent Solids and Volatile Solids Content (%) _____

Type of Sludge Treated _____

Safety Equipment:

Type of Alarm System:

Spare Parts Inventory:

Maintenance:

Mode of Operation:

Comments:

APPENDIX E

DESIGN INFORMATION SUMMARY FORM (Continued)

B. Unit Processes (Continued)

Sludge Handling

Sludge Thickening:

Number of Units _____ Size of Units (m) _____

Volume (m^3) _____ Surface Area (m^2) _____

Detention Time (hrs.) _____ Influent Sludge Volume (m^3/d) _____

Influent Solids Content (%) _____ Underflow Solids Content (%) _____

Overflow Volume (m^3/d) _____

Hydraulic Loading (l/m^2-hr) _____

Solids Loading (kg/m^2-hr) _____ Mixer Speed (rpm) _____

Size (m^3/min) and Type of Underflow Sludge Pump: _____

Type of Alarm System:

Spare Parts Inventory:

Maintenance:

Mode of Operation:

Comments:

APPENDIX E

DESIGN INFORMATION SUMMARY FORM (Continued)

B. Unit Processes (Continued)

Sludge Handling

Thermal Sludge Conditioning:

Design Influent Sludge Flow (m^3/d) _____ Design Temperature (°F) _____

Design Pressure (Pa) _____ Influent Solids Content (%) _____

Treated Sludge Volume (m^3/d) _____ Recycle Liquor Flow (m^3/d) _____

Treated Solids Concentration _____

Treatment of Recycle or Decant Liquor:

Operating Time (hrs./wk.):

Type of Alarm System:

Type of Safety Equipment:

Spare Parts Inventory:

Maintenance:

Mode of Operation:

Comments:

APPENDIX E

DESIGN INFORMATION SUMMARY FORM (Continued)

B. Unit Processes (Continued)

Sludge Handling

Sludge Dewatering:

Type of Dewatering Equipment (Vacuum Filter, Centrifuge, Filter Press, Drying Bed) _____

Centrifuge (rpm & horsepower) _____

Size of Unit (Centrifuge Diameter, Vacuum Drum Diameter and Width _____(m)

Filter Cloth Area (m^2) _____ Filter Vacuum (Pa) _____

Sludge Feed Rate (l/s) _____

Solids Feed Rate (kg Dry Solids/hr.) _____

Chemical and Polymer Conditioners Used and Dosage Rate (mg/l of Sludge) ___
_____

Chemical Pumping Method (Automatic or Manual) _____

Type of Sludge Treated (Primary, Waste Activated, Digested) _____

Cake Solids Content (%) _____

Filtrate or Centrate Solids Content (%) _____

Comments:

APPENDIX E

DESIGN INFORMATION SUMMARY FORM (Continued)

B. Unit Processes (Continued)

Land Application (Sludge)

Sludge Produced (Metric Tons/Yr.) _____

Dry Solids Content (%) _____ Volatile Solids Content (%) _____

Sludge Application Rate (kg Dry Solids/Hectare) _____

Type of Sludge Applied (Wet, Dewatered, Dry, Etc.) _____

Nitrogen Concentration (ppm) Heavy Metals Concentration (ppm) _____

Provisions for Emergency Storage:

Method of Land Application (Surface, Subsurface, Mix w/Soil, Etc.):

Number, Type, and Size of Application Equipment:

Mode of Operation:

Comments:

APPENDIX E

DESIGN INFORMATION SUMMARY FORM (Continued)

C. Other Design Information

Stand-by Power:

Alarm Systems:

Miscellaneous:

APPENDIX E

DESIGN INFORMATION SUMMARY FORM (Continued)

D. Plant Automation:

E. Laboratory Capability:

Location _____ Floor Dimensions _____

Counter Space _____ ft = _____ m Hot Water? _____

File Cabinet? _____ Desk? _____

Tests Performed by Whom _____

Operational Tests Conducted (TSS, D.O., S.V.I., BOD, pH, & Others) and Frequency:

Monitoring Tests Conducted (TSS, BOD, pH, Fecal Coliform, Others) and Frequency:

Quality Control:

Comments:

APPENDIX F

SUMMARY OF OPERATIONS PERFORMANCE INDICATORS

	Adequate	Marginal	Inadequate	None
Operating Personnel				
Level of Education				
Aptitude				
Attitude				
Plant Monitoring				
Sampling Procedures				
Performance Testing				
Process Testing				
Analytical Capabilities				
Laboratory Equipment				
Laboratory Organization				
Testing Procedures				
Monitoring Records				
Process Control				
Operator's Understanding				
Use of Process Testing Data				
Emphasis on Process Control				
Effectiveness of Control Procedures				
Records of Control Actions				
Operations References				
Completeness of Plant Manual				
Attention to Process Control				
Coverage of Laboratory Functions				
Start/Stop Procedures				
Control Systems				
Troubleshooting Coverage				
Comprehension Understandability by Staff				
Use by Staff				
Adequacy of Supplemental References				
Organization of Supplemental References				
Use of Supplemental References				

APPENDIX G

LABORATORY TESTING CAPABILITY AND PERFORMANCE
WASTEWATER TREATMENT FACILITIES

Parameter	Capability	Testing Method	Frequency	Sampling Location	Type of Sample[1]
Flow					
BOD_5					
Suspended Solids					
Fecal Coliform					
pH					
Phosphorus					
Ammonia Nitrogen					
Nitrate Nitrogen					
Total Kjeldahl					
Dissolved Oxygen					
Chlorine Residual					
COD					
Other - Settleable Solids					
Total: Volatile Solids					
Volatile Acids					

[1] C-24 = Composite, 24 hour
C = Grab

APPENDIX H

SUMMARY OF MAINTENANCE PERFORMANCE INDICATORS

	Adequate	Marginal	Inadequate	None
Units Out of Service				
Extent of Inoperable Equipment				
Length of Downtime				
Efforts to Return Units to Service				
Mechanical Reliability of Equipment				
Multiple Units for Major Processes				
Units Needing Repairs				
Extent of Equipment Needing Repairs				
Reasons for Delay in Repairs				
Long-range Correction Program				
Routine Maintenance Procedures				
Routine Maintenance Capabilities				
Scheduling of Routine Maintenance				
Performance According to Schedule				
Records				
Spare Parts & Equipment Availability				
Spare Parts Inventory				
Availability of Commonly Needed Parts				
Availability of Major Equipment Items				

APPENDIX H

SUMMARY OF MAINTENANCE
PERFORMANCE INDICATORS
(Continued)

	Adequate	Marginal	Inadequate	None
Chemical Supplies				
Chemical Supply Inventory				
Chemical Delivery Reliability				
Records				
Ordering Practices				
Housekeeping				
Equipment				
Plant Grounds				
Control Building				
Pumping Stations				
Emergency Provisions				
Auxiliary Power				
Alarm Systems				
Portable Equipment				
Manpower Resources				
Records				
Maintenance References				
Completeness of Plant Manual				
Routine Maintenance Descriptions in Plant Manual				
Availability of Supplemental Information				
Use of All Maintenance References				

APPENDIX I

PLANT BUDGET DATA AND SUMMARY

D. Plant Budget:

Revenue:

Type of Tap	Tap Fee	User Fee

Current Assessed Valuation _____

Current Mill Levy _____

Current Annual Revenue From Property Tax _____

Other Revenue Sources:

Comments:

APPENDIX I

PLANT BUDGET DATA AND SUMMARY (Continued)

D. Plant Budget (Continued)

(Budget Year _____)

APPENDIX I

PLANT BUDGET DATA AND SUMMARY (Continued)

D. Plant Budget (Continued)

Expenditures (Continued)

Bond Type	Year Issued	Duration	Interest Rate	Project Financed

Comments:

APPENDIX I

PLANT BUDGET DATA AND SUMMARY (Continued)

D. Plant Budget (Continued)

Electrical Costs

Source of Information _____

Month & Year	Days in Billing Period	KWH	Demand	Cost	¢/Kwh	Flow
Totals						mgd
						cu m/day

KWH/Day _____ $/Day _____

KWH/1000 gal _____ ¢/1000 gal _____

KWH/cu m _____ ¢/cu m _____

Cost Summary

	¢/cu m	¢/1000 gal
Electrical		
Salaries		
Total Operations		
Total Cost		

APPENDIX I

PLANT BUDGET DATA AND SUMMARY (Continued)

Operation and Maintenance

Salaries and Wages (Plant Staff)	$_____
Power	$_____
Fuel	$_____
Other Utilities (Water, Telephone, etc.)	$_____
Chemicals	$_____
Transportation	$_____
Supplies	$_____
Repairs (Parts and Equipment)	$_____
Contract Services	$_____
Miscellaneous	$_____
Subtotal	$_____

Administration

Salaries and Wages (Administrative Staff)	$_____
Benefits (All Staff)	$_____
Insurance	$_____
Office Rental	$_____
Bond Debt Retirement	$_____
Utilities	$_____
Supplies	$_____
Miscellaneous	$_____
Subtotal	$_____
Total	$_____

Cost/1000 gal
Cost/cu m

APPENDIX J

PLANT ADMINISTRATION SUMMARY

A. Organization:

Governing Body _____ No. Members _____

Terms of Election _____

Scheduled Meetings _____

Authority and Responsibility:

History:

Chain of Responsibilities:

Comments:

APPENDIX J

PLANT ADMINISTRATION SUMMARY (Continued)

B. Plant Personnel:

Personnel Classification (Title, Number, Pay Scale, Fraction of Time Spent at Sewage Treatment, Certification Grade):

Comments:

C. Plant Coverage:

Weekdays _____

Weekends & Holidays _____

APPENDIX J

PLANT ADMINISTRATION SUMMARY (Continued)

	Adequate	Marginal	Inadequate	None
Plant Staffing				
Staff Size				
Shift Coverage				
Labor Category Distribution				
Budgeting				
Total Funds Available				
Distribution of Available Funds				
Salaries				
Records				
Staff Training				
Certification of Staff				
Classroom Training				
Plant-specific (On-the-Job) Training				
Availability of Training Programs				
Retention of Training by Operators				
Willingness of Administrators to Fund Training				
Use of Consultant Services				
Extent of Use				
Availability of Such Services				
Ability to Afford Such Services				
Willingness to Accept Such Assistance				

APPENDIX K

PLANT EVALUATION SUMMARY
(SAMPLE FORM)

GENERAL INFORMATION (PART 1)

PLANT NAME _____

PLANT TYPE:
DESIGN FLOW:
ACTUAL FLOW:
YEAR PLANT BUILT:
YEAR OF MOST RECENT UPGRADE:
PLANT PERFORMANCE:

RANKING TABLE (PART 2)

RANKING	WEIGHTING TABLE REFERENCE CODE	CAUSE	POINTS
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

WEIGHTING TABLE (PART 3)

CATEGORY	PTS.	COMMENTS
A. ADMINISTRATION		
1. Plant Administrators		
a. Policies		
b. Familiarity with Plant Needs		
2. Plant Staff		
a. Manpower		
1. Number		
2. Plant Coverage		
b. Morale		
1. Motivation		
2. Pay		
3. Supervision		
4. Working Conditions		
c. Productivity		
d. Personnel Turnover		
3. Financial		
a. Insufficient Funding		
b. Unnecessary Expenditures		
c. Bond Indebtedness		

WEIGHTING TABLE (CONTINUED)

CATEGORY	PTS.	COMMENTS
B. MAINTENANCE		
1. General		
a. Housekeeping		
b. Equipment Age		
c. Scheduling & Recording		
d. Manpower		
2. Preventive		
a. Lack of Program		
b. References Available		
c. Spare Parts Inventory		
3. Emergency		
a. Staff Expertise		
b. Critical Parts Procurement		
c. Technical Guidance		

WEIGHTING TABLE (CONTINUED)

CATEGORY	PTS.	COMMENTS
C. DESIGN		
1. Plant Loading		
a. Organic		
b. Hydraulic		
c. Industrial		
d. Toxic		
e. Seasonal Variation		
f. Infiltration/Inflow		
g. Return Process Streams		
2. Unit Design Adequacy		
a. Preliminary		
b. Primary		
c. Secondary		
1. Process Flexibility		
2. Process Controlability		
3. Aerator		
4. Clarifier		
d. Advanced Waste Treatment		
1.		
2.		
3.		
4.		
e. Disinfection		
f. Sludge Wasting and Return		
g. Sludge Treatment		
h. Ultimate Sludge Disposal		
3. Miscellaneous		
a. Alarm Systems		
b. Alternate Power Source		
c. Plant Location		

WEIGHTING TABLE (CONTINUED

CATEGORY	PTS.	COMMENTS
3. Miscellaneous (Continued)		
d. Process Accessibility		
For Sampling		
e. Equipment Accessibility		
For Maintenance		
f. Plant Inoperability due		
to Weather		
g.		
h.		
4. Unit Process Layout		
a. Lack of Unit Bypass		
b. Hydraulic Profile		
1. Flow Backup		
2. Submerged Weirs		
3. Flow Proportioning to		
Units		
c. Unit Accessibility		
d. Process Automation		
1. Monitoring		
2. Control		
e. Lack of Stand-by Units For		
Key Equipment*		
f. Laboratory Space & Equipment		
* Include lack of duplicate pumps, chemical slakers, etc.		

WEIGHTING TABLE (CONTINUED)

CATEGORY	PTS.	COMMENTS
D. OPERATION		
1. Staff Qualifications		
a. Ability		
1. Aptitude		
2. Level of Education		
b. Certification		
1. Level of Certification		
2. Training		
c. Sewage Treatment Understanding		
d. Insufficient Time on the Job		
(Green crew)		
2. Testing		
a. Performance Monitoring		
b. Process Control Testing		
3. Process Control Adjustments		
a. Operator Application of Con-		
cepts and Testing to Process		
Control		
b. Technical Guidance		
4. O & M Manual		
a. Adequacy		
b. Use by Operators		
5. Miscellaneous		
a. Equipment Malfunction		
b. Shift Staffing Adequacy		
(Operations)		
c.		
d.		
e.		
f.		