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Office of Water
Enforcement and Permits (EN-338)
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NPDES Compliance Inspection Manual

NPDES COMPLIANCE INSPECTION MANUAL

Office of Water

Office of Water Enforcement and Permits

June 1984

U.S. Environmental Protection Agency
EN-338
401 M Street S.W.
Washington, D.C. 20460

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF WATER

MEMORANDUM

SUBJECT: NPDES Compliance Inspection Manual

FROM: Rebecca W. Hanmer, Director
Office of Water Enforcement and Permits (EN-338)

TO: Users of the NPDES Compliance Inspection Manual

This manual consolidates and amplifies the inspection information contained in the various guidance manuals previously published. Rather than being based on inspection types (i.e., compliance evaluation or compliance sampling inspections, etc.), it is based on compliance inspection activities (i.e., sampling, flow measurement, etc.). This structure makes the manual a flexible tool that can be used regardless of changes in inspection types because the inspector can refer to specific chapters relative to a particular activity. This flexibility also applies to the checklists provided at the end of each technical activity chapter.

The inspector's primary objective is to gather information and report facts. Integral to attaining this objective is a clear understanding of the purpose of the inspection. This manual will enable inspectors to focus their efforts properly, thereby maximizing the effectiveness of inspections and the use of available resources.

I believe that this manual will provide valuable assistance to inspectors in the conduct and successful completion of their very important duties. Please feel free to write the Office of Water Enforcement and Permits (EN-338) with suggestions, additions or improvements.

ACKNOWLEDGEMENTS

We wish to acknowledge the considerable efforts and cooperation of the many people whose contributions helped in the successful completion of this document.

This manual was prepared under the direction of Gary Polvi with assistance from David Rogers and Joseph Dowd, all of the Office of Water Enforcement and Permits. Extensive reviews were conducted by EPA Headquarters, Regional Offices and many State agencies. These reviews provided valuable comments, most of which were incorporated into this manual. Robert Reeves, EPA Region VI, Charles Sweatt, EPA Region IV, and Joe Kilby of the Delaware Department of Natural Resources and Environmental Control participated as peer reviewers and are acknowledged for their important contributions.

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Foreword

The National Pollutant Discharge Elimination System (NPDES) Compliance Inspection Manual has been developed to support inspection personnel in conducting the field investigations fundamental to the NPDES compliance program and to provide inspectors with standardized procedures for conducting complete, accurate inspections.

The depth of coverage of the information presented in this manual will provide a qualified inspector with the basic guidance necessary to complete an accurate inspection. The manual presents standard procedures for inspection; it is assumed the inspector has a working knowledge of wastewater and related problems, regulations, and control technologies. The clear, straightforward information presented in the manual will provide the experienced inspector with sufficient flexibility and easy reference. New inspection personnel will find support in the orderly and detailed presentation.

This manual presents the most recent information on NPDES compliance inspections to date. As new information concerning inspection protocols and policies emerge, the manual will be revised accordingly. Comments or changes to the present draft of the manual should be addressed to:

Compliance Branch Chief (EN-338)
Office of Water Enforcement and Permits
U.S. Environmental Protection Agency
401 M Street S.W.
Washington, DC 20460

The information contained in this manual is comprehensive and is designed to address a wide range of activities. Since each inspection may not involve all activities, the inspector should use those parts of the Manual applicable to the particular inspection. This also applies to the comprehensive checklists at the end of each technical chapter. Although the manual is written from the point of view of the U.S. Environmental Protection Agency, the information is applicable to other regulatory authorities or their authorized representatives.

The manual is organized into eight chapters.

- Chapter One: Introduction describes the NPDES program and provides general information relating to legal authority and inspector responsibilities.

- Chapter Two: Inspection Procedures discusses general procedures common to all NPDES inspections, including pre-inspection preparation, entry, opening conference, documentation, and closing conference.

- Chapters Three through Eight provide the specific technical information necessary to conduct the full range of NPDES compliance inspection activities. Each chapter describes procedures for the major technical activities involved in compliance inspections:

  - Chapter Three: Recordkeeping and Reporting
  - Chapter Four: Facility Site Review
  - Chapter Five: Sampling
  - Chapter Six: Flow Measurement
  - Chapter Seven: Biomonitoring
  - Chapter Eight: Laboratory Quality Assurance

The new NPDES Compliance Inspection Manual consolidates much information found in previous inspection manuals. Each of the earlier inspection manuals was based on a particular inspection type and is still accurate. In some cases, the older manuals cover some technical issues in greater depth. Those manuals should be retained as technical references, but in the event of contradictions the new consolidated manual will take preference.

Inspection Types

The following are descriptions of the different types of inspections that an NPDES Inspector may conduct at a wastewater facility. At the end of the descriptions, a table matches minimum inspection activities with inspection types. Remember that the given activities are only minimum requirements, and an inspector is not limited to the stated activities.

The inspector should plan all activities with the compliance personnel prior to inspection. The minimum requirements may serve as a basis for deciding what activities will be conducted on site and for determining what additional information is to be gathered or verified during the inspection. Compliance personnel should choose the type of inspection to be conducted based on 1) the compliance status of the facility, 2) the information needed from the facility, and 3) the category of facility involved (e.g., toxic organic effluents, federally funded, etc).

Compliance Evaluation Inspection (CEI)

A CEI is a nonsampling inspection designed to verify permittee compliance with applicable permit self-monitoring requirements and compliance schedules. This inspection is based on record reviews and visual observations and evaluations of the treatment facilities, effluents, receiving waters, etc. The CEI is used for both chemical and biological self-monitoring programs. The CEI forms the basis for all other inspection types except the Reconnaissance Inspection.

Compliance Sampling Inspection (CSI)

During the CSI, representative samples of a permittee's influent and/or effluent are collected. Samples that are required by the permit are also obtained. Chemical analyses are then performed and the results are used 1) to verify the accuracy of the permittee's self-monitoring program and reports, 2) to determine the quantity and quality of effluents, 3) to develop permits, and 4) where appropriate, as evidence for enforcement proceedings. In addition, a CSI includes the same objectives and tasks as a CEI.

Performance Audit Inspection (PAI)

The PAI is used to evaluate the permittee's self-monitoring program. As with a CEI, the PAI is used to verify the permittee's reported data and compliance through a check of the records. In a CEI, the inspector carries out a cursory visual observation of the treatment facilities, effluents and receiving waters. In a PAI, the inspector actually observes the permittee going through all of the steps in the self-monitoring process from sample collection and flow measurement, through lab analyses, data workup and reporting. Also, the PAI inspector may leave a check sample for the permittee to analyze. The PAI is more resource intensive than a CEI, but less than a CSI because sample collection and analyses by EPA or the State are not included.

Compliance Biomonitoring Inspection (CBI)

A CBI evaluates the biological effect of a permittee's effluent discharge(s) on test organisms through the utilization of acute toxicity bioassay techniques. In addition, this inspection includes the same objectives and tasks as CEI.

Toxics Sampling Inspection (XSI)

The XSI has the same objectives as a conventional CSI, however, it places increased emphasis on toxic substances (i.e. the priority pollutants) other than heavy metals, phenols and cyanide, which are typically included in a CSI. Increased resources over a CSI are needed because highly sophisticated techniques are used to sample and analyze the samples for toxic pollutants.

Diagnostic Inspection (DI)

The DI focuses primarily on municipal POTW's that have received Federal construction grants but are not in compliance with permit requirements. The DI is designed to assist smaller POTW's that do not have a self-diagnostic capability. The emphasis of the DI is to identify compliance problems and to direct them to the permittee for correction.

Reconnaissance Inspection (RI)

The RI is used to obtain a preliminary overview of a permittee's compliance program. The inspector performs a brief visual inspection of the permittee's treatment facility, effluents and receiving waters. The RI utilizes the inspector's experience and judgment to quickly summarize a permittee's compliance program. The objective of the RI is to expand inspection coverage without increasing inspection resources. It is the briefest of all NPDES inspections.

Legal Support Inspection (LSI)

The LSI is a resource intensive inspection conducted when an enforcement problem is identified as a result of a routine inspection or a complaint. For an LSI, the appropriate resources are assembled to effectively deal with a specific enforcement problem.

COMPARISON OF INSPECTION ACTIVITIES WITH INSPECTION TYPES

ACTIVITY/LOCATION IN MANUAL	INSPECTION TYPES						
	CEI	CSI	TOX	BIO	PAI	RI	DIAG
Meeting with Compliance Personnel	C	C	C	C	C		I
Compliance File Review (Chapter 2, Section 1)	I	I	I	I	I		I
Entry (Chapter 2, Section 2)	C	C	C	1	C	C	C
Opening Conference (Chapter 2, Section 3)	C	C	C	1	I	C	I
Outfall/Receiving Waters Review (Chapter 4)	C	C	C	I	C	C	I
Facility Site Review (Chapter 4)	C	C	C	C	C	C	I
Compliance Schedule Verification (Pg. 3-4)	C	C	C	C	C		C
Laboratory Review (Chapter 8)	C	C	C	C	I	C	I
Quality Assurance Verification (Chapter 8)	C	C	C	C	I	C	I
Record Keeping/Datahandling Verification (Chapter 3)	C	C	C	C	I	C	I
Sampling and Analysis (Chapter 5, Section 2)		C	I	2			O
Inspect Flow Measurement Equipment (Chapter 6)		C	C	2		C	I
Sampling Techniques Verification (Chapter 5, Section 1)					I		C
Analysis Techniques Verification (Pg. 8-2)					I		C
Leave a QA Sample					O		
Biomonitoring Verification (Chapter 7, Section 1)	C						
Conduct Bioassay (Chapter 7, Section 2)				1			
Closing Conference (Chapter 2, Section 5)	C	C	C	C	I	C	I
Inspection Documentation (Chapter 2, Section 4)	C	C	C	C	C	C	I

LEGEND

I = Activity is conducted in depth (detailed)
C = Activity is conducted in a cursory fashion (brief)
O = Activity is optional

1. Activity is completed in either an in depth fashion or a cursory fashion depending on whether inspection is a flow-through bioassay or a static bioassay respectively.

2. Activity is completed during a flow through bioassay but is not completed during a static bioassay.

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Chapter One

Introduction

Legal Authority for NPDES Inspections

The Federal Water Pollution Control Act of 1972, as amended by the Clean Water Act of 1977, gives the Environmental Protection Agency (EPA) the authority to regulate the discharge of pollutants to waters of the United States. The Act provides broadly defined authority to establish the National Pollutant Discharge Elimination System (NPDES) Permit Program, to define control technologies, to establish effluent limitations, to obtain information through reporting and compliance inspections, and to take enforcement actions (both civil and criminal) when violations of the Act are found.

Inspection Authority

Dischargers of pollutants are issued permits under Section 402 that set specific limits and operating conditions to be met by the permittee. Section 308 authorizes inspections and monitoring to determine whether or not NPDES permit conditions are being met. The section provides for two types of monitoring:

- Self-monitoring, where the facility must monitor itself; and

- EPA monitoring, which may consist of checking the self-monitoring or conducting monitoring of its own.

According to the Act, EPA may conduct an inspection wherever there is an existing NPDES permit, or where a discharge exists or is likely to exist and no permit has been issued.

State Program Authority

Much of the compliance monitoring in the NPDES program takes place at the State level. Sections 308 and 402 of the Act provide for the transfer of Federal program authority to the States to conduct NPDES permit compliance monitoring. EPA Regional Administrators and some State water pollution control agencies have signed formal cooperative agreements that ensure timely, accurate monitoring of compliance with permit conditions.

Responsibilities of the NPDES Inspector

The primary role of an NPDES inspector is to gather information that can be used to determine compliance with permit conditions, applicable regulations, and other requirements. The NPDES inspector also plays an important role in enforcement case development and support, and in permit development. To fulfill these roles, inspectors are required to know and abide by legal requirements concerning inspections, procedures for effective inspection and evidence collection, accepted safety practices, and quality assurance standards.

Legal Responsibilities

It is essential that inspectors conduct all inspection activities within the legal framework established by the Act, including:

- Presenting proper credentials;
- Presenting required notices and receipts; and
- Properly handling confidential business information.

It is also important that inspectors be familiar with the conditions of the specific permit and with all applicable statutes and regulations.

Procedural Responsibilities

Inspectors must be familiar with general inspection procedures and evidence collection techniques to ensure accurate inspections and avoid endangering potential legal proceedings on procedural grounds.

- Inspection Procedures. Inspectors should observe standard procedures for conducting each inspection element. Responsibilities are illustrated in Table 1-1.
- Evidence Collection. Inspectors must be familiar with general evidence gathering techniques. Because the government's case in a civil or criminal prosecution depends on the evidence gathered by the inspector, it is imperative that each inspector keep detailed records of each inspection. These data will serve as an aid in preparing the inspection report, in determining the appropriate enforcement response, and in giving testimony in an enforcement case.

In particular, inspectors must know how to:

- Substantiate facts with items of evidence, including samples, photographs, document copies, statements from witnesses, and personal observations.

- Evaluate what evidence is necessary (routine inspections);
- Know chain-of-custody procedures;
- Collect and preserve evidence in a manner that will be incontestable in legal proceedings;
- Write clear, objective, and informative inspection reports; and
- Testify in court and administrative hearings.

Safety Responsibilities

The inspection of wastewater and other environmental pollution control facilities always poses a certain degree of risk. To avoid unnecessary health and safety risks, the inspector should be familiar with all safety guidance and practices and should:

- Use safety equipment in accordance with guidance received and labeling instructions;
- Maintain safety equipment in good condition and proper working order;
- Dress appropriately for the particular activity, and wear appropriate protective clothing; and
- Use any safety equipment customary in the establishment being inspected (e.g., hard hat or safety glasses).

If there are any safety related questions, consult the current approved safety manual.

Professional Responsibilities

Inspectors are expected to perform their duties with the highest degree of professionalism. Procedures and requirements ensuring ethical actions have been established through many years of government inspection experience. These procedures and standards of conduct have evolved for the protection of the individual and the Agency, as well as industry, so that the rights of all parties are protected.

- All investigations are to be conducted within the framework of the United States Constitution and with due regard for individual rights regardless of race, sex, creed, or national origin.
- Inspectors are to conduct themselves at all times in accordance with the regulations prescribing employee responsibilities and conduct.

- The facts of an investigation are to be developed and reported completely, accurately, and objectively.

- In the course of an investigation, any act or failure to act motivated by reason of private gain is illegal. Actions which could be construed as such should be scrupulously avoided.

- A continuing effort to improve professional knowledge and technical skill in the investigative field should be made.

Professional Attitude. The inspector is a representative of EPA and is often the initial or only contact between the Agency and the permittees. In dealing with facility representatives and employees, inspectors must be dignified, tactful, courteous, and diplomatic. A firm but responsive attitude will help to establish an atmosphere of cooperation and will initiate good working relations. Inspectors should not speak of any product, manufacturer, or person in a derogatory manner.

Attire. Inspectors should dress appropriately, including wearing protective clothing or equipment, for the activity in which they are engaged.

Gifts, Favors, Luncheons. Inspectors should not accept favors or benefits under circumstances that might be construed as influencing the performance of governmental duties. EPA regulations provide an exemption whereby an inspector could accept food and refreshment of nominal value on infrequent occasions in the ordinary course of a luncheon or dinner meeting or other meeting, or during an inspection tour. Inspectors should use this exemption only when absolutely necessary.

Requests for Information. EPA has an "open-door" policy on releasing information to the public. This policy aims at making information about EPA and its work freely and equally available to all interested individuals, groups, and organizations. In fact, EPA employees have both a legal and traditional responsibility for making useful educational and safety information available to the public. This policy, however, does not extend to information relating to the suspicion of a violation, evidence of possible misconduct, or confidential business information.

Quality Assurance Responsibilities

The inspector must assume primary responsibility for ensuring the quality of compliance inspection data. While other organizational elements play an important role in quality assurance, it is the inspector who must ensure that all data introduced into an inspection file are complete, accurate, and representative of existing conditions. To help the inspector meet these responsibilities, Regional Offices have established quality assurance plans that identify individual responsibilities and document detailed procedures.

The objective of a quality assurance plan is to establish standards that will guarantee that inspection data meet the requirements of all users. Many elements of quality assurance plans are incorporated directly into the basic inspection procedures and may not be specifically identified as quality assurance techniques.

The inspector must be aware that following established inspection procedures is critical to the inspection program. These procedures have been developed to reflect the following quality assurance elements:

- Valid data collection;
- Approved, standard methods;
- Control of service, equipment, supplies;
- Quality analytical techniques; and
- Standard data handling and reporting.

Table 1-1

Inspector Responsibilities in the Inspection Process

The elements of the inspection process listed below are common to most NPDES compliance inspections. While the emphasis given to each element may vary with each facility, the inspector's procedural responsibilities remain as listed.

1. Pre-Inspection Preparation: Ensure effective use of inspection resources.
   - Establish purpose and scope of inspection.
   - Review background information and Agency records.
   - Develop plan for inspection.
   - Prepare documents and equipment.
   - Coordinate schedule with laboratory if samples are to be collected.
   - Coordinate schedule with other appropriate regulatory authority.

2. Entry: Establish legal entry to facility.
   - Present official credentials.
   - Manage denial of entry if necessary.

3. Opening Conference: Orient facility officials to inspection plan.
   - Discuss inspection objectives and scope.
   - Establish working relationship with facility officials.

4. Facility Inspection: Determine compliance with permit conditions; collect evidence of violations.
   - Conduct visual inspection of facility.
   - Review facility records.
   - Inspect monitoring equipment and operations.
   - Collect samples.
   - Prepare documentation of inspection activities.

5. Closing Conference: Conclude inspection.
   - Collect missing or additional information.
   - Clarify questions with facility officials.
   - Prepare necessary receipts.
   - Review inspection findings and inform officials of follow-up procedures.
   - Issue deficiency notice if appropriate.

6. Inspection Report: Organize inspection findings into a useful, objective evidence package.
   - Complete NPDES Compliance Inspection Report form.
   - Prepare narrative report, if appropriate.

Chapter Two

Inspection Procedures

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1 Pre-Inspection Preparation

Preplanning is necessary to ensure that the inspection is properly focused and is conducted smoothly and efficiently. This planning involves:

- Review of facility background;
- Development of an inspection plan; and
- Notification of the facility.

Review of Facility Background

Collection and analysis of available background information on the candidate facility is essential to the effective planning and overall success of a compliance inspection. Materials obtained from files of Federal, State, and local agencies, technical libraries, and other information sources will enable inspectors to become familiar with facility operations; conduct the inspection in a timely manner; minimize inconvenience to the facility by not requesting data previously provided to the Federal, State, and/or local agencies; conduct a thorough and efficient inspection; clarify technical and legal issues before entry; and develop a sound and factual inspection report. The types of information that may be available for review are listed below. The inspector must determine the amount of background information necessary to perform the inspection.

- General Facility Information
  - Maps showing facility location, wastewater discharge pipes, and and geographic features.
  - Names, titles, and phone numbers of responsible facility officials.

- Any special entry requirements.
- Nature of processing operation and wastewater.
- Production levels, past, present, and future.
- Hydrological data.
- Geology/hydrogeology of the area.
- Changes in facility conditions since previous inspection/permit application.
- Available aerial photographs.

• Requirements, Regulations, and Limitations

- Copies of existing permits, regulations, and requirements--Federal, State, and local--and restrictions placed on discharges, compliance schedules, monitoring and reporting requirements, available monitoring stations, and analytical methods used by the facility.
- Special exemptions and waivers, if any.
- Receiving stream water quality standards.
- Previous facility applications for water, air, and solid waste permits. These files may contain useful data not shown elsewhere.
- Grant applications for publicly owned treatment works, R&D demonstration projects, and progress reports on these projects.

• Facility Compliance and Enforcement History

- Federal and State compliance files.
- Correspondence among facility, local, State, and Federal agencies.
- Complaints and reports, follow-up studies, findings, remedial action.
- Previous inspection reports, records, correspondence on past incidents of violations, exceedences, status of requested regulatory corrective action, if any, and compliance by facility.
- Status of current and pending litigation against facility.

- Self-monitoring data and reports.
- Previous EPA, State, and consultant studies and reports.
- Previous deficiency notices issued to facility.
- Laboratory capabilities.

• Pollution Control and Treatment Systems

- Description and design data for pollution control system and process operation.
- Sources and characterization of discharge.
- Type and amount of waste discharged.
- Spill contingency plans.
- Available by-passes or diversions and spill containment facilities.
- Pollution control, treatment methods, and monitoring systems.

• Pretreatment Information

- Information concerning Pretreatment Program Compliance Schedule.
- POTW's annual pretreatment report.
- Information concerning industrial user's such as:

  o User charge
  o Waste load
  o Type of waste
  o Compliance

Sources of Facility Background Information

• Laws and Regulations - The Clean Water Act and related regulations establish procedures, controls, and other requirements applicable to a facility. In addition, State laws and regulations, and sometimes even local ordinances, are applicable to the same facility. (See Table 2-1 for applicable NPDES statutes and regulations.)

• Permits and Permit Applications - Permits provide information on the limitations, requirements, and restrictions applicable to discharges; compliance schedules; and monitoring, analytical, and reporting requirements. Applications provide technical information on facility size, layout, and location of pollutant sources; treatment and control practices; contingency plans and emergency procedures; and pollutant characterization--types, amounts, and points/locations of discharge.

- Regional and State Files and Contacts - Files or contacts often can provide facility self-monitoring data, inspection reports, and permits and permit applications applicable to individual facilities. They can provide compliance, enforcement, and litigation history; special exemptions and waivers applied for and granted or denied; citizen complaints and action taken; process operational problems/solutions; pollution problems/solutions; laboratory capabilities or inabilities; and other proposed or historical remedial actions. Consultant reports can provide design and operation data and recommendations for processes, pollutant sources, treatment/control systems, and remedial measures.

- Technical Reports, Documents, and References - These information sources provide generic information on industrial process operations, as well as pertinent specific data on available treatment/control techniques, such as their advantages or drawbacks, and limits of application. Such sources include Effluent Guideline and New Source Performance Standard development documents. Other important information from these sources includes waste characterization and loads from industrial processes and removal efficiencies for exemplary treatment systems.

- Other Statutory Requirements - Facility files maintained pursuant to other statutes (e.g. TSCA, RCRA, CERCLA, FIFRA, Clean Air Act, etc.) also contain information useful to the NPDES inspection.

Table 2-1

NPDES Related Statutes and Regulations

Topic	Reference CWA[1]	Reference 40 CFR[2]
Inspection Authority	§308	122.41(i)[a], 123.26[a]
Self-Monitoring and Recordkeeping Authority	§308	122.41(h), (j), and (l)[a], 122.48[a]
Confidential Information	§308(b)	2.201, 2.215, 2.302, 122.7[b]
Emergency Authority	§504	123.27[a]
Employee Protection	§507	
Permits	§402	122[b], 123.25[a]
EPA Permitting Procedures		124
Technical Requirements		129[a], 133[a], 136[a]
Best Management Practices (BMP)	§304(e)	125
Spill Prevention Control and Countermeasure Plan (SPCC)	§311	112
Waivers	§301	125, 230
Effluent Guidelines	§304	400-460[a]
Pretreatment Standards	§307, 402	125,403 and 400-460[a]

[1] Clean Water Act

[2] Code of Federal Regulations, Revised as of July 1, 1983

[a]Applies to State Programs
[b]Partially applies to State Programs

Development of an Inspection Plan

A plan is recommended for the effective conduct of a compliance inspection. After reviewing the available background information, a comprehensive plan is prepared to define inspection objectives, the tasks required to fulfill the objectives, the inspection schedule, and when findings and conclusions on the work will be reported. A project plan generally addresses the following items:

- Objectives
  - What is the purpose of the inspection?
  - What is to be accomplished?
- Tasks
  - What tasks are to be completed?
  - What information must be collected?
- Procedures
  - What procedures are to be used?
  - Will the inspection require special procedures?
- Resources
  - What personnel will be required?
  - What equipment will be required?
- Schedule
  - What will be the time requirements and order of inspection activities?
  - What will be the milestones?
- Coordination
  - What coordination with laboratories or other regulatory agencies is required?

Notification of the Facility

In the NPDES program, the permittee is sometimes notified by a "308 Letter" that the facility is scheduled for an inspection. The 308 Letter advises the permittee that an inspection is imminent, and usually requests information regarding on-site safety regulations to avoid problems concerning safety equipment at the time of the inspection. The 308 Letter may also specify the exact date of the inspection if coordination with the permittee is required. It is also used to inform the permittee of the right to assert a claim of confidentiality. (Figure 2-1 is an example of a typical 308 Letter.) Depending on the type of inspection, the permittee may also be notified by telephone that an inspection is imminent.

Notification is not recommended when illegal discharges or emissions or improper records are suspected. The concern that physical conditions may be altered prior to the inspection or that records will be destroyed justifies an unannounced inspection. A written notification could then be presented at the time of the unannounced inspection.

State Notification of Federal Inspection

The inspector must be sure that the appropriate State regulatory agency is notified in a timely manner of inspections to be conducted within their jurisdictions. The State should be notified of all Federal inspections unless there are exceptional circumstances where disclosing inspection information would jeopardize an unannounced inspection.

Equipment Preparation

Part of the pre-inspection process involves obtaining and preparing inspection equipment. The type of equipment may vary according to the facility inspected and the type of inspection. All equipment must be checked, calibrated, and tested before use. The inspector must also ensure that all materials necessary to complete an inspection are taken to the inspection site. The inspector is responsible for maintaining the equipment properly in accordance with operating instructions.

Safety equipment and procedures required for a facility will be based on the response to the notification or 308 Letter and standard safety procedures. Safety requirements must be met, not only for safety reasons but to ensure that the inspector is not denied entry to the facility or parts of it.

Photocopies of appropriate checklists should be obtained during the pre-inspection preparation.

Figure 2-1

Sample 308 Letter

Certified Mail - Return Receipt Requested

Date

Dear Sir:

Pursuant to the authority contained in Section 308 of the Clean Water Act (33 U.S.C. 1251 et seq.), representatives of the U.S. Environmental Protection Agency (EPA), or a contractor retained by EPA, shall conduct, within the next year, a compliance monitoring inspection of your operations including associated waste treatment and/or discharge facilities located at (site of inspection). This inspection will ascertain the degree of compliance with the requirements of the National Pollutant Discharge Elimination System (NPDES) permit issued to your organization.

Our representatives may observe your process operations, inspect your monitoring and laboratory equipment and methods, collect samples, examine appropriate records, and will be concerned with related matters.

In order to facilitate easy access to the plant site, please provide the name of the responsible facility official that can be contacted upon arrival at the plant. Additionally, we would appreciate receiving a list of the safety equipment you would recommend that our representatives have in their possession in order to safely enter and conduct the inspection. Please provide the information requested within 14 days of receipt of this letter.

If you have any questions relating to anything concerning this inspection, please call (appropriate designated official).

Sincerely yours,

Director
Water Management Division

2 Entry

Entry Procedures

Authority

§308(a)(4)(B) of the Clean Water Act states:

> ". . . the Administrator or his authorized representative, upon presentation of his credentials shall have a right of entry to, upon, or through any premises in which an effluent source is located or in which any records required to be maintained. . . and may at reasonable times have access to and copy any records, inspect any monitoring equipment or method. . . and sample any effluents which the owner or operator of such source is required to sample. . ."

Arrival

Arrival at the facility should be during normal working hours. The facility owner or agent in charge should be located as soon as the inspector arrives on the premises.

Credentials

When the proper facility officials have been located, the inspector should introduce himself or herself as an EPA/State inspector and present the proper EPA credentials. These credentials indicate that the holder is a lawful representative of the regulatory agency and is authorized to perform NPDES inspections. The credentials must be presented whether or not identification is requested.

After facility officials have scrutinized the credentials, they may telephone the appropriate State or EPA Regional Office for verification of the inspector's identification.

Credentials should never leave the sight of the inspector.

Consent

Consent to inspect the premises must be given by the owner or operator at the time of the inspection. As long as the inspector is allowed to enter, entry is considered voluntary and consensual, unless the inspector is expressly told to leave the premises. Express consent is not necessary; absence of an express denial constitutes consent.

Reluctance To Give Consent. The receptiveness of facility officials toward inspectors is likely to vary from facility to facility. Most inspections will proceed without difficulty. If consent to enter is flatly denied, the inspector should follow Denial of Entry procedures. In other cases, officials may be reluctant to give entry consent because of misunderstandings of responsibilities, inconvenience to a firm's schedule, or other reasons that may be overcome by diplomacy and discussion.

Whenever there is difficulty in gaining consent to enter, inspectors should tactfully probe the reasons and work with officials to overcome the obstacles. Care should be taken, however, to avoid threats of any kind, inflammatory discussions, or deepening of misunderstandings. If the situation is beyond the authority or ability of the inspector, the regulatory office should be contacted for guidance.

Uncredentialed Persons Accompanying an Inspector. The consent of the owner or agent in charge must be obtained for the entry of persons accompanying an inspector to a site if they do not have specific authorization. If consent is not given voluntarily, these persons may not enter the premises. If consent is given, these persons may not view confidential business information unless officially authorized for access.

Waivers, Releases, and Sign-In Logs

When the facility provides a blank sign-in sheet, log, or visitor register, it is acceptable for inspectors to sign it. Note however that EPA employees will not sign any type of "waiver" or "visitor release" that would relieve the facility of responsibility for injury or which would limit the rights of the Agency to use data obtained from the facility. The inspector must not agree to any such unwarranted restrictive conditions.

If such a waiver or release is presented, the inspectors should politely explain they cannot sign and request a blank sign-in sheet. If the inspectors are refused entry because they do not sign such release, they should leave and immediately report all pertinent facts to the appropriate supervisory and/or legal staff. All events surrounding the refused entry should be fully documented. Problems should be discussed cordially and professionally. Facility officials must not be subjected to intimidation by the Federal/State government's right to inspect.

Problems with Entry or Consent

Because inspections may be considered adversary proceedings, inspectors may be challenged as to their legal authority, techniques, and competency. Facility officials may also display antagonism to Agency personnel. In all cases, the inspectors must cordially explain the authorities and the reasons for the protocols followed. If explanations are not satisfactory or disagreements are irresolvable, the inspectors should leave and obtain further direction from the appropriate Agency supervisory or legal staff. Professionalism and politeness must prevail at all times.

Denial of Entry

If an inspector is refused entry into a facility for the purpose of an inspection under the Clean Water Act (CWA), certain procedural steps must be followed. The procedures have been developed in accordance with the 1978 U.S. Supreme Court decision in Marshal v. Barlow's, Inc.

1. Make certain that all credentials and notices have been properly presented to the facility owner or agent in charge.

2. If entry is not granted, ask why. Tactfully probe the reason for the denial to see if obstacles (such as misunderstandings) can be cleared. If resolution is beyond the authority of the inspector, he or she may suggest that the officials seek advice from their attorneys on clarification of the scope of EPA's inspection authority under Section 308 of the CWA.

3. If entry is still denied, the inspector should withdraw from the premises and contact his or her supervisor. The supervisor will confer with attorneys to discuss the desirability of obtaining an administrative warrant.

4. All observations pertaining to the denial are to be carefully noted in the field notebook. Include facility name and exact address, name and title of person(s) approached, authority of person(s) who refused entry, date and time of denial, detailed reasons for denial, facility appearance, any reasonable suspicions that refusal was based on a desire to cover up regulatory violations, etc. All such information will be important should a warrant be sought.

Important Considerations

- Under no circumstances should the inspector discuss potential penalties or do anything that may be construed as coercive or threatening.

- Inspectors should use discretion and avoid any situations that may be potentially threatening or inflammatory. In the event of a threatening confrontation, the inspector should document the event and report it immediately to the staff attorney. If feasible, statements from witnesses should be obtained and included in the documentation.

Withdrawal of Consent During Inspection

If the agent-in-charge asks the inspector to leave the premises after the inspection has begun, the inspector should leave as soon as possible, following the procedures above for denial of entry. All activities and evidence obtained prior to the withdrawal of consent are valid. The inspector should ensure that all personal and government equipment is removed from the facility.

Denial of Access to Some Areas of the Facility

If, during the course of the inspection, access to some parts of the facility is denied, the inspector should make a notation of the circumstances surrounding the denial of access and of the portion of the inspection that could not be completed. He or she should then proceed with the rest of the inspection. After leaving the facility, the inspector should contact the Regional Office to determine whether a warrant should be obtained to complete the inspection.

Warrants

The inspectors may be instructed by Agency attorneys, under certain circumstances, to conduct an inspection under search warrant. A warrant is a judicial authorization for appropriate persons to enter specifically described locations and to perform specific inspection functions. It is possible that a pre-inspection warrant could be obtained where there is reason to believe that entry will be denied when the inspector arrives at the facility or when the inspector anticipates violations that could be hidden during the time required to obtain a search warrant.

3 Opening Conference

Once credentials have been presented and legal entry has been established, the inspector can proceed to outline inspection plans with facility officials. At the opening conference, the inspector provides names of the inspectors, purpose of the inspection, authorities under which the inspection is being conducted, and procedures to be followed. The Agency encourages cooperation between the inspectors and the facility officials; this will facilitate assignments and contribute to the success of the inspection.

Considerations

- Inspection Objectives. An outline of inspection objectives will inform facility officials of the purpose and scope of the inspection and may help avoid misunderstandings.

- Order of Inspection. A discussion of the order in which the inspection will be conducted will help eliminate wasted time by allowing officials time to make records available and start up intermittent operations.

- Meeting Schedules. A schedule of meetings with key personnel will allow them to allocate a clear time to spend with the inspector.

- List of Records. A list of records to be inspected will allow officials to gather and make them available for the inspector.

- Accompaniment. It is important that a facility official accompany the inspector during the inspection not only to answer questions and to describe the plant and its principal operating characteristics, but also for safety and liability considerations.

- Permit Verification. The inspector should verify the following information from facility officials:

  - Correct name and address of facility;
  - Correct name and location of receiving waters;
  - Number and location of discharge points; and
  - Principal product(s) and production rates where specifically requested.

- Safety Requirements. The inspector should determine what OSHA and facility safety regulations will be involved in the inspection, and should be prepared to meet these requirements.

- Closing Conference. A post-inspection meeting should be scheduled with appropriate officials to provide a final opportunity to gather information, answer questions, present findings and deficiencies, and complete administrative duties.

- New Requirements. The inspector should discuss any new rules and regulations that might affect the facility and answer questions pertaining to them. If the inspector is aware of proposed rules that might affect the facility, he or she may wish to encourage facility officials to obtain a copy.

- Split Samples. Facility officials should be informed during the opening conference of their right to receive a split of any physical sample collected for laboratory analysis. Officials should indicate at this point the desire to receive split samples so that arrangements can be made to secure the samples during the inspection.

- Photographs. Photographs can be used to prepare a more thorough and accurate inspection report, as evidence in enforcement proceedings, and to better explain conditions found at the plant. The facility, however, may object to the use of cameras on their property. If a mutually acceptable solution cannot be reached and photographs are considered essential to the inspection, Agency supervisory and legal staff should be contacted for advice.

  Facility personnel may also request that any photographs taken during the visitation be considered confidential. The Agency is obliged to comply with this request pending further legal determination. Self-developing film, although of lower quality, is useful in certain situations. A facility may refuse permission to take photographs unless they can see the finished print. Duplicate photographs (one for the inspector and the other for the company) should satisfy this need.

4 Documentation

Providing strong documentary support of discrepancies uncovered in an inspection is a basic responsibility of an inspector. Documentation serves to "freeze" the actual conditions existing at the time of the inspection so that evidence may be examined objectively at a later date by compliance personnel.

Documentation is a general term referring to all print and mechanical media produced, copied, or taken by an inspector to provide evidence of suspected violations. Types of documentation include the field notebook, statements, photographs, drawings and maps, printed matter, mechanical recordings, and copies of records.

Inspector's Field Notebook

The core of all documentation relating to an inspection is the field notebook, which provides accurate and inclusive documentation of all inspection activities. The notebook will form the basis for written reports and should contain only facts and pertinent observations.

Language should be objective, factual, and free of personal feelings or terminology that might prove inappropriate. Notebooks become an important part of the evidence package and can be entered in court as evidentiary material.

Inspection Entries

Since an inspector may be called to testify in an enforcement proceeding, it is imperative that each inspector keep detailed records of inspections, investigations, samples collected, and related inspection functions. Types of information that should be entered into the field notebook include:

- Observations. All conditions, practices, and other observations that will be useful in preparing the inspection report or that will validate evidence should be recorded.

- Documents and Photographs. All documents taken or prepared by the inspector should be noted and related to specific inspection activities. (Photographs taken at a sampling site should be listed, and described.)

- Unusual Conditions and Problems. Unusual conditions and problems should be noted and described in detail.

- General Information. Names and titles of facility personnel and the activities they perform should be listed along with statements they may have made and other general information. Weather condition should be recorded. Information about a facility's record-keeping procedures may be useful in later inspections.

The field notebook is a part of the Agency's files and is not to be considered the inspector's personal record. Notebooks are held indefinitely pending disposition instructions.

Samples

Samples are the evidence most frequently gathered by inspectors. For the analysis of a sample to be admissible as evidence, a logical and documented connection must be shown between samples taken and analytical results reported. This connection is shown by using a chain-of-custody system that identifies and accompanies a sample between the time it is collected and the time it is analyzed.

Sampling techniques and procedures are discussed in detail in Chapter Five, "Sampling."

Statements

Inspectors can obtain formal statements from persons who have personal, firsthand knowledge of facts pertinent to a potential violation. This statement of facts is signed and dated by the person who can testify to those facts in court, and it may be admissible as evidence.

The principal objective of obtaining a statement is to record in writing, clearly and concisely, relevant factual information so that it can be used to document an alleged violation.

Procedures and Considerations

- Determine the need for a statement. Will it provide useful information? Is the person making the statement qualified to do so by personal knowledge?

- Ascertain all the facts and record those which are relevant and which the person can verify in court. Make sure all information is factual and firsthand. Avoid taking statements that cannot be personally verified.

- In preparing a statement:

  Use a simple narrative style; avoid stilted language.

  - Narrate the facts in the words of the person making the statement.

  - Use the first-person singular ("I am manager of ...").

  - Present the facts in chronological order (unless the situation calls for other arrangement).

- Positively identify the person (name, address, position).

- Show why the person is qualified to make the statement.

- Present the pertinent facts.

- Have the person read the statement and make any necessary corrections before signing. If necessary, read the statement to the person in the presence of a witness.

  - All mistakes that are corrected must be initialed by the person making the statement.

- Ask the person making the statement to write a brief concluding paragraph indicating that he or she read and understood the statement. (This safeguard will counter a later claim that the person did not know what he or she was signing.)

- Have the person making the statement sign it.

- If he or she refuses to sign the statement, elicit an acknowledgement that it is true and correct. Ask for a statement in his or her own hand ("I have read this statement and it is true but I am not signing it because..."). Failing that, declare at the bottom of the statement that the facts were recorded as revealed and that the person read the statement and avowed it to be true. Attempt to have any witness to the statement sign the statement including witness' name and address.

- Provide a copy of the statement to the signer if requested.

Photographs

The documentary value of photographs ranks high as admissible evidence. Clear photos of relevant subjects, taken in proper light and at proper lens settings, provide an objective record of conditions at the time of inspection. If possible, photographs should be taken in such a way as to keep "sensitive" buildings or operations out of background.

When a situation arises that dictates the use of photographs, the inspector should obtain the permittee's approval to take photographs. The inspector is to be tactful in handling any concerns or objections a permittee may have about the use of a camera. In some cases, the inspector may explain to the permittee's representative that waste streams, receiving waters, and wastewater treatment facilities are public information, not trade secrets. In the event the permittee's representative still refuses to allow photographs and the inspector believes the photographs will have a substantial impact on future enforcement proceedings, Regional enforcement attorneys should be consulted for further instructions. At all times the inspector is to avoid confrontations that might jeopardize the completion of the inspection.

Photographs may always be taken from areas of public access (e.g. across a stream, from a parking lot, etc).

Equipment

A single lens reflex camera may be used whenever one is available. This type of camera will take high-quality photographs, enable the inspector to use a variety of film speeds, and allow the use of appropriate lenses. Fully automatic pocket cameras can often be used for routine inspections to record the conditions of the facility during the inspection.

All photographs should be made with color print film because additional equipment, such as projector and screen, are not needed to review the photographs. Also, the negatives are easily duplicated and the prints can be enlarged and distributed as needed.

Scale, Location, and Direction

It is sometimes useful to photograph a subject from a point that will indicate the location and direction of the subject. The addition of an object of known size (e.g., a person, an auto) will help indicate the approximate size of the subject.

Safety

In areas where there is a danger of explosion, flash photographs should not be taken. If there is a danger of electrical shock, photographs should be taken from a distance known to be safe.

Documenting Photographs

A photographic log should be maintained in the Inspector's Field Notebook for all photographs taken during an inspection, and the entries are to be made at the time the photograph is taken. These entries are to be numerically identified so that after the film is developed the prints can be serially numbered corresponding to the logbook descriptions and, if necessary, pertinent information can be easily transferred to the back of the photograph. The log entries are to include:

- Name and signature of the photographer and witness;
- Description of film used (i.e., its expiration date, ASA number, origin, etc.);
- Type of camera and attachments;
- Focal length of the lens being used;
- F-stop and shutter speed at which the camera is set;
- Lighting conditions encountered;
- Time of day, weather conditions;
- Date;
- Location; and
- A brief description of the subject being photographed.

When a pocket camera is used to record conditions of the facility, less formal documentation procedures may be used.

Drawings and Maps

Schematic drawings, maps, charts, and other graphic records can be useful in supporting violation documentation. They can provide graphic clarification of site location relative to the overall facility, relative height and size of objects, and other information which, in combination with samples, photographs, and other documentation, can produce an accurate, complete, evidence package.

Drawings and maps should be simple and free of extraneous details. Basic measurements and compass points should be included to provide a scale for interpretation.

Drawings and maps should be identified by source and be dated.

Printed Matter

Brochures, literature, labels, and other printed matter may provide important information regarding a facility's conditions and operations. These materials may be collected as documentation if, in the inspector's judgment, they are relevant.

All printed matter should be identified with date, inspector's initials, and origin.

Mechanical Recordings

Records produced electronically or by mechanical apparatus can be entered as evidence. Charts, graphs, and other "hard copy" documents should be treated as documentation and handled accordingly.

Copies of Records

Records and files may be stored in a variety of information retrieval systems, including written or printed materials, computer or electronic systems, or visual systems such as microfilm and microfiche.

When copies of records are necessary for an inspection report, storage and retrieval methods must be taken into consideration:

- Written or printed records can generally be photocopied on-site. Portable photocopy machines may be available to inspectors through the Regional Office. When necessary, however, inspectors are authorized to pay a facility a "reasonable" price for the use of facility copying equipment.

  - At a minimum, all copies made for or by the inspector should be initialed and dated for identification purposes. (See identification details below.)

  - When photocopying is impossible or impracticable, close-up photographs may be taken to provide suitable copies.

- Computer or electronic records may require the generation of "hard" copies for inspection purposes. Arrangements should be made during the opening conference, if possible, for these copies.

  - Photographs of computer screens may possibly provide adequate copies of records if other means are impossible.

- Visual systems (microfilm, microfiche) usually have photocopying capacity built into the viewing machine, which can be used to generate copies.

  - Photographs of the viewing screen may provide adequate copies if "hard" copies cannot be generated.

Identification Procedures

Immediate and adequate identification of records reviewed is essential to ensure the ability to identify records throughout the Agency custody process and to ensure their admissibility in court. When inspectors are called to testify in court, it is imperative that they be able to positively identify each particular document and state its source and the reason for its collection.

Initial, date, number, and write in the facility's name on each record, and log these items in the field notebook.

- Initialing/Dating. Each inspector should develop a unique system for initialing (or coding) and dating records and copies of records so that he or she can easily verify their validity. This can be done by initialing each document in a similar position, or by another method, at the time of collection. Both the original and copy should be initialed. All record identification notations should be made on the back of the document.

  The inspector must be able to positively identify that he or she so marked the document.

- Numbering. Each document or set of documents substantiating a suspected violation or violations should be assigned an identifying number unique to that document. The number should be recorded on each document and in the field notebook.

- Logging. Documents obtained during the inspection should be entered in the field notebook by a logging or coding system. The system should include the identifying number, date, and other relevant information:

  - The reason for copying the material (i.e., the nature of the suspected violation or discrepancy).

  - The source of the record (i.e., type of file, individual who supplied record).

  - The manner of collection (i.e., photocopy, other arrangements).

General Considerations

- Originals must be returned to the proper personnel or to their correct location.
- Related records should be grouped together.
- Confidential business records should be handled according to the special confidential provisions discussed below.

Routine Records

The inspector may find it convenient to make copies of some records such as lab analysis sheets and data summaries to refresh his or her memory when preparing an inspection report. It is not always necessary to follow the formal identification and logging requirements when such records are obtained for general information purposes or to aid in the preparation of routine inspection reports.

Confidential Information

Disclosure of Official Information

Inspectors may give general information about EPA programs and activities and describe what they are doing but should be cautious about divulging specific information regarding an inspection. It is permissible to discuss with the permittee's representative deficiencies encountered during an evaluation of self-monitoring procedures and the action required to correct these deficiencies. But it is not advisable to discuss information collected during the course of an inspection that may indicate that a violation has occurred. Therefore, when an inspector has reason to believe that there may be cause for an enforcement action, no information should be disclosed before consulting with the Regional Office. Caution should be exercised in disclosing findings or speculating on the type of action the Agency may choose to take.

Trade Secrets and Confidential Information

Trade secrets and confidential information are protected from public disclousre by Section 308(b)(2) of the Clean Water Act (1977). The type of information that may be considered business information is defined in Title 40, Code of Federal Regulations, Part 2. (40 CFR Part 2.)

Section 308(a)(4) of the CWA states that an inspector may sample an effluent, request information, have access to the location of the effluent, and inspect any monitoring equipment. The information that is collected is available to the public. If a permittee does not want inspection information to be available to the public, it must request the

Administrator of EPA to consider the information confidential. The permittee must show that the information, if made available, would divulge trade secrets. The information may then be classified confidential, but may still be disclosed to authorized representatives of EPA concerned with enforcing the Act.

Therefore, a business is entitled to a claim of confidentiality for all information that an inspector requests or has access to; but a business may not refuse to release information requested by the inspector under the authority of Section 308 of the Act on the grounds that the information is considered confidential or a trade secret. The claim of confidentiality relates only to the public availability of such data and cannot be used to deny access to a facility to EPA inspectors performing duties under Section 308 of the Act.

Handling Confidential Information

Routine security measures will help ensure that reasonable precautions are taken to prevent unauthorized persons from viewing confidential information. When practical circumstances prohibit the inspector from following the procedures exactly, the inspector is expected to take steps for protection of the information that will achieve this objective. All confidential information received must be marked as such and placed in a locked filing cabinet or a safe immediately following the completion of the inspection. A chain-of-custody record must be maintained for all confidential information.

While Traveling. The inspector may be on the road for several days while doing inspections. It is the inspector's responsibility to ensure that the information he or she collects is handled securely.

- Documents and field notes are considered secure if they are in the physical possession of the inspector and are not visible to others while in use.

- Inspection documents contain sensitive information and should be kept in a locked briefcase. If it is impractical to carry the briefcase into a given situation, the briefcase may be stored in a locked area such as a motel room or trunk of a motor vehicle.

- Physical samples should be placed in locked containers and stored in a locked portion of a motor vehicle. The chain-of-custody procedures provide further protection for ensuring the integrity of the sample.

In the Office. Only personnel authorized by the Regional Administrator, Division Director, or Branch Chief will be allowed access to the file. An access log should be maintained for all transactions. Copies of information marked "trade secret" and/or "confidential" should not be made unless written authorization has been obtained from the Regional Administrator, Division Director, or Branch Chief. Requests for access to confidential information by any member of the public, or by an employee of a State, local, or Federal agency, shall be handled according to the procedures contained in the Freedom of Information Act regulations (40 CFR Part 2). All such requests shall be referred to the responsible Regional organizational unit.

5 Closing Conference

To achieve the most effective results from compliance inspections, it is essential for the inspector to promptly communicate the results to the facility management and/or operating personnel. However, the inspector's discussion should be limited to specific findings of the visit. If appropriate, the findings should be compared with the permittee's NPDES permit requirements, consent decrees, administrative orders, and other enforcement actions.

Precautions and Guidelines

Although a discussion of the inspection results is important, certain precautions are essential:

- The inspector should not discuss compliance status or any legal effects or enforcement consequences with the permittee's representative or with facility operating personnel.
- The inspector should refrain from recommending a particular consultant or consulting firm, even if asked to do so. Inspectors should tell the permittee's representative to contact a professional society or approved listing for advice concerning this matter.

These guidelines are subject to rules promulgated by the Regional Administrator or State Director regarding permittee contacts in the Region/State.

Deficiency Notice

The inspector may issue a Deficiency Notice following an inspection that uncovered existing or potential problems in a permittee's self-monitoring program. Issuing a Deficiency Notice at the completion of an inspection provides a swift and simple method for improving the quality of data from NPDES self-monitoring activities. It also helps the permittee to comply with the self-monitoring requirements of the permit. This tool is to be used in conjunction with any type of NPDES compliance inspection during which the inspector identifies problems with the permittee's self-monitoring activities.

The Deficiency Notice is to be used by the inspector only to alert permittees to deficiencies in their self-monitoring activities. The enforcement office of the regulatory authority, not the inspector, handles effluent violations.

Inspectors can issue the Deficiency Notice to a permittee immediately following a compliance inspection if they discover any permit deficiences in the seven categories that the Notice addresses.

6 Inspection Report

The adequacy of compliance follow-up to correct problems or deficiencies noted during an inspection depends in a large part on the inspection report package prepared by the inspector. The preceding chapter detailed the procedures for collecting and substantiating this information. Once collected, however, the material must be organized and arranged in a manner that will allow compliance personnel to make maximum use of the information.

The information presented in this section provides general guidelines for organizing evidence and preparing an inspection report.

Objective of the NPDES Inspection Report

The objective of an inspection report is to organize and coordinate all inspection information and evidence in a comprehensive, usable manner. To meet this objective, information in an inspection report must be:

- Accurate. All information must be factual and based on sound inspection practices. Observations should be the verifiable result of firsthand knowledge. Compliance personnel must be able to depend on the accuracy of all information.

- Relevant. Information in an inspection report should be pertinent to the subject of the report. Irrelevant facts and data will clutter a report and may reduce its clarity and usefulness. Personal comments and opinions should be avoided.

- Comprehensive. Suspected violation(s) should be substantiated by as much factual, relevant information as is feasible to gather. The more comprehensive the evidence is, the better and easier the prosecution task will be.

- Coordinated. All information pertinent to the subject should be organized into a complete package. Documentary support (e.g., photographs, statements, sample documentation, etc.) accompanying the report should be clearly referenced so that anyone reading the report will get a complete, clear overview of the situation.

- Objective. Information should be objective and factual; the report should not speculate on the ultimate result of any factual findings.

- Clear. The information in the report should be presented in a clear, well-organized manner.

- Neat and Legible. Allow time to prepare a neat, legible report, with complete clear copies of all documents.

Elements of a Report

Although specific information requirements for an inspection report will vary, most reports will contain the same basic elements:

- NPDES Compliance Inspection Report Form
- Supplementary narrative information
- Copies of completed checklists
- Documentary support

NPDES Compliance Inspection Report Form

It is the inspector's responsibility to report all compliance inspection activities by completing the current Compliance Inspection Report Form as soon as possible after the inspection. The Federal or State compliance office should forward the inspection report form to the regulatory authority no later than thirty days after completion of the inspection. Copies should be sent to the permittee in a timely manner except when formal enforcement procedures are under way. In this instance, the case attorney will direct any disclosure of data.

Supplementary Narrative Information

Supplementary narrative information could be a memo in the case of routine inspections or could be a narrative report where major violations are detected. When a narrative report is necessary to fully describe a compliance inspection, the contents of the report should focus on supporting or explaining the information provided in the Compliance Inspection Report Form.

The narrative report should be a concise, factual summary of observations and activities, organized in a logical, legible manner, and supported by specific references to accompanying documentary support.

A work plan will simplify preparation and will help ensure that information is organized in a usable form. Basic steps in writing the narrative report include:

- Reviewing the Information. The first step in preparing the narrative is to collect all information gathered during the inspection. The inspector's field notebook should be reviewed in detail. All evidence should be reviewed for relevance and completeness. Gaps may need to be filled by a phone call or, in unusual circumstances, by a follow-up visit.

- Organizing the Material. The information may be organized in many forms depending on the individual need, but should present the material in a logical, comprehensive manner. The narrative should be organized so that it will be understood easily by the reader.

- Referencing Accompanying Material. All documentary support accompanying a narrative report should be clearly referenced so that the reader will be able to locate these documents easily. The Documentation section elsewhere in this chapter provides details on document identification. All documentary support should be checked for clarity prior to writing the report.

- Writing the Narrative Report. Once the material collected by the inspector has been reviewed, organized, and referenced, the narrative can be written. The purpose of the narrative is to record factually the procedures used in, and findings resulting from, the evidence-gathering process. The inspector should refer to routine procedures and practices used during the inspection, but should describe facts relating to potential violations and discrepancies in detail. The field notebook is a guide for preparing the narrative report.

If the inspector has followed the steps presented in this manual, the report will develop logically from the organizational framework of the inspection. In preparing the narrative, simplicity should be a prime consideration:

- Use a simple writing style; avoid stilted language.
- Use an active, rather than passive approach: (e.g., "He said that..." rather than "It was said that...").
- Keep paragraphs brief and to the point.
- Avoid repetition.
- Proofread the narrative carefully.

Copies of Completed Checklists

Comprehensive checklists are included in the technical chapters of this manual. When appropriate, these concise checklists may be used by the inspector to collect information during the inspection. Copies of all completed checklists should be included in the inspection report.

Documentary Support

All documentation that is produced or collected by the inspector to provide evidence of suspected violations should be included in the inspection report. Types of documentation include the field notebook, statements, photographs, drawings and maps, printed matter, mechanical recordings, and copies of records. The Documentation section elsewhere in this chapter provides details on obtaining and organizing this material.

The Permit Compliance System (PCS)

The inspection office should make sure that all data listed in Section A of the NPDES Compliance Inspection Report are entered into the PCS, which is used for national tracking of NPDES permit information. An inspection is not credited to the inspection program office until coded into the PCS. Timely completion of reports is therefore essential for the effective follow-up of a compliance inspection. Every effort should be made to ensure that data are entered within 15 days of completion of the inspection.

Recordkeeping and Reporting

Contents	Page

Recordkeeping and Reporting

Authority and Scope

Statutory Recordkeeping Authority:	Clean Water Act §308, §402
Regulatory Requirements:	40 CFR Parts 122.41 and 122.48
Inspection Authority:	Clean Water Act §308

The NPDES permit system requires permittees to maintain records and to report periodically on the amount and nature of the waste components in the effluent. The permit stipulates recordkeeping and reporting conditions.

Evaluations are conducted at all permittee facilities to determine compliance with permit requirements. The procedures listed below should be used for these routine inspections. If suspected violations are uncovered during the routine evaluation, a more in-depth investigation should be conducted.

Inspection Objectives

A review of facility records should determine that recordkeeping requirements are being met. In particular:

- Is all required information available?
- Is the information current?
- Is the information being maintained for the required period of time? Do the records reviewed indicate areas needing further investigation?

Permit Verification

[Refer to Checklist, page 3-9.]

Beginning in the records inspection phase and continuing throughout the inspection, the facility's operations should be compared with the permit to verify that required permit activities are correct, current, and complete.

Much of the information needed to verify the permit can be quickly obtained and should be collected during the opening conference and compared with the facility permit. This information includes:

- Correct name and address of facility;
- Correct name and location of receiving waters; and
- Number and location of discharge points.

During the Records Inspection. The inspector should check for records that will verify that:

- If discharges differ from those stated in the permit, notification has been made to EPA or to the State;
- Accurate records of influent quality and volume are maintained when appropriate;
- Notification of a permit violation has been made to EPA or the State; and
- Notification of bypassing has been made to EPA or to the State.

During the Walk-Through Inspection. The Inspector should verify the following requirements of the permit through visual observations and sense of smell:

- Number and locations of dischargers are as described in the permit; and
- All dischargers are in accordance with the general provisions of the permit, such as, no obnoxious odors, no discharge, no visible entrained solids in discharge, and no fish or vegetation kills near the outfalls.

Recordkeeping and Reporting Evaluation Procedures

[Refer to Checklist, page 3-9.]

1. Review permit to determine recordkeeping and reporting requirements.

2. Check the records required by the permit to verify that the requirements are being met, including record maintenance for a minimum period of 3 years. These records may include:

- Sampling and Analysis Data

  - Dates, times, locations of sampling
  - Analytical methods and techniques
  - Results of analyses
  - Dates and times of analyses
  - Name(s) of analyses and sampling personnel

- Monitoring Records

  - Discharge Monitoring Reports (DMR's). These would include flow, pH, D.O., etc., as required by permit
  - Original charts from continuous monitoring instrumentation

- Laboratory Records

  - Calibration and maintenance of equipment
  - Calculations
  - QA/QC analysis data

- Facility Operating Records (Daily) (when required)

  - Daily operating log
  - Summary of all laboratory tests run and other required measurements
  - Chemicals used (such as pounds of chlorine per day)
  - Weather conditions (temperature, precipitation, etc.)
  - Equipment maintenance completed and scheduled

- Plant Records*

  - Plant O&M Manual
  - Percent removal records
  - "As built" engineering drawings
  - Copy of construction specifications
  - Equipment supplier manual
  - Data cards on all equipment

- Spill Prevention Control and Countermeasure (SPCC) Plan

  When required, a properly completed SPCC Plan should be available. The inspector may also complete the SPCC inspection form and forward the completed form to the appropriate program for follow-up action.

- Best Management Practices

  Two types of Best Management Practices (BMP) are included in NPDES permits:

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*These items should be available, but they are only required for those facilities built with Federal construction grant funds.

- BMP plans to minimize or prevent the potential for release of significant amounts of any toxic or hazardous pollutants to public waters. The plans may discuss general operation and maintenance of the plant, good housekeeping procedures on the facility grounds, and other plans and procedures specific to best management of the facility.

- Site-specific BMPs to address particular toxic or hazardous chemicals or other conditions particular to the facility. Site-specific BMPs may include procedures, monitoring requirements, construction of barriers such as dikes and berms, or other appropriate measures for solving specific problems.

- Management Records

  - Average monthly operating records
  - Annual reports
  - Emergency conditions (power failures, bypass and chlorine failure reports, etc.)

- Pretreatment Records

  - Industrial Waste Ordinance (or equivalent documents)
  - Inventory of industrial waste contributors including compliance records and user charge information.

3. Document all inspection activity (see Chapter Two, Section 4). Inadequacies, discrepancies, or other problems uncovered during this review may warrant an in-depth investigation.

Compliance Schedule Status Review

[Refer to Checklist, page 3-10.]

If the permit contains a compliance schedule, a status review should be conducted to determine:

- Whether or not the permittee is currently conforming to the compliance schedule and, if not, whether final requirements will be achieved on time;

- The accuracy of reports relating to compliance schedules;

- The length of delay associated with a particular construction violation;

- Whether any schedule violations are the result of matters beyond the control of the discharger; or

- Whether or not requests for permit modifications are valid.

Construction Progress. It is important to know whether contracts for labor and material are timely and whether the permittee or the permittee's engineering consultant is monitoring progress. These aspects are extremely important, particularly in plants where there are likely to be numerous contracts for labor and equipment. If the permittee or the engineering consultant reports that construction or the acquisition of equipment is behind schedule, the inspector should:

- Ask to see the permittee's or the resident engineer's progress report and determine whether the report indicates that the final compliance schedule required by the permit can be met;

- If the report indicates that the final date will not be met, advise the permittee that the compliance schedule of the NPDES permit requires the permittee to notify the permit-issuing authority promptly of any possible delay in achieving compliance and of measures taken to minimize the delay; and

- Inquire whether the facility superintendent or chief operator and operating personnel are receiving adequate training concerning the operational aspects of the new treatment unit while construction work is in full progress. They must be prepared to perform the essential operating functions when the facility is placed in service.

Contract and Equipment Orders. The inspector should review the appropriate documents to determine whether the permittee has obtained the necessary approval from the appropriate agencies in order to begin construction. The inspector should determine the start and completion dates or scheduled delivery dates in service or equipment contracts.

Authorization and Financing. If the necessary treatment works are not in place, the inspector should ascertain whether the permittee has authority to construct the necessary installation (corporate resolutions, etc.) and has made arrangements for proper financing (mortgage commitments, etc.).

Attainment of Operational Status. If construction has been completed but operational status not yet been attained, the inspector should determine whether appropriate procedures are being used to ensure attainment of working levels at the earliest possible time.

The inspector should verify that:

- Adequate self-monitoring procedures have been initiated. It is especially important that the operational and effluent quality result be reviewed to determine whether progress is being made toward optimum efficiency in each treatment unit and in the entire plant;

- Adequate recordkeeping procedures have been established and initiated; and

- Adequate work schedules and assignments have been established. (For municipal facilities, the O&M Manual should provide the essential guidance in this regard.)

POTW Pretreatment Requirements Review

[Refer to Checklist, page 3-11.]

The inspector must do the following when addressing pretreatment requirements:

1. Determine the status of the pretreatment program by the POTW.

    - Has the program been approved by EPA/State or is the approval in progress?

    - Is the POTW in compliance with the enforceable schedule? If not, what information is lacking, why is the information overdue, and what does the POTW intend to do to get back on schedule?

2. Collect information about the compliance status of contributing industrial facilities with Categorical Pretreatment Standards. The inspector should review POTW records to determine:

    - Number of contributing industries;
    - Whether these industries have been notified of applicable standards;
    - Whether industries have submitted baseline reports to the POTW;
    - Number of contributing industries in compliance with standards; and
    - Whether contributing industries with compliance schedules are meeting applicable schedule deadlines.

3. Collect information about the status of compliance of contributing industries with Prohibited Limits (403.5) and Local Limits, if more stringent than EPA Categorical Pretreatment Standards. This applies in cases where the POTW determines that more stringent discharge requirements are needed due to industrial loadings in relation to available POTW treatment systems. The inspector should report:

    - How many and which industrial facilities appear not to be in compliance;

    - Any reasons for non-compliance; and

    - Any follow-up action recommended, such as other inspections, monitoring, review of discharge limits, etc.

In-Depth Investigations

An in-depth inspection of a permittee's records and reports will be conducted when necessary to substantiate a suspected violation, to verify self-monitoring data that may be used as corroborative evidence in an enforcement action, or to confirm apparent sampling, analysis, or reporting discrepancies discovered during the limited inspection. Discrepancies warrant an in-depth review if, for example:

- The discharge does not meet required standards and no definite operational problems have been established;
- Self-reported data are suspected to be grossly inaccurate and the problem appears to be with recordkeeping procedures and/or the filing of reports;
- The cursory review indicates omissions or laxity in the preparation of records; or
- There is evidence of falsification of records.

If more guidance or assistance is needed in carrying out an in-depth investigation, the inspector should confer with the National Enforcement Investigations Center.

Investigation Procedures

1. Determine the investigation objective. (What is the specific purpose of the investigation?)
2. Determine what information is needed. (What specific data will substantiate a violation or respond to the investigation objective?)
3. Determine the data source. (What records will contain these required data?)
4. Review inspection authority. Authority to inspect under §308 is limited to those records required by the permit. Specific authority may be necessary to inspect other documents.
5. Inspect direct and indirect sources of data. Look at those records likely to provide the required data directly. In the absence of direct data, indirect sources of information can be used to develop a network of information relevant to the data being sought.
6. Take statements from qualified facility personnel. (See Chapter Two, Section 4 for procedures.)

7. Prepare documentation. Copy and identify all records relevant to the information being sought. (See Chapter Two, Section 4 for specific procedures.)

8. Follow confidentiality procedures. Any record inspected may be claimed by the facility as confidential. Such records must be treated in accordance with Agency procedures (see page 2-22).

Records, Reports, and Schedules Checklist

A. Permit Verification

YES NO N/A	INSPECTION OBSERVATIONS VERIFY INFORMATION CONTAINED IN PERMIT
Yes No N/A	1. Correct name and mailing address of permittee.
Yes No N/A	2. Facility is as described in permit.
Yes No N/A	3. Notification has been given to EPA/State of new, different, increased discharges.
Yes No N/A	4. Accurate records of influent volume are maintained, when appropriate.
Yes No N/A	5. Number and location of discharge points are as described in the permit.
Yes No N/A	6. Name and location of receiving waters are correct.
Yes No N/A	7. All discharges are permitted.

B. Recordkeeping and Reporting Evaluation

YES NO N/A	RECORDS AND REPORTS ARE MAINTAINED AS REQUIRED BY PERMIT
Yes No N/A	1. All required information is available, complete, and current; and
Yes No N/A	2. Information is maintained for required period.
Yes No N/A	3. Analytical results are consistent with the data reported on the DMR's.
	4. Sampling and Analysis Data are adequate and include:
Yes No N/A	a. Dates, times, location of sampling
Yes No N/A	b. Name of individual performing sampling
Yes No N/A	c. Analytical methods and techniques
Yes No N/A	d. Results of analysis
Yes No N/A	e. Dates of analysis
Yes No N/A	f. Name of person performing analysis
Yes No N/A	g. Instantaneous flow at grab sample stations
	5. Monitoring records are adequate and include
Yes No N/A	a. Flow, pH, D.O., etc. as required by permit
Yes No N/A	b. Monitoring charts
Yes No N/A	6. Laboratory equipment calibration and maintenance records are adequate.
	7. Plant Records are adequate* and include
Yes No N/A	a. O&M Manual
Yes No N/A	b. "As-built" engineering drawings
Yes No N/A	c. Schedules and dates of equipment maintenance and repairs
Yes No N/A	d. Equipment supplies manual
Yes No N/A	e. Equipment data cards
	*Required only for facilities built with Federal construction grant funds.

Records, Reports, and Schedules Checklist

	8. Pretreatment records are adequate and include:
Yes No N/A	a. Industrial Waste Ordinance (or equivalent documents)
Yes No N/A	b. Inventory of industrial waste contributors, including:
Yes No N/A	1. Compliance records
Yes No N/A	2. User charge information

Yes No N/A	9. SPCC properly completed, when required.

Yes No N/A	10. Best Management Practices Program available, when required.

C. Compliance Schedule Status Review

YES NO N/A	THE PERMITTEE IS MEETING THE COMPLIANCE SCHEDULE
Yes No N/A	1. The permittee has obtained necessary approvals to begin construction.
Yes No N/A	2. Financing arrangements are complete.
Yes No N/A	3. Contracts for engineering services have been executed.
Yes No N/A	4. Design plans and specifications have been completed.
Yes No N/A	5. Construction has begun.
Yes No N/A	6. Construction is on schedule.
Yes No N/A	7. Equipment acquisition is on schedule.
Yes No N/A	8. Construction has been completed.
Yes No N/A	9. Start-up has begun.
Yes No N/A	10. The permittee has requested an extension of time.
Yes No N/A	11. The permittee has met compliance schedule.

D. POTW Pretreatment Requirements Review

YES NO N/A	THE FACILITY IS SUBJECT TO PRETREATMENT REQUIREMENTS
	1. Status of POTW Pretreatment Program
Yes No N/A	a. The POTW Pretreatment Program has been approved by EPA. (If not, is approval in progress? ________)
Yes No N/A	b. The POTW is in compliance with the Pretreatment Program Compliance Schedule. (If not, note why, what is due, and intent of the POTW to remedy)

	2. Status of Compliance with Categorical Pretreatment Standards.
Yes No N/A	a. How many industrial users of the POTW are subject to Federal or State Pretreatment Standards?________________
Yes No N/A	b. Are these industries aware of their responsibility to comply with applicable standards?
Yes No N/A	c. Have baseline monitoring reports (403.12) been submitted for these industries?
Yes No N/A	i. Have categorical industries in noncompliance (on BMR reports) submitted compliance schedules?
Yes No N/A	ii. How many categorical industries on compliance schedules are meeting the schedule deadlines?_______
Yes No N/A	d. If the compliance deadline has passed, have all industries submitted 90 day compliance reports?
Yes No N/A	e. Are all categorical industries submitting the required semiannual report?
Yes No N/A	f. Are all new industrial discharges in compliance with new source pretreatment standards?
Yes No N/A	g. Has the POTW submitted its annual pretreatment report?
Yes No N/A	h. Has the POTW taken enforcement action against noncomplying industrial users?
Yes No N/A	i. Is the POTW conducting inspections of industrial contributors?

Yes No N/A	3. Are the industrial users subject to Prohibited Limits (403.5) and local limits more stringent than EPA in compliance? (If not, explain why, including need for revision of limits.)

Facility Site Review

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Facility Site Review

Objectives

In performing a facility site review, an inspector examines areas on the permittee's premises where pollutants are generated, pumped, conveyed, treated, stored, or disposed. The inspector also conducts a visual inspection of monitoring equipment.

The proper conduct of a facility site review requires that the inspector have a full understanding of the treatment processes used at the facility and how each process fits into the overall treatment scheme.

The objectives of a facility site review are to:

- Assess the conditions of the permit in regard to current facility processes and operations;
- Evaluate the permittee's operation and maintenance activities; and
- Check on the completeness and accuracy of the permittee's performance/compliance records.

The overall review of the facility allows the compliance inspector to gain a feeling for the facility being inspected, to review areas that may indicate problems with effluent limitations, and to evaluate overall performance of the treatment facility.

The information presented in this chapter is comprehensive and inspectors should use only that information that is applicable to the situation at hand.

A Facility Site Review Checklist for inspectors' use is included at the end of this chapter.

Physical Inspection of the Facility

During the physical "walk-through" of the facility, the inspector should look at the areas listed below. Because these areas may contain potential problems, the physical inspection should be carefully documented. Areas that should be covered are:

- Influent characteristics, including:
  - combined sewer loads,
  - infiltration/inflow,
  - industrial contributions, and
  - diurnal/seasonal loading variations;
- Process control;
- Unit operations;
- Equipment condition; and
- Other conditions particular to the plant.

The manual, Performance Evaluation and Trouble Shooting at Municipal Wastewater Facilities, published by the Municipal Operations Branch of the EPA, MO #16, January 1978 is a good reference for the above areas.

The physical inspection may lead to the following determinations:

- Whether or not there is a major design problem that requires an engineering solution;
- Problem areas that can be solved through the evaluation (and eventual correction) of operation and maintenance functions; or
- Periodic equipment malfunctions that need to be addressed by complete overhaul or replacement of equipment.

If the first condition, a facility design problem, exists, one of the recommendations will be to develop engineering solutions. In that case, the inspector must evaluate the operation and maintenance functions from the point of view of what can be done to minimize problems, if the design problems continue to exist.

When the second condition exists, the inspector should use the facility inspection findings to tailor the evaluation of the operation and maintenance functions. This information would enable the inspector to look for specific practices that either contribute to or cause the problems uncovered in the physical inspection.

When conducting the walk-through, the inspector should be aware of and should look for indicators of potential problems. The presence of these indicators will give the inspector an idea of the types of problems present, the parts of the treatment process causing the problems, and the potential solution to existing problems. Indicators for various treatment process problems are given below.

General Indicators

- Surcharging of influent lines, overflow weirs, and other structures;
- Flow through by-pass channels;
- Accumulation of solids and scum in wet wells, excessive scum build-up, grease, foam, or floating material in clarifiers;
- Alternative discharge points, channels, or other areas likely to have overflows. Discoloration of the ground may indicate past spills at the plant and further investigation may be warranted;
- Excessive suspended solids, turbidity, foam, grease, scum, color, and other macroscopic particulate matter in the plant effluent;
- Obnoxious odors in wet wells and grit chambers and around aerobic and anaerobic biological units, scum removal devices, and sludge handling facilities;
- Vital treatment units out of service for repairs. Determine when they were out of service, the type of failure, and when the unit will be put back in service;
- Any unusual equipment such as special pumps, floating aerators in diffused air systems, chemical feeders, temporary construction or structures, or any jerry-rigged systems intended to correct operational problems;
- The lack of alternative power sources in accordance with permit requirements that can be used during electrical failures to prevent the discharge of untreated or inadequately treated wastes;
- Collected screening, slurries, sludges, or other by-products of treatment. Their disposal, including the runoff of wastewaters, must be in an approved manner as to prevent entry into navigable waters or their tributaries;
- Spills or mishandling of chemicals;
- Air slaking during storage of quicklime;
- Incomplete slaking of quicklime;

- Evidence of severe corrosion problem;
- Excessive grit in bar screen chamber;
- Excessive screen clogging;
- Ruptures in chemical feed lines;
- Excessive septage dumping by septic tank pumpers;
- Too much vibration of cyclone degritter;
- Primary clarifier or grit chamber with grease and gas bubbles rising or with evident septic waste;
- Improper storage of all chemicals and hazardous substances with particular attention to the proper diking of chemicals and hazardous substances;
- Improper chlorine storage and reserve supply; and
- No recycling of filtrates and supernatant from sludge beds.

Primary Clarifier

- Evidence of short circuiting;
- Floating sludge;
- Excessive gas bubbles on surface;
- Black and odorous wastewater;
- Excessive sludge on bottom, inadequate sludge removal;
- Scum overflow or lack of adequate scum disposal, scum pit full;
- Scum rake inadequately removes scum;
- Poor suspended solids removal in primary clarifier;
- Broken scraper;
- Noisy scraper drive;
- Discharge weirs unlevel; and
- Center well on circular clarifiers has accumulated solids.

Secondary Biological Treatment Units

- Trickling filter ponding (indicating clogged media);
- Leak at center of column of trickling filter's distribution arms;
- Clogging of trickling filter's distributor-arm orifices;
- Distribution arms do not rotate freely;
- Filter flies;
- Ice build-up on trickling filter media;
- Uneven distribution of flow on filter surface;
- Dead spots in activated sludge aeration tanks or dark foam and bad odor;
- Air rising in clumps in activated sludge diffused aeration tank;
- Excessive air leaks in compressed air piping;
- Dark black mixed liquor in activated sludge aeration tank;
- Stable dark tan foam on aeration tanks which sprays cannot break up;
- Failure of surface aerators;
- Inoperative air compressors;
- Thick billows of white sudsy foam on aeration tank;
- Low DO (< 1.0 mg/l) in aeration tank;
- Erosion of stabilization pond bank or dike;
- Excessive weed and algae in stabilization ponds;
- Foaming and spray in aerated lagoon;
- Development of white biomass on rotating biological contactor media;
- Solid accumulating on rotating biological contactors;
- Excessive sloughing of biomass from rotating biological contactors;
- Excessive breaking of rotating disks in orbal units;
- Excessive breakage of paddles on brush aerators; and

- Shaft, bearing, drive gear, or motor failure on disk or brush aerators.

Secondary Clarifier

- Evidence of short circuiting;
- Sludge floating to surface;
- Excessive gas bubbles on surface;
- Fouling of overflow weirs;
- Overflow weirs unlevel;
- Deflocculation in clarifier;
- Scum rake ineffective;
- Billowing sludge;
- Sludge blanket too high;
- Pin floc in overflow;
- Excessive buildup of material in center well of circular clarifier; and
- All sludge withdrawal ports on secondary clarifier clogged or flowing improperly thick sludge.

Physical Treatment Units

- Filter surface clogging;
- Short filter run;
- Recycled filter backwash water in excess of five percent;
- Gravel displacement of filter media;
- Formation of mud balls in filter media;
- Loss of filter media during backwashing;
- Air binding of filter media;
- Erratic rotation of microscreen drums;

Sludge Handling

- Thickened sludge too thin;
- Fouling of overflow weirs on gravity thickeners;
- Air flotation skimmer blade binding on beaching plate;
- Poor dewatering characteristics of thermal treated sludge;
- Substantial down time of heat treatment unit; and
- Inadequate sludge removal from clarifiers or thickeners.

Sludge Anaerobic Digestion

- Floating cover of anaerobic digester tilting with heavy, little, or no scum around the edges;
- Inadequate gas production;
- Yellow gas flame from waste gas burner;
- Gas burner not burning or inoperative;
- Moisture trap on gas line full of water;
- Supernatant exudes a sour odor from either primary or secondary anaerobic digester;
- Foaming in supernatant in single stage or primary tank of anaerobic digester;
- Manometer shows digester gas pressure above or below normal;
- Mechanical or gas mixers inoperative;
- Wide fluctuation of sludge temperature in anaerobic digester;
- Sludge heater inoperative;
- Excessive foaming in aerobic digestion tank;
- Inadequate supernatant removal from sludge lagoons;
- Aerobically digested sludge has objectionable odor;

- Sludge lagoons full, overflowing sludge back to plant or to natural drainage;
- Clogging of diffusers in aerobic digester; and
- Mechanical aerator failure in aerobic digester.

Sludge Drying/Filtering

- Poor sludge distribution on drying bed;
- Dry sludge not removed from drying beds;
- Dry sludge stacked up around drying beds--runoff enters navigable waters;
- Excessive dewatering time of sludge drying bed;
- Too many solids in centrifuge's centrate;
- Inadequate dryness of centrifugal sludge cake;
- High level of solids in filtrate;
- Thin filter cake with poor dewatering;
- Vacuum filter cloth binding;
- Improperly cleaned vacuum filter media;
- Sludge build-up on belts and/or rollers of filter press;
- Difficult cake discharge from filter presses;
- Filter cake sticks to solids-conveying equipment of filter press;
- Frequent media binding of filter press;
- Excessive moisture in filter press cake;
- Sludge blowing out of filter press;
- Objectionable odor from sludge drying lagoon;
- Broken dikes between sludge drying lagoon; and
- Sludge lagoons not lined.

Sludge Disposal

- Surface runoff of sludge at land application site;
- Liquid sludge, i.e., less than 10 percent solids, applied to land fill site;
- Flies breeding and/or odors at landfill site;
- Inadequate burial of sludge at landfill site;
- Inadequate coverage of sludge in subsurface plow injection system;
- Slow drying of soil-sludge mixture in subsurface injection system;
- Sludge ponding at land applications sites;
- Inadequate groundwater monitoring at landfill or land application sites;
- Excessive erosion at sludge landfill sites;
- Inadequate leachate collection and/or treatment at landfill or land application sites;
- Inadequate runoff control at landfill or land application sites;
- Sludge applied to land has not been treated to significantly reduce pathogens, according to relevant sludge disposal regulations;
- Sludge is not being transported in an appropriate and approved vehicle, and
- Sludges disposed in landfills are not done so in accordance with Federal, State or local regulations.

Miscellaneous

- Offensive odor in recalcining area;
- Recalcined lime tends to agglomerate into particles one-quarter-inch in diameter or larger; and
- Large clinkers forming in lime recalcining furnace.

Maintenance of Facilities and Equipment

Inspectors should discuss maintenance programs with facility officials, including:

- All aspects of preventive, routine, and remedial maintenance programs including inventory of spare parts;
- Emergency operating and response programs;
- Qualifications, training, and certification of plant personnel;
- Alarm systems for power or equipment failures and the availability of alternate power sources; and
- The regularity of housekeeping throughout the plant.

Flow Measuring Equipment

- Build up of solids in flume or weir;
- Broken or cracked flume or weir;
- Magnetic flowmeter not functioning properly;
- Stilling wells clogged, broken; and
- Weir plate damaged or not level.

Chemical Treatment Units

- Heavy corrosion evident;
- No portion measuring device at feed unit;
- pH measuring not evident at pH adjustment tank;
- Chemicals left out in open atmosphere;
- Chemicals stockpiled longer than shelf-life;
- Chemical containers stored in improper or hazardous fashion;
- Chemical tanks cars (trucks or train) stored, moved or handled inappropriately;
- Dry chemicals spilled on floor between storage area and feed units;
- Empty chemical containers improperly disposed;

- Large containers handled improperly, container transfer equipment not maintained;
- No appropriate sized burms or dikes at liquid chemical feed units;
- Inadequate supply of chemicals on hand;
- Chemical dust covering feed unit area or storage and transfer areas;
- Use of an inappropriate coagulent; and
- Glass carboys (acid storage) stored or handled improperly.

Oil Separation

- Waste oil disposed improperly;
- Oily waste accumulated on floor/ground near separation unit; and
- Oil sheen on wastewater after oil-water separator.

General Housekeeping

- Facility control panel in disrepair or not in use; and
- Wastewater pipelines not clearly distinguished from product pipelines.

Polishing Ponds or Tanks

- Contents of polishig or tanks have foul smell, excessive foams, floating solids or oil sheens;
- Solids or scum accumulated in tank or at side of pond; and
- Evidence of polishing ponds or tanks being bypassed due to low capacity.

Production Changes

Industries frequently make production changes because of advances in technology and introduction of new products. Therefore, during the tour of an industrial facility, the inspector should also inquire:

- Whether a permittee has made any changes in production processes, raw material, amount of finished product, water use, waste treatment processes, or other such changes. Specifically, the inspector should determine whether the permittee has modified any production process that would change the types or loads of pollutants so that when the permit is reissued it will reflect these modifications; and

- Whether the regulatory agency was notified of such changes.

The inspector should verify any changes and include the results of the findings and other pertinent information in the Compliance Inspection Report. Changes in the loading to POTW's by the addition of a significant industrial discharger or large population growth should also be ascertained and reported.

Operation Evaluation

Operating factors affecting plant performance range from qualitative factors such as the skills and aptitude of operators (e.g., process knowledge and general aptitude), to physical deficiencies in laboratory equipment or a lack of flexibility in process equipment.

The evaluation of operation functions must focus on wastewater treatment, sludge treatment/disposal, energy recovery, and laboratory analysis. The evaluation should be based on the following areas:

- Policies and Procedures
- Organization
- Staffing
- Planning
- Management Controls

Table 4-1 (at the end of this chapter) presents the basic review questions that an inspector should use to evaluate operation functions.

Although each of the above evaluation areas must be covered in the review of operation functions, the following three areas should be of particular concern to the inspector.

Policies and Procedures

Written operating procedures and standard reference texts enable the operator to achieve efficient plant operation. The operations manual prepared for the facility is the most important reference that an inspector should review when evaluating plant policies and procedures. Other reference materials relating to operations that should be available to the operator include manufacturers' literature, publications by professional organizations (e.g., the Water Pollution Control Federation), and EPA publications.

Staffing

Even the best engineered facility cannot perform to its potential without a capable and qualified staff. The inspector must consider the abilities and limitations of the operating staff. Staff interviews may include the individual in charge of overall operation, the chief operator, specific unit process operators, and laboratory staff.

Management Controls

Monitoring practices are a good indication of both the emphasis placed on operations and the operator's understanding of process controls. Factors affecting a facility's monitoring capabilities are:

- The sampling program;
- Performance testing;
- Analytical capabilities; and
- Recordkeeping practices.

An effective process control program is essential to a treatment facility's optimal performance. However, process control cannot be easily quantified by the inspector. In most cases, the inspector must rely on discussions with the plant superintendent and/or operators to supplement available records and the technical evaluation. The key considerations for effective process controls are:

- Process knowledge of the operators;
- The basis for the control practices;
- Past performance;
- Operator emphasis on controls; and
- Recordkeeping.

Maintenance Evaluation

Facility maintenance directly affects the ability of the facility to run efficiently and to remain in compliance with its NPDES permit. There are two types of facility maintenance:

- Preventive Maintenance

  reduces facility operating costs by eliminating breakdowns and the need for corrective maintenance;

- improves the facility's reliability by minimizing the time equipment is out of service;
- increases the useful life of equipment, thus avoiding costly premature replacement;
- avoids possible compliance violations;

- Corrective Maintenance
  - gets malfunctioning equipment back into operation; and
  - avoids or minimizes possible compliance violations.

The evaluation of the maintenance function must focus on the ability to maintain the following: process equipment, vehicles, and buildings and grounds.

Although each of the five evaluation topics (policy and procedures, organization, staffing, planning, and management controls) must be covered for each facility inspected, the following are three common areas of concern in the maintenance function:

- Staffing and training;
- Planning and scheduling; and
- Management control--records systems and inventory control.

Only well-trained, competent plant staff can be expected to perform ade quate physical inspections, repairs, and preventive maintenance. Waste water facility maintenance is complex and requires a variety of skills. Because many of these skills are not readily available, an ongoing training program is essential.

Maintenance planning and scheduling is essential to effective corrective and preventive maintenance. The maintenance supervisor must prepare work schedules listing job priorities, work assignments, available personnel, and timing.

A detailed records system is the basis of any maintenance program. Records are used to establish maintenance histories on equipment, diagnose problems, and anticipate--and thereby avoid--equipment failure, making them effective tools for preventive maintenance.

A central inventory for spare parts, equipment, and supplies must be maintained and controlled. The basis for the inventory should be the equipment manufacturer's recommendations, supplemented by specific, historical experience with maintenance problems and requirements. Inventoried supplies must be kept at levels sufficient to avoid process interruptions.

A maintenance cost control system should be an integral part of every wastewater facility. Budgets must be developed from past cost records and are usually categorized according to preventive maintenance, corrective maintenance, and major repair requirements, both projected and actual. Costs over a given year must be compared to the budget on a periodic basis to control maintenance expenditures. Evaluating costs in this manner provides both control over expenditures and a basis for development of future budgets.

The basic concerns that need to be addressed and evaluated during the inspector's maintenance program review are presented in Table 4-1 (at the end of this chapter).

References

U.S. Environmental Protection Agency. 1982. Comprehensive Diagnostic Evaluation and Selected Management Issues, EPA 430/9-82-003.

U.S. Environmental Protection Agency. 1979. Inspector's Guide for Evaluation of Municipal Wastewater Treatment Plants, EPA 430/9-79-010.

U.S. Environmental Protection Agency. 1978. Field Manual for Performance Evaluation and Troubleshooting at Municipal Wastewater Treatment Facilities, MO #16, EPA 430/9/78-001.

U.S. Environmental Protection Agency. 1973. Maintenance Management Systems for Municipal Wastewater Facilities, EPA 430/9-74-004.

Water Pollution Control Federation (WPCF). 1977. Operation of Wastewater Treatment Plants, MOP No. 11, WPCF, 1977.

Table 4-1

Operations and Maintenance Functions Evaluation Questions

POLICIES AND PROCEDURES

- Is there a formal or informal set of policies for facility operations?
- Do policies address?
  - Remaining in Compliance
  - Maintaining Process and Cost Controls
  - Quality control
  - Preventative maintenance
- Is there a set of standard procedures to implement these policies?
- Are they written or informal?
- Do the procedures consider the following areas?
  - Safety
  - Emergency
  - Laboratory
  - Process Control
  - Operating Procedures
  - Monitoring
  - Labor Relations
  - Energy Conservation
  - Collection System
  - Pumping Stations
  - Treatment Process
  - Sludge Disposal
  - Equipment Record System
  - Maintenance Planning and Scheduling
  - Work Orders
  - Inventory Management
- Are the procedures followed in fact?

ORGANIZATION

- Is there an Organizational Plan (or Chart) for operations?
- Does the Plan include?
  - Delegation of responsibility and authority
  - Job descriptions
  - Interaction with other functions (such as maintenance)

- Is the Organizational Plan formal or informal?
- Is the Organizational Plan available to and understood by the staff?
- Is the Organizational Plan followed in fact?
- Is the Organizational Plan consistent with policies and procedures?
- Is the Organizational Plan flexible? Can it handle emergency situations?
- Does the Organizational Plan clearly define lines of authority and responsibility in such subfunctional areas as?
  - Laboratory
  - Process Control
  - Equipment Operation
  - Instrumentation
  - Sludge Disposal
  - Collection System
  - Pump Stations
  - Monitoring Practices
  - Mechanical
  - Electrical
  - Instrumentation
  - Buildings and Grounds
  - Automotive
  - Supplies and Spare Parts

STAFFING

- Is there an adequate number of staff persons to achieve policies and procedures?
- Are staff members adequately qualified for their duties and responsibilities?
  - Certification
  - Qualifications
  - Ability
  - Job performance
  - Understanding of treatment processes
- Is staff effectively utilized?
- Has the potential for borrowing personnel been considered?
- Are training procedures followed for?
  - Orientation of new staff
  - Training new operators
  - Training new supervisors
  - Continuing training of existing staff
  - Cross training

- What training procedures are used?
  - Formal classroom
  - Home study
  - On-the-job training
  - Participation in professional organization
  - Text and manuals
- Does the training program provide specific instruction for the various operations and maintenance activities?
  - Safety
  - Laboratory procedures
  - Treatment processes
  - Instrumentation
  - Equipment trouble-shooting
  - Handling personnel problems
  - Monitoring practices
  - Handling emergencies
  - Mechanical
  - Electrical
  - Automotive
  - Building maintenance
  - Inventory control
- Does management encourage staff motivation?
- Does management support its first-line supervisors?
- How is staff motivation maintained?
  - Encouragement for training
  - Job recognition
  - Promotional opportunities
  - Salary incentives
  - Job security
  - Working environment

<u>PLANNING</u> (OPERATIONS)

- How are operating schedules established?
- Do schedules attempt to attain optimum staff utilization?
- Are line supervisors included in manpower scheduling?
- Are staff involved in/informed of manpower planning?
- Is there sufficient long-term planning for staff replacement and system changes?
- Are there procedures in manpower staffing for emergency situations?
- How are process control changes initiated?

- How do process control changes interact with management controls?
- How effectively are laboratory results used in process control?
- Are there emergency plans for treatment control?
- Is there an effective energy management plan? Is the plan utilized?
- To what extent are operations personnel involved in the budgetary process?
- Do budgets adequately identify and justify the cost components of operations?
- Are future budgets based on current and anticipated operating conditions?
- Do operating and capital budget limits constrain operations (capital replacement and improvements)?
- Can budget line items be adjusted to reflect actual operating conditions?

PLANNING (MAINTENANCE)

- Are maintenance activities planned? Formally or informally?
- Does the facility have sufficient management controls to affect realistic planning and scheduling? If the controls exist are they utilized?
- To what extent do the other facility functions become involved in the planning process?
- Are operating variables exploited to simplify maintenance efforts?
- Is efficient staff utilization a significant factor in planning?
- To what extent is the supplies and spare parts inventory planned in conjunction with maintenance activities?
- Have minimum and maximum levels been established for all inventory items?
- Does maintenance have an emergency plan in harmony with the utility emergency plan?

- Is plan up to date? Is the staff knowledgeable about emergency procedures?
- Does a plan exist for returning to the preventive maintenance mode following an emergency?
- Are preventive maintenance tasks scheduled in accordance with manufacturer's recommendations?
- Is adequate time allowed for corrective maintenance?
- Are basic maintenance practices (preventive and corrective) and frequencies reviewed for cost-effectiveness?
- Do the management controls provide sufficient information for accurate budget preparation?
- Does the maintenance department receive feedback on cost performance to facilitate future budget preparation?
- To what extent are maintenance personnel involved in the budgetary process?
- Do the management controls provide sufficient information for accurate budget preparation?
- Do budgets adequately identify and justify the cost components of maintenance?
- Are future budgets based on current and anticipated operating and maintenance conditions?
- Do maintenance and capital budget limits constrain preventive maintenance (equipment replacement and improvements)?
- Does the maintenance department receive adequate feedback on cost performance?
- Can budget line items be adjusted to reflect actual maintenance conditions?

MANAGEMENT CONTROLS (OPERATIONS)

- Are the following documents maintained in a current state?
  - Operating Reports
  - Work Schedules
  - Activity Reports
  - Performance Reports (labor, supplies, energy)

- Expenditure Reports (labor, supplies, energy)
- Cost Analysis Reports
- Emergency and Complaint Calls
- Process Control Data Including Effluent Quality

- Do the reports contain sufficient information to support their intended purpose?
- Are they usable and accepted by the staff?
- Are reports being completed as required?
- Are reports consistent with one another?
- Are reports used directly in process control?
- Are the reports reviewed and discussed with operating staff?
- What type of summary reports are required?
- To whom are reports distributed and when?

MANAGEMENT CONTROLS (MAINTENANCE)

- Does a maintenance record system exist? Does it include?
  - As-built drawings
  - Shop drawings
  - Construction specifications
  - Capital and equipment inventory
  - Maintenance history (preventive and corrective)
  - Maintenance costs
- Is the base record system kept up to date as part of daily maintenance practices?
- Is there a work order system for scheduling maintenance? Is it explicit or implicit?
- Do work orders contain?
  - Date
  - Work order number
  - Location
  - Nature of problem
  - Work required
  - Time requirements
  - Assigned personnel

  - Space for reporting work performed, required supplies, time required, and cost summary
  - Responsible staff member and supervisory signature requirements

- When emergency work must be performed without a work order, is one completed afterwards?

- Are work orders usable and acceptable by staff as essential to the maintenance program? Are they actually completed?

- Is work order information transferred to a maintenance record system?

- Does a catalog or index system exist for controlling items in inventory?

- Are withdrawal tickets used for obtaining supplies from inventory?

- Do the tickets contain cost information and interact well with inventory controls and the work order system?

- Is the cost and activity information from work orders aggregated to provide management reports? Is this information also used for budget preparation?

- Is maintenance performance discussed regularly with the staff?

- How is the cost of contract maintenance or the use of specialized assistance recorded?

- Are there adequate safeguards and penalties to prevent maintenance cards from being returned without the work being done?

- Is the preventive maintenance record checked after an emergency equipment failure?

Facility Site Review Checklist

Yes No N/A	1. Standby power or other equivalent provision is provided.
Yes No N/A	2. Adequate alarm system for power or equipment failures is available.
Yes No N/A	3. POTW handles and disposes of sludge according to applicable Federal, State, and and local regulations.
Yes No N/A	4. All treatment units, other than back-up units, are in service.
Yes No N/A	5. Procedures for facility operation and maintenance exist.
Yes No N/A	6. Organization plan (chart) for operation and maintenance is provided.
Yes No N/A	7. Operating schedules are established.
Yes No N/A	8. Emergency plan for treatment control is established.
	9. Operating management control documents are current and include:
Yes No N/A	a. Operating report
Yes No N/A	b. Work schedule
Yes No N/A	c. Activity report (time cards)
	10. Maintenance record system exists and includes:
Yes No N/A	a. As-built drawings
Yes No N/A	b. Shop drawings
Yes No N/A	c. Construction specifications
Yes No N/A	d. Maintenance history
Yes No N/A	e. Maintenance costs
Yes No N/A	11. Adequate number of qualified operators are on-hand.
Yes No N/A	12. Established procedures are available for training new operators.
Yes No N/A	13. Adequate spare parts and supplies inventory and major equipment specifications are maintained.
Yes No N/A	14. Instruction files are kept for operation and maintenance of each item of major equipment.
Yes No N/A	15. Operation and maintenance manual is available.
Yes No N/A	16. Regulatory agency was notified of by-passing. (Dates ______________________________)

Yes No N/A	17. Hydraulic and/or organic overloads are experienced. Reasons for overloads ______________________________ ______________________________ ______________________________ ______________________________
Yes No N/A	18. Up-to-date equipment repair records are maintained.
Yes No N/A	19. Dated tags show out of service equipment.
Yes No N/A	20. Routine and preventive maintenance are scheduled/performed on time.

Chapter Five

Sampling

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Chapter Five

1 Evaluation of Permittee Sampling Program

Wastewater sampling/analysis is an integral part of the NPDES Compliance Monitoring Program. NPDES permits contain specific and legally enforceable effluent limitations and self-monitoring requirements for effluent sampling/analysis and flow measurement. The sampling frequency, the sample type, the parameters to be monitored, the parameter limitations, the analytical methods, and the reporting frequency are determined by the permitting agency.

Objectives and Requirements

In an evaluation of the permittee sampling program the inspector should set the following objectives:

- Verification that permittee's sampling program is in compliance with permit;
- Verification that sampling program complies with 40 CFR 136; and
- Support of enforcement action.

Requirements for sampling, analysis, preservation techniques, sample holding times, and sample containers are given under 40 CFR 136 as authorized by Section 304(h) of the Clean Water Act. 40 CFR 136 superceded any method or techniques specified in the manual. More information on required analytical procedures can be found under "Evaluation of Permittee Laboratory Analytical Procedures" in Chapter Eight.

A Permittee Sampling Inspection Checklist for the inspector's use appears at the end of this chapter.

Evaluation of Permittee Sampling Procedures

An evaluation of the permittee sampling program should include an inspection of sampling procedures used by the facility and of quality control measures used to ensure the integrity of sample data. Evaluation of sampling procedures should include an assessment of the following five areas:

(1) Sample Collection Techniques

Depending on the objectives or requirements of the monitoring program, samples can be collected either manually or with automatic samplers. The following general guidelines apply when taking samples:

- Take samples at a site specified in the NPDES permit and/or at a site selected to yield a representative sample.
- Use the approved sample method (grab, composite, automatic sampler) as required in the sampling and analysis methods of 40 CFR 136. Some parameters that are not to be sampled by automatic samplers or compositing include the following: dissolved oxygen, total residual chlorine, pH, temperature, oil and grease, fecal coliform, and purgeable organics.
- Exclude large nonhomogeneous particles and objects.
- Collect the sample facing upstream to avoid contamination.
- Do not rinse sample container with sample when collecting microbiological samples, but fill it directly to within 2.5 to 5 cm from the top.
- Fill the container completely if the sample is to be analyzed for purgeable organics, oxygen, ammonia, hydrogen sulfide, free chlorine, pH, hardness, sulfite, ammonium, ferrous iron, acidity, or alkalinity.
- Collect sufficient volume to allow for quality assurance testing.

(2) Types of Samples

Two types of sampling techniques are used: grab and composite.

Grab Samples. Grab samples are individual samples collected over a period of time not exceeding 15 minutes; the grab sample can be taken manually. The collection of a grab sample is appropriate when a sample is needed to:

- Provide information about instantaneous concentrations of pollutant at specific time;
- Allow collection of a variable sample volume;
- Corroborate composite samples; and
- Collect samples for parameters not amenable to automatic sampling (e.g., oil and grease, coliform bacteria).

Composite Samples. These samples consist of grab samples collected at equal intervals and combined proportional to flow, a sample continuously collected proportionally to flow, or equal volumes taken at varying time intervals. Composite samples are used when stipulated in a permit and when:

- Determining average pollutant concentration during the compositing period;
- Calculating mass/unit time loadings; and
- Wastewater characteristics are highly variable.

There are six methods for compositing samples; they may be collected using either manual or automatic sampling. The six compositing methods, all of which depend on either a continuous or periodic sampling, are shown in Table 5-1. In any manual compositing method, sample manipulation should be minimized to reduce the possibility of contamination.

Others. Special collection methods are generally required for purgeable organics and microbiological samples because of their unique nature. These samples are usually collected manually.

(3) Sample Containers

An accurate description of the required sample containers, sample container preparation, and sample collection techniques is presented in 40 CFR 136.

It is essential that the sample containers be made of chemically resistant material and do not affect the concentrations of the pollutants to be measured. In addition, sample containers must have a closure that will protect the sample from contamination.

Wastewater samples for chemical analysis are generally collected in plastic (polyethylene) containers. Exceptions to this general rule are oil and grease samples, pesticides, PCBs, and other organic pollutant samples. These are collected in properly rinsed glass jars or bottles and sealed. Bacteriological samples are generally collected in properly sterilized plastic or glass containers.

(4) Sample Identification

Each sample must be accurately and completely identified. It is important that any label used to identify the sample be moisture-resistant and able to withstand field conditions. A numbered label associated with a field data sheet containing detailed information on the sample may be preferable to using only a label for information.

(5) Sample Preservation and Holding Time

In most cases, wastewater samples contain one or more unstable pollutants that require immediate analysis or preservation. Prompt analysis is the most positive assurance against error from sample deterioration, but this is not feasible for composite samples, in which portions may be stored for as long as 24 hours. It is important that preservation of the samples be provided for during compositing, where possible, in addition to being preserved before being transferred to the laboratory. Procedures used to preserve samples include refrigeration, pH adjustment, and chemical treatment. Proper preservation and holding time for samples is essential to the integrity of the monitoring program. (See Table 5-2 and refer to 40 CFR 136.)

Quality Control

Control checks should be performed during the actual sample collection to determine the performance of the sample collection system. In general, the most common monitoring errors are usually caused by improper sampling, improper preservation, inadequate mixing during compositing and splitting, and excessive sample holding time. The following samples should be used to check the sample collection system:

- Duplicate Samples. These are separate samples taken from the same source at the same time. These provide a check on sampling equipment and precision techniques.

- Split Samples. This is a sample that has been divided into two containers for analysis by separate laboratories. These aid in identifying discrepancies in the permittee's analytical techniques and procedures.

- Spike Samples. This is a sample to which a known quantity of the same substance has been added. These provide a proficiency check for accuracy of the analytical procedures.

- Sample Preservative Blanks. This is a sample of distilled water to which a known quantity of preservative is added. This sample is then analyzed to determine the efficacy of the preservative. These provide a check on the contamination of chemical preservatives.

2 Inspector's Compliance Sampling

Objectives and Requirements

Specific objectives of the sampling conducted by inspectors include the following:

- Verification of compliance with effluent limitations;
- Verification of self-monitoring data;
- Support of enforcement action; and
- Support of permit reissuance and/or revision.

It must be stressed that the laboratory that will analyze the samples must be notified far enough in advance of the inspection to avoid analysis scheduling problems.

Sample Collection

Sample collection is an important part of the compliance monitoring program. Without proper sampling procedures, the results of such monitoring programs are neither useful nor valid, even with the most precise and accurate analytical measurement.

Selection of Representative Sampling Sites

Samples should be collected at the location specified in the permit. In some instances, the sampling location specified in the permit or the location chosen by the permittee may not be adequate for the collection of a representative sample. In that case the inspector should choose the most representative sampling point available.

Influent Samples. These should be taken at points of high-turbulence flow to ensure good mixing. In some instances, the most desirable location may not be accessible. Sampling points should always be above plant return lines. The preferred sampling points for raw wastewater are:

- The upflow siphon following the comminutor (in absence of grit chamber);
- The upflow distribution box following pumping from the main plant wet well;
- Aerated grit chamber;
- Flume throat; and
- Pump wet well (if turbulent).

Effluent Samples. These should be collected at the site specified in the permit or, if no site is specified in the permit, at the most representative site downstream from all entering waste streams prior to entry into the receiving waters. Samples should be collected after chlorination. This will require dechlorination and reseeding for the BOD_5 analysis. It may occasionally be desirable to sample before chlorination if it is felt that the simplified laboratory procedures will result in better BOD_5 results.

Sampling Techniques

Both grab and composite samples can be collected either manually or with automatic samplers. A composite sample should consist of a minimum of eight grab samples collected at equal intervals and combined proportional to flow, or a sample continuously collected proportionally to flow. More than the minimum number of discrete samples may be required where the wastewater loading is highly variable. In any manual compositing method, sample manipulation should be minimized to reduce the possibility of contamination. Variability in waste stream flow rate and parameter concentration should be carefully considered when choosing compositing methods.

Although eight samples is the recommended number for a composite sample, the number specified in the permit or in other applicable standards should be used if it differs from the recommended number.

Sample Volume

The volume of samples collected depends on the type and number of analyses that are needed, as reflected in the parameters to be measured. The volume of the sample obtained should be sufficient to perform all the required analyses plus an additional amount to provide for any split samples or repeat analyses. The laboratory receiving the sample should be consulted for any specific volume required. A breakdown of the recommended minimum sample volumes for different pollutant parameters can be found in EPA's "Methods for Chemical Analysis of Water and Wastes," 1979; "Handbook for Sampling and Sample Preservation of Water and Wastewater," 1982; and the current, EPA approved edition of "Standard Methods."

Selection and Preparation of Sample Containers

The selection and preparation of sample containers will be based on the parameters to be measured. A detailed description of selection and preparation of sample containers for different pollutant parameters is included in the current, approved edition of "Standard Methods," and in EPA's "Handbook for Sampling and Sample Preservation of Water and Wastewater," 1982.

Preservation Method and Holding Time

Prompt analysis is the best insurance against error caused by sample deterioration, but this is not always possible. Table 5-2 shows the recommended preservation method and maximum holding time for different parameters. It is important that preservation of samples be provided for during compositing (icing is the most commonly used method), where possible, in addition to preservation of the composited sample before transit to the analytical laboratory.

Sample Identification Methods

Each sample must be accurately and completely identified. It is important that any label used to identify the sample be moisture-resistant and able to withstand field conditions. A numbered label associated with a field data sheet containing detailed information on the sample may be preferable to using only a label for information. The information provided for each sample should include the following:

- Sample site location, discharge, and facility;
- Name of collector(s);
- Date and time of collection;
- Indication of grab or composite sample with appropriate time and volume information;
- Identification of parameter to be analyzed;
- Preservative used;
- Indication of any unusual condition at the sampling location and/or in the appearance of the wastewater; and

- Notation of conditions such as pH, temperature, residual chlorine, and appearance that may change before the laboratory analysis, including the identification number of instruments used to measure parameters in the field.

Transfer of Custody and Shipment

In order to ensure the validity of the permit compliance sampling data in court, there must be accurate written records tracing the custody of each sample through all phases of the monitoring program. The primary objective of this chain-of-custody is to create an accurate written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis and introduction as evidence.

- When transferring possession of samples, the transferee must sign and record the date and time on the Chain-of-Custody Record (use currently approved Chain-of-Custody Record). In general, custody transfers are made on each individual sample, although samples may be transferred as a group, if desired. Every person who takes custody must fill in the appropriate section of the Chain-of-Custody Record. The number of transfers should be kept to a minimum.

- The person taking the sample is responsible for properly packing and dispatching the samples to the appropriate laboratory for analysis. This responsibility includes filling out, dating, and signing the appropriate portion of the Chain-of-Custody Record.

- All packages sent to the laboratory must be accompanied by the Chain-of-Custody Record and other pertinent forms. A copy of these forms should be retained by the originating office.

- Mailed packages should be sent with return receipt requested. If sent by common carrier, receipts are retained as part of the permanent chain-of-custody documentation.

- Shipped samples should be properly packed to prevent breakage, and the package sealed or locked so that any evidence of tampering may be readily detected.

Quality Control

The objectives of quality control are to obtain reproducible and consistent sampling results, and to produce complete, precise, accurate, and representative data. Refer to page 5-4 for quality control procedures for checking the sample collection system.

Data Handling and Reporting

To obtain meaningful data for the compliance monitoring program, a properly preserved representative sample must be delivered for analysis. The analysis must be performed in the prescribed fashion according to EPA approved procedures. The calculations should be completed and the results converted to final form so that the analytical data can be permanently recorded in meaningful, exact terms.

The analytical information reported should include the measured parameters and the details of the analysis, such as original analytical instrumentation readings, correction factors, blanks, and the reported data values.

The compliance monitoring records should include sampling date, time and location, analyses dates and time, names of analysts, analytical methods/ techniques used, and analytical results. To ensure that data resulting from various analyses are recorded, transferred, and stored correctly, the data should be checked at the various transfer points.

Table 5-1

COMPOSITING METHODS

Compositing Principle	Advantages	Disadvantages	Comments
Constant sample volume, constant time interval between samples	Minimal instrumentation and manual effort; requires no flow measurement	May lack representativeness especially for highly variable flows	Widely used in both automatic samplers and manual sampling
Constant sample volume, time interval between samples proportional to stream flow	Minimal manual effort	Requires accurate flow measurement/ reading equipment; manual compositing from flow chart	Widely used in automatic as well as manual sampling
Constant time interval between samples, sample volume proportional to total stream flow at time of sampling	Minimal instrumentation	Manual compositing from flow chart in absence of prior information on the ratio of minimum to maximum flow; chance of collecting too small or too large individual discrete samples for a given composite volume	Used in automatic samplers and widely used as manual method
Constant time interval between samples, sample volume proportional to total stream flow since last sample	Minimal instrumentation	Manual compositing from flow chart in absence of prior information on the ratio of minimum to maximum flow; chance of collecting either too small or too large individual discrete samples for a given composite volume	Not widely used in automatic samplers but may be done manually

Table 5-1

COMPOSITING METHODS (Continued)

Compositing Principle	Advantages	Disadvantages	Comments
Constant pumping rate	Minimal manual effort, requires no flow measurement	Requires large sample capacity; may lack representativeness for highly variable flows	Practical but not widely used
Sample pumping rate proportional to stream flow	Most representative especially for highly variable flows; minimal manual effort	Requires accurate flow measurement equipment, large sample volume, variable pumping capacity, and power	Not widely used

Table 5-2

RECOMMENDED* CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES

Parameter	Container(1)	Preservative(2), (3)	Maximum Holding Time(4)
Bacterial Tests			
Coliform, fecal and total	P,G	Cool, 4°C 0.008% $Na_2S_2O_3$ (5)	6 hours
Fecal streptococci	P,G	Cool, 4°C 0.008% $Na_2S_2O_3$ (5)	6 hours
Inorganic Tests			
Acidity	P,G	Cool, 4°C	14 days
Alkalinity	P,G	Cool, 4°C	14 days
Ammonia	P,G	Cool, 4°C H_2SO_4 to pH<2	28 days
Biochemical oxygen demand	P,G	Cool, 4°C	48 hours
Biochemical oxygen demand, carbonaceous	P,G	Cool, 4°C	48 hours
Bromide	P,G	None required	28 days
Chemical oxygen demand	P,G	Cool, 4°C H_2SO_4 to pH<2	28 days
Chloride	P,G	None required	28 days
Chlorine, total residual	P,G	None required	Analyze immediately
Color	P,G	Cool, 4°C	48 hours
Cyanide, total and amenable to chlorination	P,G	Cool, 4°C NaOH to pH>12 0.6g ascorbic acid (5)	14 days(6)
Fluoride	P	None required	28 days
Hardness	P,G	HNO_3 or H_2SO_4 to pH<2	6 months

Table 5-2

RECOMMENDED* CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES (Continued)

Parameter	Container(1)	Preservative(2), (3)	Maximum Holding Time(4)
Hydrogen ion (pH)	P,G	None required	Analyze immediately
Kjeldahl and organic Nitrogen	P,G	Cool, 4°C H_2SO_4 to pH<2	28 days
Metals (7)			
Chromium VI	P,G	Cool, 4°C	24 hours
Mercury	P,G	HNO_3 to pH<2	28 days
Metals, except Chromium VI and Mercury	P,G	HNO_3 to pH<2	6 months
Nitrate	P,G	Cool, 4°C	48 hours
Nitrate-nitrite	P,G	Cool, 4°C H_2SO_4 to pH<2	28 days
Nitrite	P,G	Cool, 4°C	48 hours
Oil and grease	G, (wide mouth, teflon lined cap recommended)	Cool, 4°C H_2SO_4 to pH<2	28 days
Organic carbon	P,G	Cool, 4°C HCl or H_2SO_4 to pH<2	28 days
Orthophosphate	P,G	Filter immediately Cool, 4°C	48 hours
Dissolved oxygen, Probe	G bottle and top	None required	Analyze immediately
Dissolved oxygen, Winkler method	G bottle and top	Fix on site and store in dark	8 hours
Phenols	G only	Cool, 4°C H_2SO_4 to pH<2	28 days
Phosphorus (elemental)	G	Cool, 4°C	48 hours

Table 5-2

RECOMMENDED* CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES (Continued)

Parameter	Container(1)	Preservative(2), (3)	Maximum Holding Time(4)
Phosphorus, total	P,G	Cool, 4°C H_2SO_4 to pH<2	28 days
Residue, total	P,G	Cool, 4°C	7 days
Residue, filterable	P,G	Cool, 4°C	48 hours
Residue, non-filterable (TSS)	P,G	Cool, 4°C	7 days
Residue, settleable	P,G	Cool, 4°C	48 hours
Residue, volatile	P,G	Cool, 4°C	7 days
Silica	P	Cool, 4°C	28 days
Specific conductance	P,G	Cool, 4°C	28 days
Sulfate	P,G	Cool, 4°C	28 days
Sulfide	P,G	Cool, 4°C, add zinc acetate plus sodium hydroxide to pH>9	7 days
Sulfite	P,G	None required	Analyze immediately
Surfactants	P,G	Cool, 4°C	48 hours
Temperature	P,G	None required	Analyze immediately
Turbidity	P,G	Cool, 4°C	48 hours
<u>Organic Tests</u>(8)			
Purgeable halocarbons	G, Teflon-lined septum	Cool, 4°C 0.008% $Na_2S_2O_3$ (5)	14 days

Table 5-2

RECOMMENDED* CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES (Continued)

Parameter	Container(1)	Preservative(2), (3)	Maximum Holding Time(4)
Purgeable aromatic hydrocarbons	G, Teflon-lined septum	Cool, 4°C 0.008% $Na_2S_2O_3$ (5) HCl to pH<2 (9)	14 days
Acrolein and acrylonitrile	G, Teflon-lined septum	Cool, 4°C 0.008% $Na_2S_2O_3$ (5) Adjust pH to 4-5 (10)	14 days
Phenols (11)	G, Teflon-lined cap	Cool, 4°C 0.008% $Na_2S_2O_3$ (5)	7 days until extraction, 40 days after extraction
Benzidines (11)	G, Teflon-lined cap	Cool, 4°C 0.008% $Na_2S_2O_3$(5,12)	7 days until extraction (13)
Phthalate esters (11)	G, Teflon-lined cap	Cool, 4°C	7 days until extraction, 40 days after extraction
Nitrosamines (11, 14)	G, Teflon-lined cap	Cool, 4°C store in dark 0.008% $Na_2S_2O_3$	7 days until extraction, 40 days after extraction
PCBs (11) acrylonitrile	G, Teflon-lined cap	Cool, 4°C	7 days until extraction, 40 days after extraction
Nitroaromatics and isophorone (11)	G, Teflon-lined cap	Cool, 4°C store in dark 0.008% $Na_2S_2O_3$ (5)	7 days until extraction, 40 days after extraction
Polynuclear aromatic hydrocarbons (11)	G, Teflon-lined cap	Cool, 4°C 0.008% $Na_2S_2O_3$ (5) store in dark	7 days until extraction, 40 days after extraction
Haloethers (11)	G, Teflon-lined cap	Cool, 4°C 0.008% $Na_2S_2O_3$ (5)	7 days until extraction, 40 days after extraction

Table 5-2

RECOMMENDED* CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES (Continued)

Parameter	Container(1)	Preservative(2), (3)	Maximum Holding Time(4)
Chlorinated hydrocarbons (11)	G, Teflon-lined cap	Cool, 4°C	7 days until extraction, 40 days after extraction
TCDD (11)	G, Teflon-lined cap	Cool, 4°C 0.008% $Na_2S_2O_3$ (5)	7 days until extraction, 40 days after extraction
Pesticides Tests			
Pesticides (11)	G, Teflon-lined cap	Cool, 4°C pH 5-9 (15)	7 days until extraction, 40 days after extraction
Radiological Tests			
Alpha, beta and radium	P,G	HNO_3 to pH<2	6 months

* Will become mandatory when promulgated under 40 CFR 136.

TABLE 5-2 NOTES

(1) Polyethylene (P) or Glass (G).

(2) Sample preservation should be performed immediately upon sample collection. For composite chemical samples, each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.

(3) When any sample is to be shipped by common carrier or sent through the United States Mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring such compliance. For the preservation requirements of Table 5-2, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials Regulations do not apply to the following materials: Hydrochloric acid (HCl) in water solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO_3) in water solutions at concentration of 0.15% by weight or less (pH about 1.62 or greater); Sulfuric acid (H_2SO_4) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater); and Sodium hydroxide (NaOH) in water solutions at concentrations of 0.080% by weight or less (pH about 12.30 or less).

(4) Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid. Samples may be held for longer periods only if the permittee, or monitoring laboratory, has data on file to show that the specific types of samples under study are stable for the longer time, and has received a variance from the Regional Administrator under §136.3 (e). Some samples may not be stable for the maximum time period given in the table. A permittee or monitoring laboratory is obligated to hold the sample for a shorter time if knowledge exists to show this is necessary to maintain sample stability. See §136.3 (e) for details.

(5) Should only be used in the presence of residual chlorine.

(6) Maximum holding time is 24 hours when sulfide is present. Optionally all samples may be tested with lead acetate paper before pH adjustments in order to determine if sulfide is present. If sulfide is present, it can be removed by the addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12.

(7) Samples should be filtered immediately on-site before adding preservation for dissolved metals.

TABLE 5-2 NOTES

(8) Guidance applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.

(9) Sample receiving no pH adjustment must be analyzed within 7 days of sampling.

(10) The pH adjustment is not required if acrolein will not be measured. Samples for acrolein receiving no pH adjustment must be analyzed within 3 days of sampling.

(11) When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times should be observed for optimum safeguard of sample integrity. When the analytes of concern fall within two or more chemical categories, the sample may be preserved by cooling to 4°C, reducing residual chlorine with 0.008% sodium thiosulfate, storing in the dark, and adjusting the pH to 6-9; samples preserved in this manner may be held for seven days before extraction and for forty days after extraction. Exceptions to this optional preservation and holding time procedure are noted in footnote 5 (re the requirement for thiosulfate reduction of residual chlorine), and footnotes 12, 13 (re the analysis of benzidine).

(12) If 1,2-diphenylhydrazine is likely to be present, adjust the pH of the sample to 4.0 ± 0.2 to prevent rearrangement to benzidine.

(13) Extracts may be stored up to 7 days before analysis if storage is conducted under an inert (oxidant-free) atmosphere.

(14) For the analysis of diphenylnitrosamine, add 0.008% $Na_2S_2O_3$ and adjust pH to 7-10 with NaOH within 24 hours of sampling.

(15) The pH adjustment may be performed upon receipt at the laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.008% $Na_2S_2O_3$.

References

AWWA, APHA, and WPCF. Standard Methods for the Examination of Water and Wastewater. Use the most current, accepted edition.

Federal Register, Vol 44. No. 33, Dec. 23, 1979. Guidelines Establishing Test Procedures for Analysis of Pollutants: Proposed Regulations.

Harris, D.J. and Keffer, W.J. 1974. Wastewater Sampling Methodologies and Flow Measurement Techniques. U.S. Environmental Protection Agency Region VII, EPA-907/9-74-005, Kansas City, Missouri.

Lauch, R.P. 1975. Performance of ISCO Model 1391 Water and Wastewater Sampler. U.S. Environmental Protection Agency, EPA-670/4-75-003, Cincinnati, Ohio.

Lauch, R.P. 1976. A Survey of Commercially Available Automatic Wastewater Samplers." U.S. Environmental Protection Agency, EPA-600/4-76-051, Cincinnati, Ohio.

Shelley, P.E. 1975. Design and Testing of a Prototype Automatic Sewer Sampling System. Office of Research and Monitoring, U.S. Environmental Protection Agency, EPA 600/2-76-006, Washington, D.C.

Shelley, P.E., and Kirkpatrick, G.A. 1975. An Assessment of Automatic Sewer Flow Samples. Office of Research and Monitoring, U.S. Environmental Protection Agency, EPA-600/2-75-065, Washington, D.C.

U.S. Environmental Protection Agency. 1978. Methods for Benzidine, Chlorinated Organic Compounds, Pentachlorophenol and Pesticides in Water and Wastewater. Environmental Monitoring and Support Laboratory, Cincinnati, Ohio.

U.S. Environmental Protection Agency. 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020, Washington, D.C.

U.S. Environmental Protection Agency. 1981. Methods for Organic Chemical Analysis of Water and Wastes by GC, HPLC and GC/MS. Environmental Monitoring Support Laboratory, Cincinnati, Ohio.

U.S. Environmental Protection Agency. 1982. Handbook for Sampling and Sample Preservation of Water and Wastewater. EPA-600/4-82-029, Cincinnati,Ohio.

Wood, L.B., and Stanbridge, H.H. 1968. "Automatic Samplers," Water Pollution Control, Vol. 67, No. 5, pp. 495-520.

Permittee Sampling Inspection Checklist

A. Permittee Sampling Evaluation

Yes No N/A	1. Samples are taken at sites specified in permit.
Yes No N/A	2. Locations are adequate for representative samples.
Yes No N/A	3. Flow proportioned samples are obtained where required by permit.
Yes No N/A	4. Sampling and analysis completed on parameters specified by permit.
Yes No N/A	5. Sampling and analysis done in frequency specified by permit.
Yes No N/A	6. Permittee is using method of sample collection required by permit. Required Method:___________ If not, method being used is: ( ) Grab ( ) Manual composite ( ) ( ) Automatic composite
	7. Sample collection procedures are adequate:
Yes No N/A	a. Samples refrigerated during compositing
Yes No N/A	b. Proper preservation techniques used
Yes No N/A	c. Containers and sample holding times before analyses conform with 40 CFR 136.3
Yes No N/A	8 Monitoring and analyses are performed more often than required by permit. If so, results reported in permittee's self-monitoring report.

B Sampling Inspection Procedures and Observations

Yes No N/A	1. Grab samples obtained.
Yes No N/A	2. Composite sample obtained Compositing frequency ________________ Preservation ____________________
Yes No N/A	3. Sample refrigerated during compositing.
Yes No N/A	4. Flow proportioned sample obtained.
Yes No N/A	5. Sample obtained from facility sampling device.
Yes No N/A	6. Sample representative of volume and nature of discharge.
Yes No N/A	7. Sample split with permittee.
Yes No N/A	8. Chain of custody procedures employed.

Chapter Six

Flow Measurement

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1 Evaluation of Permittee's Flow Measurement

Objectives and Requirements

To comply with the permit requirements established under the NPDES, the permittee must determine the quantity of wastewater being discharged. Therefore, flow measurement is an integral part of the NPDES program and its accuracy must be evaluated by the inspector.

The importance of obtaining accurate wastewater flow data cannot be overemphasized. First, NPDES permits often limit the quantity (mass loading) of a particular pollutant that may be discharged, which represents the product of wastewater flow and pollutant concentration. Therefore, the error involved in determining these mass loadings is the accumulation of errors from flow measurement, sample collection, and laboratory analysis. Second, the current compliance strategy depends heavily on the submittal of self-monitoring data by each permittee.

In addition to providing usable information for enforcement purposes, flow measurement serves:

- To provide operating and performance data on the wastewater treatment plant;
- To compute treatment costs, where such costs are to be based on wastewater volume; and
- To obtain data for long-term planning of plant capacity versus actual capacity used.

A flow measurement inspection checklist is included in this chapter.

Evaluation of Facility Installed Devices

The accuracy of a flow measuring system (including both primary and secondary devices) depends on many factors. Proper installation is essential to accurate flow data. Faulty fabrication, construction, and installation of primary devices are main sources of errors. Secondary devices are also significant to a flow measurement system. Improper calibration, misreading, and variation in the speed of totalizer drive motors are major errors related to secondary devices.

When evaluating facility-installed devices, the inspector should:

- Verify that the system being used is accurate by measuring the flow rate instantaneously at the primary device and comparing that with the meter value, the chart value, or the integrator value, or with the flow rate reported by the facility at the time the instantaneous flow is measured by the inspector. If the values do not agree within $\pm$ 10 percent of the instantaneous value measured, the system is not acceptable for NPDES compliance purposes.

- Collect accurate flow data during inspection, in order to validate self-monitoring data collected by the permittee;

- Ensure that the flow measurement system or technique being used measures the entire wastewater discharge as described by the NPDES permit and in the manner specified by the permit (i.e., instantaneous or continuous). A careful inspection should be made to determine whether recycled wastewaters or wastewater diversions are present upstream of the system. Anomalies should be reported on the inspection form or recorded in the bound field notebooks;

- Verify that the site chosen for flow measurement is appropriate, and/or is in accordance with permit requirements;

- Verify that the method used for flow measurement is suitable for type of discharge, flow range, suspended solids concentration, and other relevant factors;

- Verify that tables, curves, and formulas are appropriate and are correctly used to calculate flow rates; and

- Review and evaluate calibration and maintenance programs for the discharger's flow measurement system. The permit normally requires that calibration be checked by the permittee on a regular basis but the minimum is a yearly calibration. Lack of such a program is considered unacceptable for NPDES compliance purposes.

Evaluation of Permittee Data Handling and Reporting

The permittee or facility should keep flow measurement records as the permit requires. Many flow measuring devices produce a continuous flow chart for plant records. Flow records should contain date, flow, time of reading, and operator's name, if applicable. Maintenance, inspection dates, and calibration data should also be recorded.

The inspector should review the permittee's records and note the presence or absence of such data as:

- Frequency of routine operational inspections;
- Frequency of maintenance inspections;
- Frequency of flowmeter calibration; and
- Irregularity or uniformity of flow.

Evaluation of Permittee Quality Control

The purpose of quality control is to produce data that meet user requirements in terms of precision and accuracy. Precision refers to data reproducibility or the ability to consistently obtain the same data from repeated measurement of the same quality. Precision can be evaluated at float driven devices when flows are stable. The float is pushed gently downward, held there for 30 seconds, then allowed to return to normal on its own. The recorded flow rate should be the same before and after the float was moved. Accuracy can be evaluated by measuring the instantaneous flow rate at the primary device used at the facility and comparing the value against the value on the meter, graph, integrator, or company record. The difference between two stable readings should not exceed $\pm$ 10 percent of the measured flow at the primary device.

The accuracy of flow measurement devices varies widely with the device, its location, the environmental conditions, and other factors such as maintenance and calibration. Accuracy refers to the agreement between the amount of a component measured by the test and the amount actually present. Accuracy can be evaluated by installing a second flow measurement system, sometimes referred to as a reference system. Agreement in measured flow rates between the two systems should be within $\pm$ 10 percent of the reference rate if all conditions are as recommended for the systems.

The following quality control issues should be carefully evaluated during a compliance inspection:

- Sound operation and maintenance of equipment;
- Accurate, current records;
- Sufficient inventory of spare parts;
- Current, valid flow measurement techniques; and
- Precise flow data.

2 Flow Measurement Compliance

Objectives

The current compliance strategy depends heavily on the permittee's submittal of self-monitoring data. The flow measured during the NPDES compliance inspection should verify the flow measurement data collected by the permittee to support any enforcement action that may be necessary, and to eventually provide a basis for reissuing or revising the NPDES permit.

Flow Measurement System Evaluation

The responsibility of the inspector during NPDES compliance flow measurement inspection includes the collection of accurate flow data during the inspection, as well as the validation of such data collected by the permittee for self-monitoring purposes.

The NPDES inspector must check both the permittee's flow data and the flow measurement system to verify the permittee's compliance with NPDES permit requirements. When evaluating a flow measurement system, the inspector should consider and record findings on:

- Whether the system measures the entire flow;
- The system's accuracy and good working order;
- The need for new system equipment; and
- The existence or absence of a regular calibration and maintenance program for flow measurement equipment.

If the permittee's flow measurement system is accurate within ± 10 percent, the inspector is encouraged to use the installed system. If flow sensor or recorder is found to be inaccurate, the inspector should determine whether it can be corrected in time for use during the inspection. If the equipment cannot be repaired in a timely manner, a portable flow sensor and recorder may be used for the duration of the inspection. If non-standard primary flow devices are being used, the permittee should supply data on the accuracy and precision of the method being employed.

For flow measurement in pipelines, the inspector may use a portable flowmeter. The inspector should select the flowmeter with an operating range wide enough to cover the anticipated flow to be measured. The selected flowmeter should be tested and calibrated prior to measurement. The inspector should select the site for flow measurement according to permit requirements and install the selected flowmeter per manufacturer's specifications. The inspector should use the proper tables, charts, and formulas as specified by the manufacturer to calculate flow rates.

Sharp-Crested Weir Inspection Procedures

The inspector has three distinct areas to investigate when evaluating the compliance of a permittee's flow measurement system: the weir's physical conditions, the flow measurement using staff gauge, the flow measurement using float gauge or other appropriate sensor, and the flow measurement at the weir plate. Staff gauges and float gauges may not be used at all installations. (Figures 6-1a and b at the end of this chapter present some types and features of sharp-crested weirs.)

Some of the flow measurement inspection procedures pertaining to the functional aspects of flow measurement devices are also discussed in this section. A detailed discussion concerning the flow measurement devices is included in a later part of this chapter.

Physical Conditions. When measuring the flow in an open channel by a sharp-crested weir, the inspector should follow in sequence the procedures listed below.

- Inspect weir plate, ascertaining whether
  - the crest is horizontal;
  - the crest is at zero gauge elevation;
  - the weir edge is of acceptable width and sharpness;
  - there is clinging debris or grease build-up;
  - there is leakage between weir plate and bulkhead.
- Inspect nappe, ascertaining whether
  - it is submerged;
  - it springs clear of downstream side of weir plate.

- Inspect approach channel, making sure there are no

  - turbulent areas;
  - large submerged or floating objects;
  - excessive sediment deposits;
  - excessive approach velocity due to poor design or sedimentation.

- Allow flow to stabilize, to monitor an undisturbed flow condition.

Flow Measurement Using Staff Gauge. To determine head using staff gauge, the inspector should:

- Verify that the staff gauge is set to zero head;

- Read, to the nearest division, the gauge division at which liquid surface intersects gauge. This reading should be made at least 4 H upstream of the weir.

- Measure head on weir from staff gauge reading; should not be less than 0.1 feet.

To determine flow rate, use the appropriate weir table. (See Figures 6-2, through 6-4 at the end of this chapter.)

Flow Measurement Using Float Gauge. To determine head using float gauge, the inspector should:

- Verify that the tape is in position and that it is giving correct reading;

- Read, to the nearest division, tape division opposite index on float gauge. This reading should be made at least 4 H upstream of the weir.

- Measure head on weir from float gauge reading; should not be less than 0.1 feet.

To determine flow rate, use the appropriate head-discharge relationship formula. (See Table 6-1 on page 6-13.)

The inspector may use an independent method of measuring head such as with a yard stick or carpenter's rule (be sure to measure at least 4H upstream and convert to nearest hundredth of a foot).

Parshall Flume Inspection Procedures

To evaluate compliance of a permittee's flow measurement system by Parshall flume (see Figure 6-5 at the end of this chapter), the inspector must investigate the system's physical conditions, the free-flow condition using staff gauge/float gauge, and the submerged-flow condition.

Physical Conditions. When inspecting the flow measurement in an open channel by Parshall flume, the inspector should follow in sequence the procedures listed below.

- Observe flow upstream of flume to ascertain whether
  - the flow is reasonably smooth or streamline;
  - the flow is distributed reasonably uniformly across channel.
- Make sure flume is located after transition point.
- Remove any objects causing disturbances of flow.
- Inspect flume for deposits of solids to ascertain build-up of sediment in structure.
- Determine whether flow condition is free or submerged.
- Inspect stilling well to determine that
  - connection to channel is not clogged;
  - there are no deposits;
  - there are no objects interfering with float;
  - inlet pipe is located at proper head measuring point.
- Clean stilling well if necessary.

Flow Measurement--Free-Flow Condition Using Staff Gauge

- To determine upstream head (H_a) using staff gauge
  - verify staff gauge is set to zero head;
  - verify staff gauge is at proper location (two-thirds the length of the converging section back from the beginning of the throat);
  - read to nearest division the gauge division at which liquid surface intersects gauge;
  - read H_a in feet from staff gauge.
- To determine flow rate, use Figure 6-6 (at the end of this chapter) in the unit desired, or use tables published in flow measurement standard references.

Flow Measurement--Free-Flow Condition Using Float Gauge

- To determine upstream head (H_a) using float gauge
  - read to nearest division the tape division opposite index on float gauge;
  - calculate H_a from float gauge reading.

- To determine flow rate, use Figure 6-6 in the unit desired.

Flow Measurement--Submerged-Flow Condition

In general, it is difficult to make field measurements with submerged-flow conditions. In cases where measurements can be obtained (using a staff or float guage), the following procedures should be followed:

- To determine upstream head using staff or float gauge
  - read to nearest division, and at the same time as for H_b, the gauge division at which liquid surface intersects gauge;
  - calculate H_a from gauge reading.

- To determine downstream head (H_b) using staff or float gauge
  - read to nearest division, and at the same time as for H_a, the gauge division at which liquid surface intersects gauge;
  - calculate H_b from staff reading.

- To determine flow rate
  - calculate percent submergence $\left(\frac{H_b}{H_a}\right) x\ 100$;
  - consult Figure 6-7;
  - when a correction factor is obtained, use H_a and find free-flow from Figure 6-6;
  - multiply this free-flow value by the correction factor to obtain the submerged flow.

The inspector may use an independent method of measuring head such as with a yard stick or carpenter's rule at the proper head measurement point. Due to the sloping water surface in the converging section of a flume, it is essential that the proper head measurement point be used.

3 Supplementary Information

Flow Measurement Devices

Flow data may be collected on an instantaneous or a continuous basis. Instantaneous flows must be measured at the time samples are taken for analysis in order to calculate the pollutants discharged at that particular instant. In a continuous flow measurement system, the flows are totaled to obtain a value for the total flow to verify NPDES permit compliance.

A typical, complete continuous flow measurement system consists of a flow device, a flow sensor, transmitting equipment, a recorder, and a totalizer. Instantaneous flow data, on the other hand, can be obtained without using such a system. The primary flow device is constructed to yield predictable hydraulic responses that are related to the rate of wastewater or water flowing through the device. Examples of such devices include weirs and flumes, which relate water depth (head) to flow; Venturi meters, which relate differential pressure to flow; and electromagnetic flow meters, which relate induced electric voltage to flow. In most cases, a standard primary flow device has undergone detailed testing and experimentation and its accuracy has been verified.

There are many methods of measuring flow; some are designed to measure open channel flows, others to measure flow in pipelines. A complete discussion of all available flow measurement methods, the theory behind them, and the devices used are beyond the scope of this manual. Only the most commonly used flow measurement devices and procedures on how to inspect them will be briefly described in the following paragraphs. For details, inspectors should consult the publications listed in the References section at the end of this chapter.

Primary Devices

Non-submerged weirs. Weirs (Figures 6-1a and b) consist of a vertical plate with a sharp crest and are placed in a stream, channel, or partly filled pipe. The top of the plate may be straight, V-notched, or trapezoidal, depending on the quantity of flow passing over it. To determine the flow rate, it is necessary only to measure the head (height) of water above the crest of the weir. For this device to be accurate, the crest must be kept clean, sharp, close to original dimensions, and level.

The head-discharge relationship formulas for rectangular weirs, both contracted and suppressed, Cipolletti weirs, and V-notch weirs are given in Table 6-1. Flow rates for 60-degree and 90-degree V-notch weirs can also be determined from the nomograph in Figure 6-2. Flow rates for Cipolletti weirs can also be obtained from Figure 6-3. Figure 6-4 is a nomograph for flow rates for rectangular weirs using the Francis formulas.

When a continuous flow record is needed, secondary devices such as bubbler meters may be used with a weir. Mechanical float and cable gauges also may be used to measure water height.

Submerged Weirs. A submerged weir is a sharp-crested weir that is completely under water. For all submerged weir types, Mauis's equation (Mauis, 1949) can be used to determine the discharge:

$$\frac{Q}{Q_1} = 1 - \left(0.45S + \frac{0.40}{2(10-10S)} \right)$$

where: Q = discharge for submerged weir in cfs

$Q1$ = free discharge ($H_2 < 0$) in cfs

$$S = \frac{a_2\sqrt{H_2}}{a_1\sqrt{H_1}}$$

where: a_2 = weir area corresponding to H_2

a_1 = weir area corresponding to H_1

Parshall Flume. The Parshall flume is comprised of three sections: 'a converging upstream section, a throat or contracted section, and a diverging downstream section (Figure 6-5).

The flume operates on the principle that open channel flow, when passing a constriction in the channel, will pass through a minimum (critical) depth. This will produce a hydraulic head at a certain point upstream of the constriction that is proportional to the flow. The flume size is given by the width of the throat section.

The Parshall flume is good for measuring open channel waste flow because the flume cleans itself; therefore, there is little difficulty with sand or suspended solids. It is both simple and accurate.

Parshall flumes have been developed with throat width from 2.50 mm (1 inch) to 15.24 m (50 feet). The configuration and standard nomenclature for Parshall flumes is given in Figure 6-5. Strict adherence to all dimensions is necessary to achieve accurate flow measurement.

Table 6-1

Head-Discharge Relationship Formulas for Non-Submerged Weirs*

Weir Type	Contracted	Suppressed	Remarks	Reference
Rectangular				
Francis formulas	$Q = 3.33\ (L - 0.2\ H^{3/2})$	$Q = 3.33\ L\ H^{3/2}$	Approach velocity neglected	American Petroleum Institute, 1969
	$Q = 3.33\ [(H + h)^{3/2} - h^{3/2}](L - 0.2\ H)$	$Q = 3.33\ L[(H + h)^{3/2} - h^{3/2}]$	Approach velocity taken into consideration	
Cipolletti	$Q = 3.367\ L\ H^{3/2}$	NA	Approach velocity neglected	Simon, 1976
	$Q = 3.367\ L\ (H + 1.5\ h)^{3/2}$	NA	Approach velocity taken into consideration	
V-Notch				
Formula for 90° V-Notch only	$Q = 2.5\ H^{2.5}$	NA	V-Notch weirs are not appreciably affected by approach velocity	Smoot, 1974

Q = discharge in cubic feet per second L = crest length in feet

H = head in feet h = head in feet due to the approach velocity (V).

NA = Not applicable

* Selectivity of the formula depends upon the suitability and parameters under consideration.

Flow through a Parshall flume may be either free or submerged. The degree of submergence is indicated by the ratio of the downstream head to the upstream head (H_b/H_a)--the submergence ratio. The flow is submerged if the submergence ratio is:

- greater than 0.5 for flumes under 0.076 m (3 inches);
- greater than 0.6 for flumes 0.15 m to 0.23 m (6 inches to 9 inches);
- greater than 0.7 for flumes 0.3 m to 2.44 m (1 to 8 feet); or
- greater than 0.8 for flumes bigger than 2.44 m (8 feet).

For a free flow in a Parshall flume of size (W), the upstream head (H_a) and discharge relationship is given by the general equation $Q = CWHa^n$.

Table 6-2 gives the values of C, n, and Q for different sizes (W) of the Parshall flume. Nomographs, curves, or tables are readily available to determine the discharge from head observations. Flow curves are shown in Figure 6-6 to determine free flow through 0.07 m to 15.24 m (3 inches to 50 feet) Parshall flumes.

For submerged conditions, the inspector should apply a correction factor to the free flow determined using the relationship $Q = CWH^n$. These correction factors are given in Figure 6-7 for different sizes of the Parshall flume.

Venturi Meter. The Venturi meter is one of the most accurate primary devices for measuring flow rates in pipes. The Venturi meter is basically a pipe segment consisting of an inlet section (a converging section), a throat, and an outlet section (a diverging section) as illustrated in Figure 6-8. A portion of potential energy transferred to kinetic energy in the throat section causes a pressure differential which is proportional to the flow rate. One of the advantages of the Venturi meter is that it has low pressure loss.

Manufacturers of Venturi meters routinely size their meters for a specific use. The accuracy of the Venturi meter is affected by changes in density, temperature, pressure, viscosity, and pulsating flow of the fluid.

The inspector should determine whether the permittee obtains accurate flow measurements, according to the following criteria:

- Install Venturi meter following manufacturer's instructions.
- Install Venturi meter downstream from a straight and uniform section of pipe, at least 5 to 20 diameters, depending upon the ratio of pipe diameter to throat diameter and whether straightening vanes are installed upstream. Installation of straightening vanes upstream will reduce the upstream piping requirements.

Table 6-2
Free Flow Values of C and N for Parshall Flume
Based on the Relationship $Q = CWH^n$ (American Petroleum Institute, 1969)

Flume Throat, W	C	n	Max. Q, cfs
1 in	0.338	1.55	0.2
2 in	0.676	1.55	0.5
3 in	0.992	1.55	1.1
6 in	2.06	1.58	3.9
9 in	3.07	1.53	8.9
1 ft	4 W(*)	$1.522W^{0.026}$	16.1
1.5 ft	"	"	24.6
2 ft	"	"	33.1
3 ft	"	"	50.4
4 ft	"	"	67.9
5 ft	"	"	85.6
6 ft	"	"	103.5
7 ft	"	"	121.4
8 ft	"	"	139.5
10 ft	39.38	1.6	200
12 ft	46.75	1.6	350
15 ft	57.81	1.6	600
20 ft	75.25	1.6	1000
25 ft	94.69	1.6	1200
30 ft	113.13	1.6	1500
40 ft	150.00	1.6	2000
50 ft	186.88	1.6	3000

[(*) W in feet]

- For wastewater application, ensure that the pressure measuring taps are not plugged.

- Calibrate Venturi meter in place by either volumetric method or comparative salt dilution method to check the manufacturer's calibration curve or to develop a new calibration curve.

The formula for calculating the flow in a Venturi meter is as follows:

$$Q = CAK\sqrt{H}$$

where:

Q = volume of water, in cubic meters per second (cubic feet per second)

C = discharge coefficient, approximately 0.98. C varies with Reynold's number, meter surfaces, and installation

A = throat area, in square meters (feet) $\frac{\pi}{4} d_2^2$

$H = H_1 - H_2$, differential head, in meters (feet) of water

H_1 = presure head at center of pipe at inlet section, in meters (feet) of water

H_2 = pressure head at throat, in meters (feet) of water

$$K = \sqrt{\frac{2g}{1-\left(\frac{d_2}{-d_1}\right)^4}}$$ (Obtain values of K from Figure 6-9)

where:

g = acceleration due to gravity, 9.82 m per sec^2 (32.2 feet per sec^2)

d_2 = throat diameter, in meters (feet)

d_1 = diameter of inlet pipe, in meters (feet)

Electromagnetic Flowmeter. The electromagnetic flowmeter operates according to Faraday's Law of Induction: the voltage induced by a conductor moving at right angles through a magnetic field will be proportional to the velocity of the conductor through the field. In the electromagnetic flowmeter, the conductor is the liquid stream to be measured and the field is produced by a set of electromagnetic coils. A typical electromagnetic flowmeter is shown in Figure 6-10. The induced voltage is subsequently transmitted to a converter for signal conditioning. The meter may be provided with recorder and totalizers using electric or pneumatic transmission systems. This type of flowmeter is useful at sewage lift stations and for measuring total raw wastewater flow or raw or recirculated sludge.

Electromagnetic flowmeters are used in full pipes and have many advantages: accuracies of $\pm$ 1 percent, a wide flow measurement range, a negligible pressure loss, no moving parts, and rapid response time. However, they are expensive and build-up of grease deposits or pitting by abrasive wastewaters can cause error. Regular checking and cleaning of the electrodes are necessary.

Propeller Meter. The propeller meter (Figure 6-11) operates on the principle that liquid hitting the propeller will cause the propeller to rotate at a speed proportional to the flow rate. The meter is self-contained and requires no energy or equipment other than a mechanical totalizer to obtain a cumulative flow reading. Equipment may be added to the meter to produce a flow rate reading, to pace chemical feed equipment, and to control telemetering equipment for remote readout.

Secondary Devices

Secondary devices are the devices in the flow measurement system that translate the interaction of primary devices in contact with the fluid into the desired records or read-out.

These devices can be classified into two broad classes:

- Non-recording type with direct read-out (such as a staff gauge) or indirect read-out from fixed points, as in a chain, wire weight and float type.

- Recording type, where the recorders may be digital or graphic. Examples are float in well, float in flow, bubbler, electrical, and acoustic.

The advantages and disadvantages of various secondary devices are given in Table 6-3.

Pump Curves

It may be necessary in some wastewater facilities to measure flow by means of the pumps through which it flows. In the case of pumps, discharge-versus-power relationships are determined by measuring the average output or input during the period in which discharge measurements are made. Suitable curves may be developed from these test data. When readily available from the manufacturer, pump curves may be used by the inspector to measure flow.

Table 6-3
Advantages and Disadvantages of Secondary Devices

Device	Advantages	Disadvantages
Hook gauge or stage board	Common, accurate	Manual only, stilling well may be needed
Differential Pressure Measurement		
a. Pressure bulb	No compressed air source can be directly linked to sampler	Can clog openings, expensive
b. Bubbler tube	Self-cleaning, less expensive, reliable	Needs compressed air or other air source;
Surface float	Inexpensive, reliable	In-stream float catches debris
Dipper	Quite reliable, easy to operate	Oil and grease will foul probe, possible sensor loss
Ultrasonic	No electrical or mechanical contact	Errors from heavy turbulence and foam, calibration procedure is more involved than the others

References

American Petroleum Institute. 1969. Manual on Disposal of Refinery Wastes, Chapter 4.

Associated Water and Air Resource Engineers, Inc. 1973. Handbook for Industrial Wastewater Monitoring, U.S. EPA, Technology Transfer.

Blasso, L. 1975. "Flow Measurement Under Any Conditions," Instruments and Control Systems, 48, 2, page 45-50.

Bos, M. G. 1976. Discharge Measurement Structures. Working Group on Small Hydraulic Structures International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands.

ISCO. Open Channel Flow Measurement Handbook. Lincoln, NB.

Mauis, F. T. 1949. "How to Calculate Flow Over Submerged Thin-Plate Weirs." Eng. News-Record, p. 65.

Metcalf & Eddy, Inc. 1972. Wastewater Engineering, McGraw-Hill Book Company, New York.

Robinson, A. R. 1965. Simplified Flow Corrections for Parshall Flumes Under Submerged Conditions. Civil Engineering, ASCE.

Shelley, P. E. and G. A. Kirkpatrick. 1975. Sewer Flow Measurement; A State of the Art Assessment. U.S. EPA, EPA-600/2-75-027.

Simon, A. 1976. Practical Hydraulics, John Wiley & Sons, Inc., New York.

Smoot, G. F. 1974. A Review of Velocity-Measuring Devices. USDI, U.S. G.S. Open File Report, Reston, Virginia.

Stevens. Water Resources Data Book. Beaverton, OR.

Thorsen, T. and R. Oden. 1975. "How to Measure Industrial Wastewater Flow," Chemical Engineering, 82, 4, page 95-100.

USDI, Bureau of Reclamation. 1967. Water Measurement Manual, 2nd Ed.

A. Flow Measurement Inspection Checklist - General

Yes No N/A	1. Primary flow measuring device is properly installed and maintained.
Yes No N/A	2. Flow records are properly kept.
Yes No N/A	3. Sharp drops or increases in flow values are accounted for.
Yes No N/A	4. Actual flow discharged is measured.
Yes No N/A	5. Influent flow is measured before all return lines.
Yes No N/A	6. Effluent flow is measured after all return lines.
Yes No N/A	7. Secondary instruments (totalizers, recorders, etc.) are properly operated and maintained.
Yes No N/A	8. Spare parts are stocked.

B. Flow Measurement Inspection Checklist - Flumes

Yes No N/A	1. Flow entering flume appears reasonably well distributed across the channel and free of turbulence, boils, or other distortions.
Yes No N/A	2. Cross-sectional velocities at entrance are relatively uniform .
Yes No N/A	3. Flume is clean and free of debris or deposits.
Yes No N/A	4. All dimensions of flume are accurate.
Yes No N/A	5. Side walls of flume are vertical and smooth.
Yes No N/A	6. Sides of flume throat are vertical and parallel.
Yes No N/A	7. Flume head is being measured at proper location.
Yes No N/A	8. Measurement of flume head is zeroed to flume crest.
Yes No N/A	9. Flume is of proper size to measure range of existing flow.
Yes No N/A	10. Flume is operating under free-flow conditions over existing range of flows.

C. Flow Measurement Inspection Checklist - Wiers

	1. What type of weir is being used?
Yes No N/A	2. The weir is exactly level.
Yes No N/A	3. The weir plate is plumb and its top edges are sharp and clean.
Yes No N/A	4. There is free access for air below the nappe of the weir.
Yes No N/A	5. Upstream channel of weir is straight for at least four times the depth of water level, and free from disturbing influences.
Yes No N/A	6. The stilling basin of the weir is of sufficient size and clear of debris.
Yes No N/A	7. Head measurements are properly made by facility personnel.
Yes No N/A	8. Proper flow tables are used by facility personnel.

D. Flow Measurement Inspection Checklist - Other Flow Devices

	1. Type of flowmeter used:____________________
	2. What are the most common problems that the operator has had with the flowmeter?
	3. Measured Wastewater flow: _______ mgd; Recorded flow: ____ mgd; Error ___ %
	4. Design flow: __________ mgd.
Yes No N/A	5. Flow totalizer is properly calibrated.
	6. Frequency of routine inspection by proper operator: ________/day.
	7. Frequency of maintenance inspections by plant personnel: _______/year.
	8. Frequency of flowmeter calibration: _________/month.
Yes No N/A	9. Flow measurement equipment adequate to handle expected ranges of flow rates.
Yes No N/A	10. Venturi meter is properly installed and calibrated.
Yes No N/A	11. Electromagnetic flowmeter is properly calibrated.

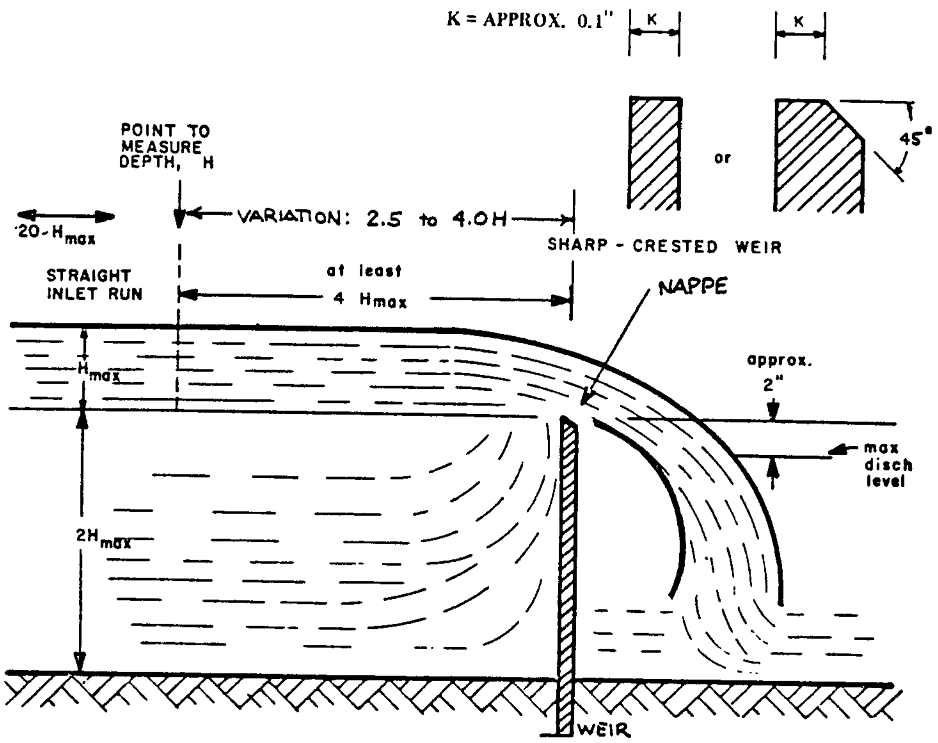


Figure 6-1a. **Nomenclature of Sharp-Crested Weirs**

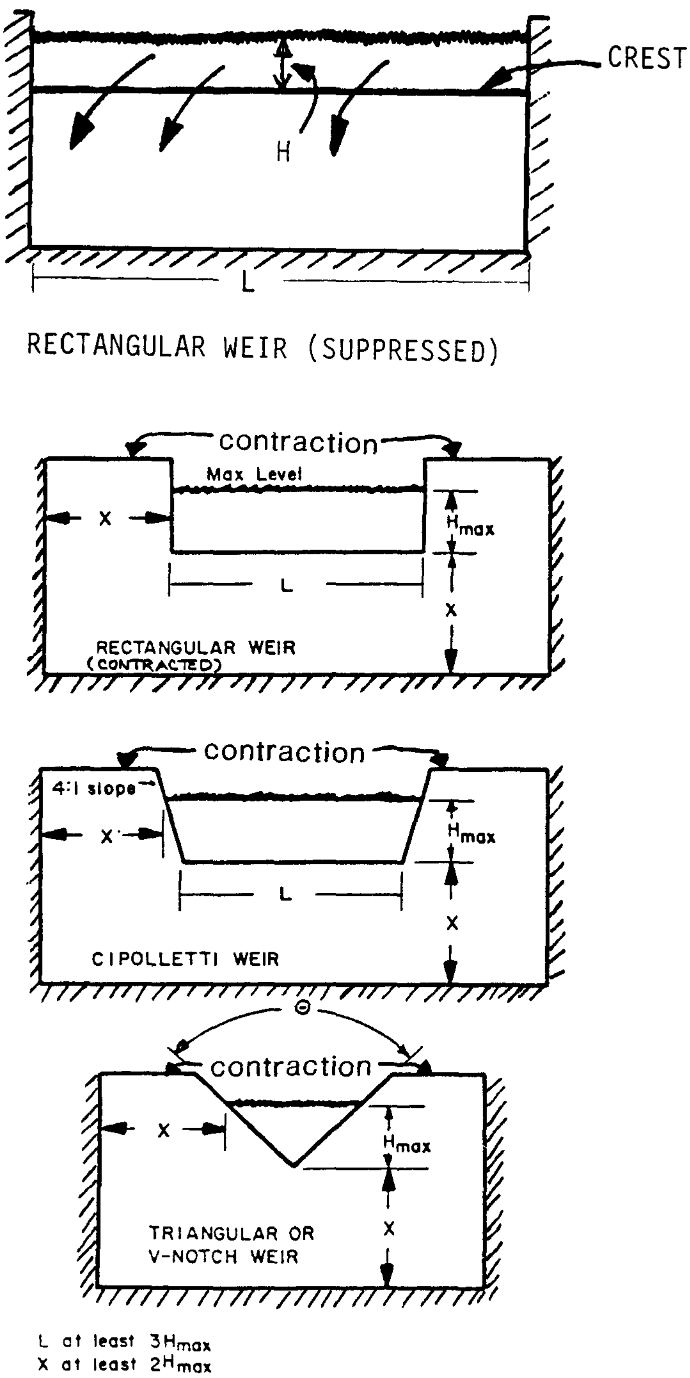


Figure 6-1b. **Three Common Types of Sharp-Crested Weirs**

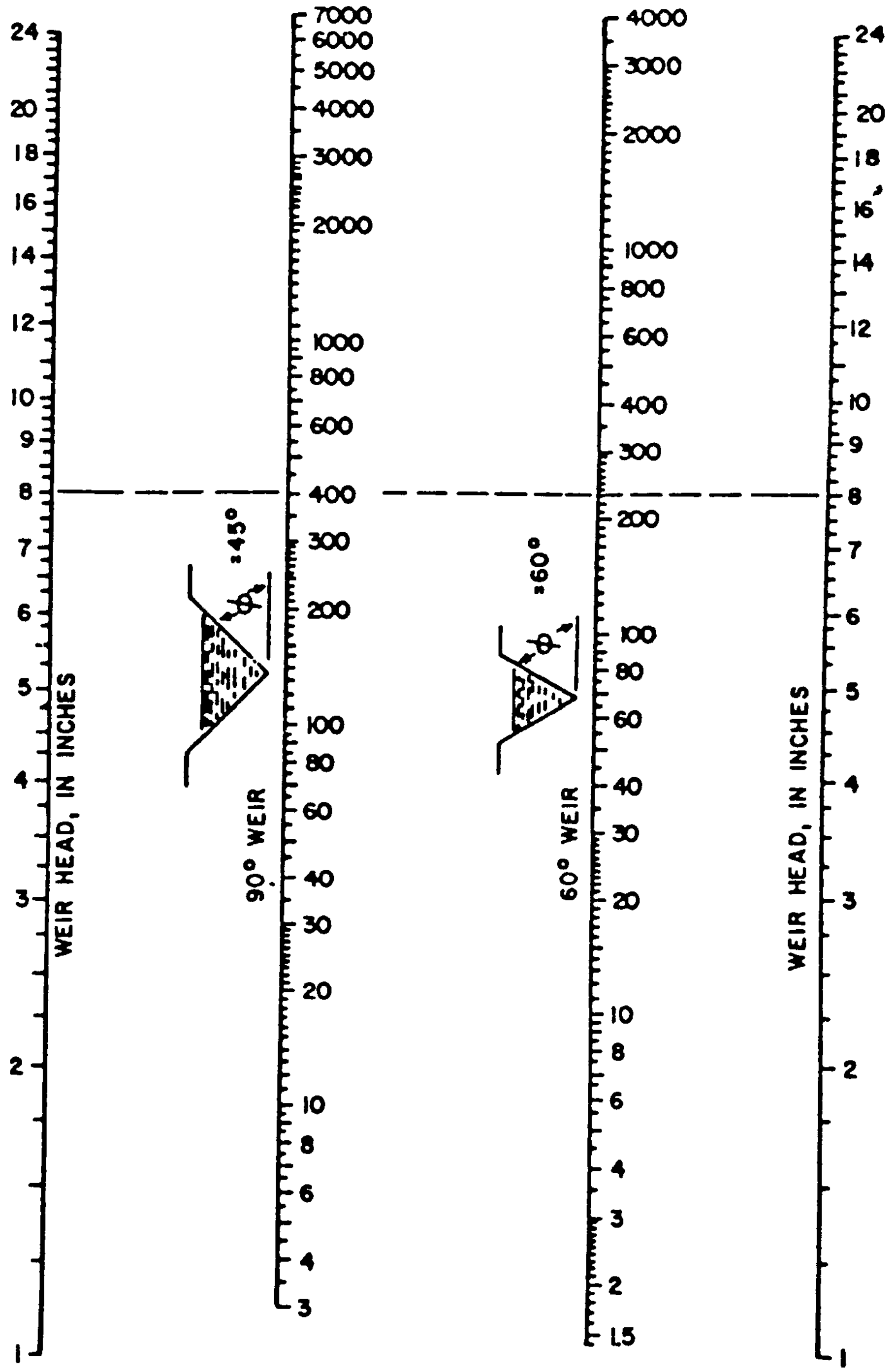


Figure 6-2. **Nomograph for Discharge (in cubic feet per second) of 60° and 90° V-Notch Weirs (Smoot, 1974)**

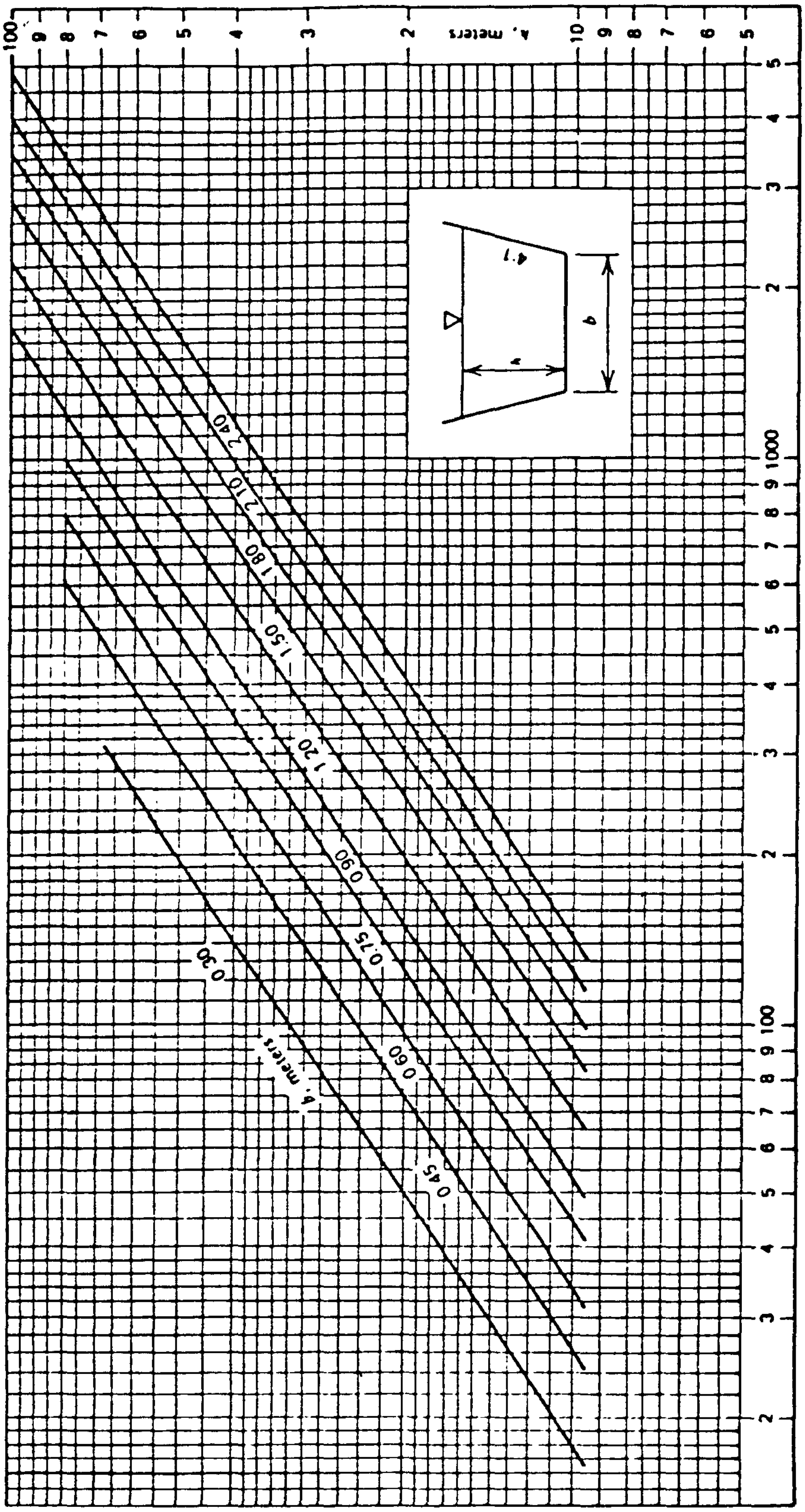
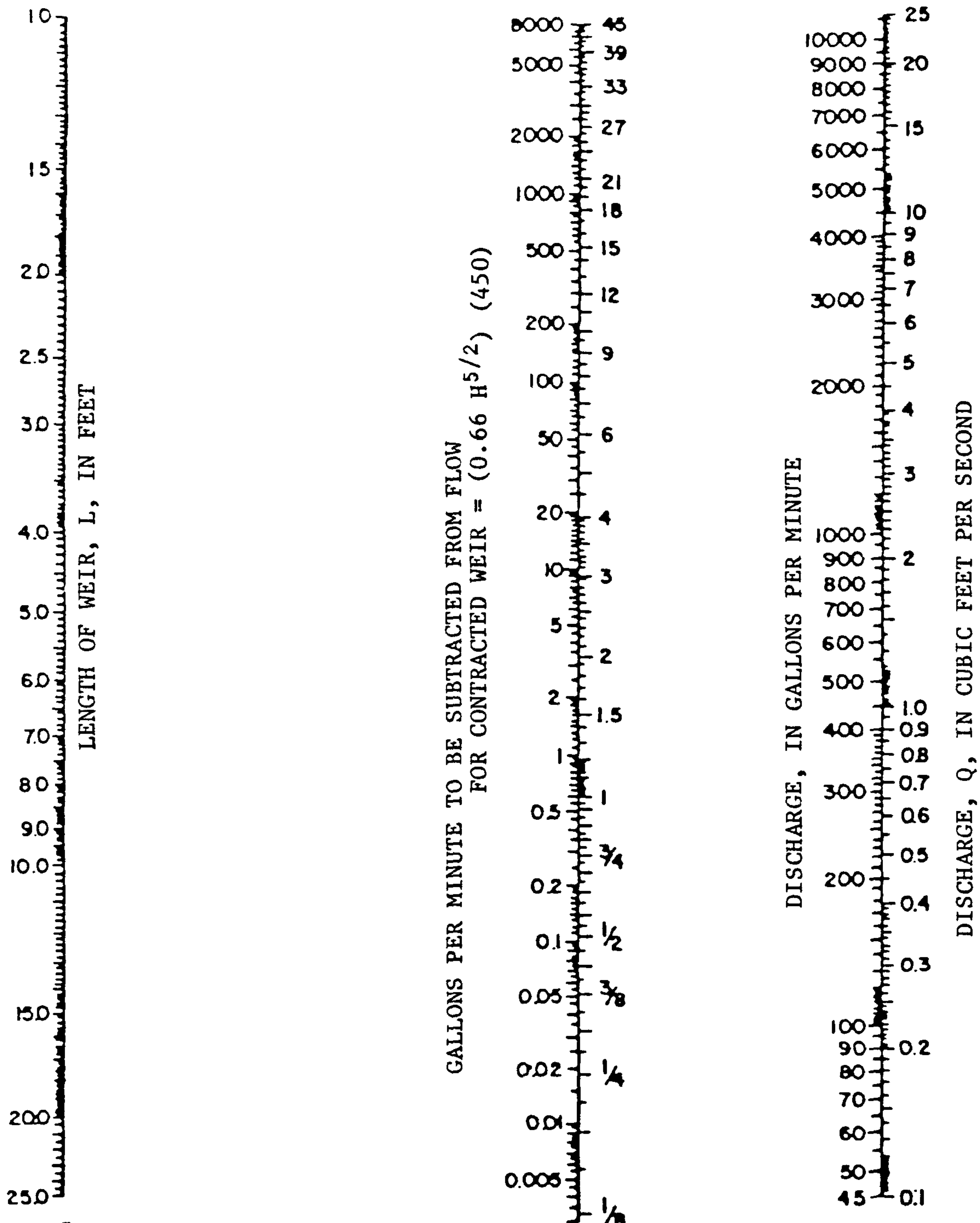


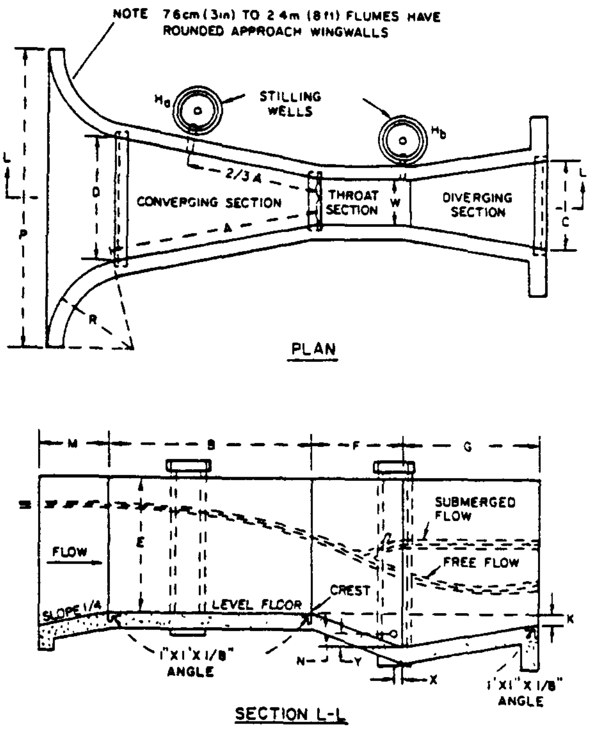
Figure 6-3. Flow Rates Curves for Cipolletti Weirs (Simon, 1976)



Note: Based on Francis Weir formula as follows:
$Q = 3.33LH^{3/2}$ (for suppressed weir)
or $Q = 3.33\ (L-0.2H)H^{3/2} = 3.33LH^{3/2} - 0.66H^{5/2}$ (for contracted weir with two end contractions)

Where:
Q = discharge, in cubic feet per second
L = length of weir, in feet
H = head, in feet.

Figure 6-4. **Nomograph for Capacity of Rectangular Weirs (American Petroleum Institute, 1969)**



LEGEND:

W	Size of flume, in inches or feet.
A	Length of side wall of converging section.
2/3A	Distance back from end of crest to gauge point.
B	Axial length of converging section.
C	Width of downstream end of flume.
D	Width of upstream end of flume.
E	Depth of flume.
F	Length of throat.
G	Length of diverging section.
K	Difference in elevation between lower end of flume and crest.
N	Depth of depression in throat below crest.
R	Radius of curved wing wall.
M	Length of approach floor.
P	Width between ends of curved wing walls.
X	Horizontal distance to H_b gauge point from low point in throat.
Y	Vertical distance to H_b gauge point from low point in throat.

Figure 6-5. **Parshall Flume Configuration and Nomenclature**

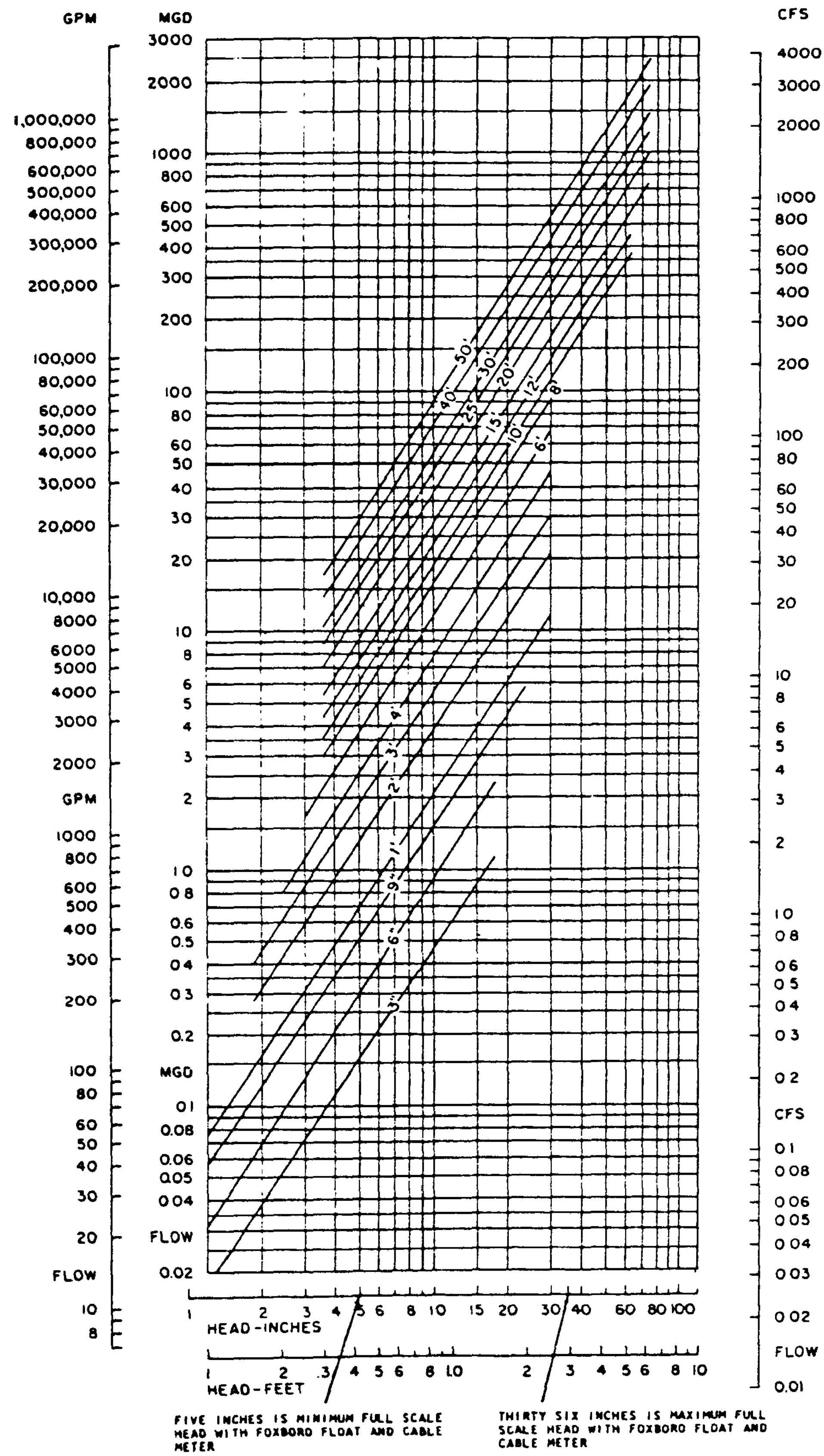
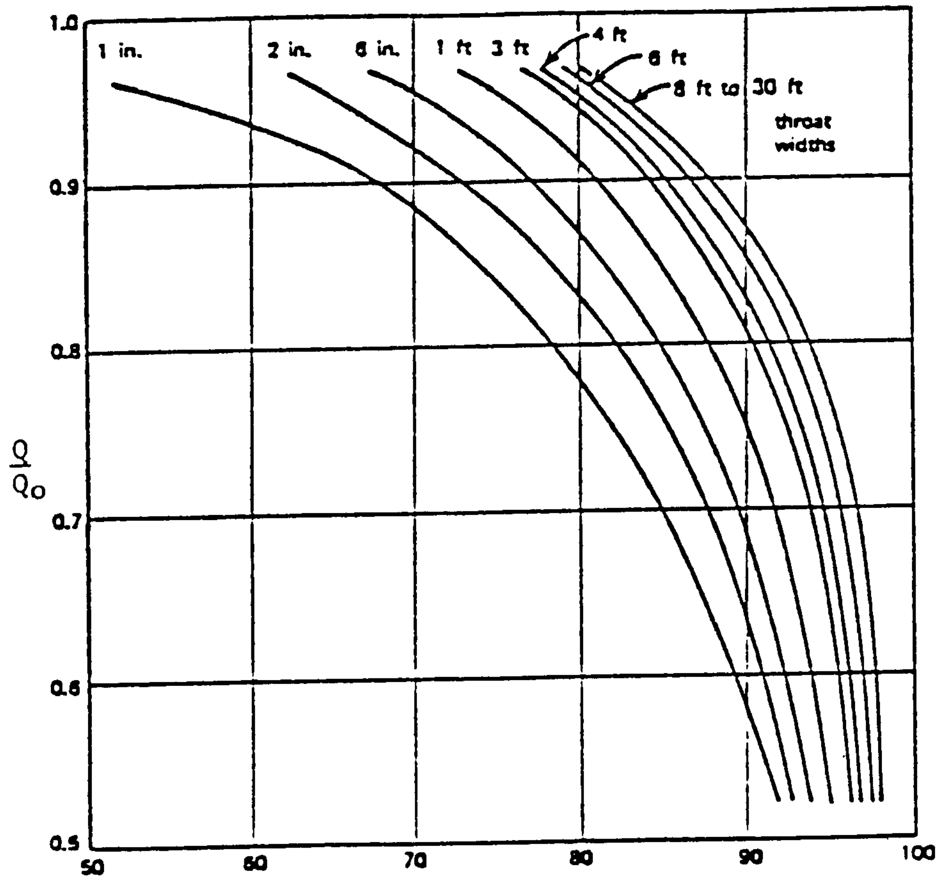


Figure 6-6. Flow Curves for Parshall Flumes (Associated Water and Air Resource Engineers, Inc., 1973)



Submergence, $\frac{H_b}{H_a}$ in percentage

Figure 6-7. **Correction Factors for Flow Discharge Determination for Parshall Flumes (Robinson, 1965)**

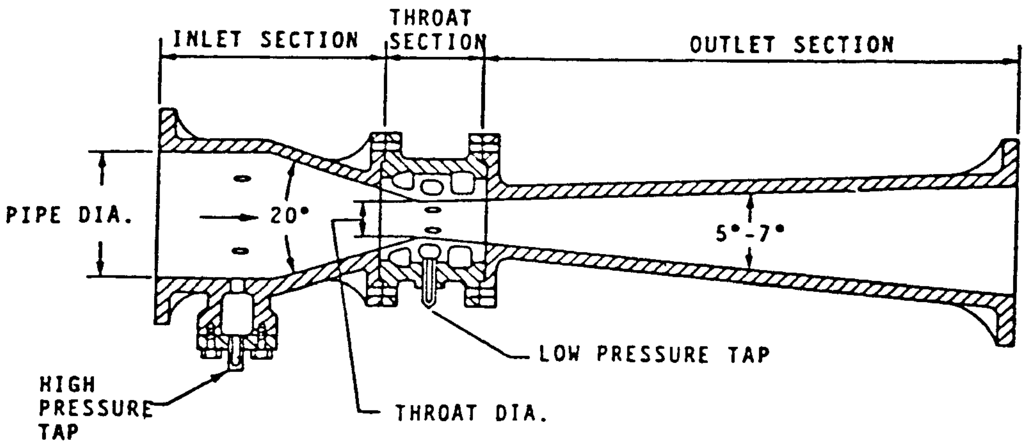


Figure 6-8. **Configuration and Nomenclature of Venturi Meter**

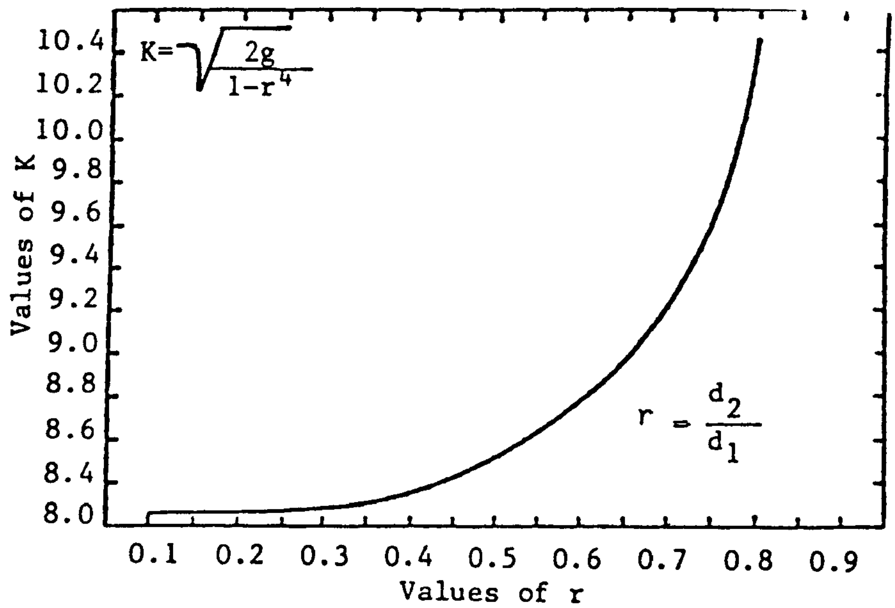


Figure 6-9. **Value of K Used To Determine Discharge with Venturi Meter (Associated Water and Air Resource Engineers, Inc., 1973)**

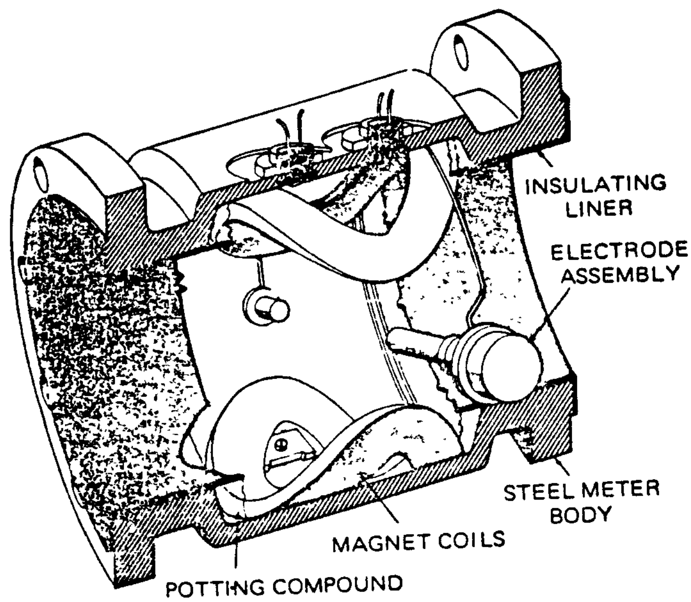


Figure 6-10. **Electromagnetic Flowmeter**

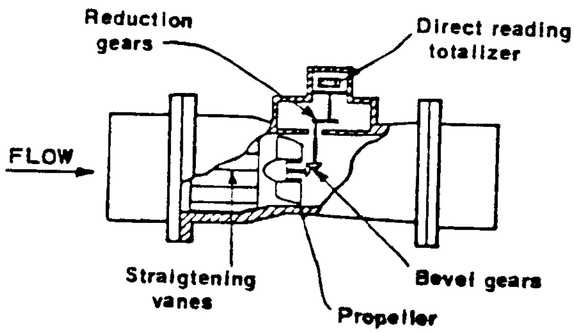


Figure 6-11. **Propeller Flowmeter**

Chapter Seven

Biomonitoring

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1 Evaluation of Permittee Self-Biomonitoring Program

Objectives and Requirements

This chapter highlights acute toxicity testing procedures which may be required by an NPDES permit. The inspector can use this information to guide his review of a permittee's self-biomonitoring program. Detailed procedures for biomonitoring testing are given in the U.S. EPA Methods for Measuring the Acute Toxicity of Effluents to Aquatic Organisms.

The objectives of a self-biomonitoring program are to

- Assess compliance with discharger's NPDES permit limitations and requirements;
- Determine whether the records and reports required by the discharger's NPDES permit are being maintained;
- Check the adequacy of the permittee's reports;
- Determine whether representative samples are being collected and analyzed properly; and
- Determine whether bioassay has been conducted properly.

Evaluation of Permittee Biomonitoring Program

The evaluation of a permittee's biomonitoring program includes the performance audit inspection (PAI) and compliance evaluation inspection (CEI). During the PAI, the inspector must review the performance of permittee staff and evaluate their testing and sampling procedures. A CEI consists of an examination of the permittee's self-biomonitoring files and records, bioassay laboratory, and sampling records.

For each set of definitive bioassay data, the 24, 48, or 96-hour LC50 or EC50 and its 95-percent confidence limits must be calculated on the basis of the initial volume percent of the effluent in the test solutions.

The inspector should determine whether or not the permittee's biomonitoring program meets the requirements of the permit and regulations. The inspector should understand the permittee's biomonitoring requirements as stated in the permit.

Effluent Sampling

When evaluating a permittee's sampling program, the inspector should verify that:

- Sampling location, method, and frequency conform to the NPDES permit;
- The sampling location specified in the permit is adequate to provide a well mixed and representative sample;
- Sample devices, if used, are appropriately calibrated, clean, and properly operated;
- Effluent samples for bioassays are properly labeled and free from chemical preservatives.
- Samples shipped to the laboratory are refrigerated and are handled according to approved chain-of-custody procedures; and
- Bioassay testing begins within 24 hours after sample collection.

Laboratory Audit

The inspector should observe and review the permittee's laboratory procedures, equipment, facilities, and logs, or those of their contractors. The following areas require detailed on-site observations and evaluation.

Facilities and Equipment. Effluent toxicity testing may be performed in either a stationary or a mobile laboratory. Bioassay facilities may include equipment for rearing, holding, and acclimating test organisms. Water temperature should be controlled by circulating water baths or environmental chambers during acclimation and testing. The inspector should verify that:

- Holding, acclimation, and dilution water are temperature-controlled and aerated with air free from oil and fumes;
- Test organisms are shielded from outside disturbances and fumes during holding, acclimating, and bioassay;
- An alternate power generating unit is provided as a stand-by;

- Thermometers, pH meters, dilutors, and other measuring devices are calibrated by the manufacturer's recommended methods before use and at appropriate intervals during use;

- All equipment is properly cleaned; and

- Glass, No. 316 stainless steel, and perfluorocarbons are used for test chambers, tubing, etc.

Test Organisms. A list of recommended test organisms is included in Table 7-1. The condition, age, exposure history, and rearing or holding conditions can all affect the results. In general, wild stock are unacceptable unless these factors are known.

The inspector should determine whether:

- Test organisms have been exposed to pollutants or other stress, including disease, prior to bioassay;

- Test organisms have a survival rate of 80 percent or better during holding/acclimation;

- Holding conditions conform to EPA recommended procedures;

- For the 24-hour bioassay screening test, fathead minnows (Pimephales promelas) or other freshwater species are used with receiving water having a salinity of less than 5 parts per thousand. Mysid shrimp (Mysidopsis bahia) or other saltwater species are used with receiving water having a salinity of greater than 5 parts per thousand; and

- The temperature at which the test organisms are maintained and what and how they are fed.

Dilution Water. The inspector should verify that:

- Pretreatment of dilution water is limited to filtration through a nylon sieve that has 2- to 4-millimeter mesh to remove debris or suspended solids;

- Dilution water from receiving water, when used, is obtained from a point close to the outfall, but one that is upstream and outside of the influenced zone;

- Dilution water is obtained from the receiving water as close as possible to the time the test begins, but not more than 96 hours prior to testing;

- Dilution water is continuously pumped to acclimation tank and dilutor; and

Table 7-1

Recommended Species and Test Temperatures

Species	Test Temperature (°C)[a]
Freshwater	
Vertebrates	
Coho salmon, Oncorhynchus kisutch	12
Rainbow trout, Salmo gairdneri	12
Brook trout, Salvelinus fontinalis	12
Goldfish, Carassius auratus	20
Fathead minnow, Pimephales promelas	20
Channel catfish, Ictalurus punctatus	20
Bluegill, Lepomis macrochirus	20
Invertebrates[a]	
Clacodera, Daphnia magna, D. pulex[b],	20
or Ceriodaphnia reticulata[c]	20
Amphipods, Gammarus lacustris, G. fasciatus,	20
G. pseudolimnaeus, or Hyalella. sp.	20
Crayfish, Orconectes sp., Cambarus sp., Procambarus sp.,	20
or Pacifastacus leniusculus	12
Stoneflies, Pteronarcys sp.	12
Mayflies, Baetis sp. or Ephemerella sp.	12
Hexagenia limbata or H. bilineata	20
Midges, Chironomus sp.	20
Marine and Estuarine	
Vertebrates	
Sheepshead minnow, Cyprinodon variegatus	20
Mummichog, Fundulus heteroclitus	20
Longnose killifish, Fundulus similis	20
Silverside, Menidia sp.	20
Threespine stickleback, Casterosteus aculeatus	20
Pinfish, Lagodon rhomboides	20
Spot, Leiostomus xanthurus	20
Sanddab, Citharichthys stigmaeus	12
Flounder, Paralichthys dentatus, P. lethostigma	20
English sole, Parophrys vetulus	12
Winter flounder, Pseudopleuronectes americanus	12

Table 7-1

Recommended Species and Test Temperatures
(continued)

Species	Test Temperature (°C)[a]
Marine and Estuarine	
Invertebrates	
Shrimp, *Penaeus setiferus*, *P. duorarum*, or *P. aztecus*	20
Grass shrimp, *Palaemonetes* sp.	20
Shrimp, *Crangon* sp.	20
Oceanic shrimp, *Pandalus jordani*	12
Blue crab, *Callinectes sapidus*	20
Dungeness crab, *Cancer magister*	12
Mysid shrimp, *Mysidopsis* sp., *Neomysis* sp.	20
Atlantic oyster, *Crassostrea virginica*	20
Pacific oyster, *Crassostrea gigas*	20

[a]To avoid unnecessary logistical problems in trying to maintain different test temperatures for each test organism, it would be sufficient to use a single temperature (12°C) for cold water organisms and one temperature (20°C) for warm organisims.

[b]*Daphnia pulex* is preferred over *D. magna* because it is more widely distributed in the United States, test results are less sensitive to feeding during tests, and it is not as easily trapped on the surface film.

[c]Test methods are under development.

(Source: U.S. Environmental Protection Agency (EPA). 1984. Methods for Measuring the Acute Toxicity of Effluents to Aquatic Organisms, EPA 600/4-83-000. In press.)

- When a chemically equivalent or "reconstituted" water is used, it has a total hardness, total alkalinity, and specific conductance within 25 percent and a pH value within 0.2 units of the receiving water at the time of testing.

Test Procedures

The most important aspect of the biomonitoring audit is the observation of permittee or contractor toxicity testing and related laboratory analysis. The inspector should verify that conditions and procedures are correct in the following areas:

- Control and effluent dilution preparation;
- Procedures for transferring, allocating, and feeding test organisms;
- Recording of times for test set-up and initiation;
- Temperature and dissolved oxygen ranges during the test; and
- Test organism age, weight, length, and species.

Test Results. The inspector should verify that:

- The number of dead (or affected) organisms in each test container are counted 24, 48, 72, and 96 hours after the test begins;
- The dissolved oxygen concentration and pH are measured at the beginning of the test, and every 24 hours thereafter, in the control and in the high, medium, and low effluent concentrations for the duration of the test;
- The specific conductance, total alkalinity, total hardness, total ammonia nitrogen, and salinity, where applicable, are measured at the beginning and end of the test;
- Samples are collected properly and analytical results are properly presented;
- The 96-hour LC50 or EC50 and its 95-percent confidence limits are calculated on the basis of the initial volume percent of the effluent in the test solutions; and
- If other (24-, 48-, 72-hour) LC and EC values are calculated, their 95-percent confidence limits are also determined.

Recordkeeping and Data Reporting

Proper recordkeeping is essential to an effective biomonitoring program. Bound notebooks should be used to maintain detailed records of bioassays. Annotations should be made as soon as possible to prevent the loss of information. When evaluating the permittee's data reporting, the inspector should verify that the following are included:

- The name of the test method, date conducted, investigator, and laboratory;
- Detailed information on the effluent, dilution water, test organisms, source of the organisms, test procedure, and test chambers;
- The definition of the adverse affect (death, immobility, etc.) used in the test, and a summary of general observations on other effects or symptoms;
- The number and percentage of organisms in each test chamber (including the control chambers) that died or showed the "effect" of the toxicity of the effluent;
- A 24-, 48-, 72-, and 96-hour LC50 or EC50 value for the test organisms, depending on the duration of exposure. If 100-percent effluent did not kill or affect more than 65 percent of the test organisms, report the percentage of the test organisms killed or affected by various concentrations of the effluent;
- The 95-percent confidence limits for the LC50 and EC50 values and the method used to calculate them;
- The methods used for the results of all chemical analyses;
- The average and range of the acclimation temperature and the test temperature;
- Any deviation from this method; and
- Any other relevant information.

An example of a laboratory data sheet is given in Figure 7-1.

Figure 7-1
NPDES BIOMONITORING EVALUATION FORM

Permit No.: ______________

Facility Name: ____________________ Laboratory/
Facility Location: ____________________ Investigator: ______________
____________________ ______________

Bioassay Conditions:

Test and Type: 24-Hour Static ____ 48-Hour Static ____ Daily Renewal ____
96-Hour Flow-through ____ 96-Hour Static ____
Test Starting Date: ______________ Completion Date: ____________
Test Organism: Fathead Minnow ____________ Other (Specify) ____________
(*Pimephales promelas*)

Summary of Results

Mortality Observed (Yes or No)	Stress Observed (Yes or No)	LC50 (% effluent)

Quality Assurance Summary

	Acceptable	Unacceptable
Control Mortality:	$\leq$10% ____	>10% ____
Temperature maintained within $\pm$2°C of the test temperature?	Yes ____	No ____
Dissolved oxygen levels always greater than 40% saturation?	Yes ____	No ____
Loading factor for all exposure chambers less than or equal to maximum allowed for the test type and test temperature?	Yes ____	No ____
Water chemistry variations during the test?	$\leq$20% ____	>20% ____

Effluent Tested:

Sampling Location: ____________________ Type of Sample: ______________

Sample Collection Dates/Time: ______________________________

Dilution Water:

Source ______________________________ Collection Date ____________

2 Compliance Biomonitoring Inspection

Objectives and Requirements

The objectives of a compliance biomonitoring inspection are to:

- Serve as a screening mechanism isolating toxic conditions in an effluent that may not have been detected through routine chemical analysis;
- Evaluate compliance with water quality standards;
- Monitor toxics that may or may not be controlled through BCT/BAT;
- Evaluate permit limitations;
- Develop enforcement cases;
- Investigate probable cause violations; and
- Develop data for establishing new effluent limitations.

Conducting Biomonitoring

A biomonitoring program is conducted to evaluate an effluent based on sampling and testing by the regulatory agency. The biomonitoring can be conducted on-site or off-site.

On-site biomonitoring usually involves the following acute toxicity tests:

- An 8- to 24-hour range-finding (screening) bioassay;
- 24- to 96-hour static bioassays;
- A 96-hour flow-through bioassay; and
- A 24-hour QA bioassay with a reference toxicant.

Off-site biomonitoring usually involves:

- Collecting an effluent sample (a grab sample or a 24-hour composite sample);
- Transporting the sample to EPA or to State laboratories; and
- Performing a preferred 24-hour static bioassay.

Effluent Sampling and Holding

The effluent sampling point must be the same as that specified in the NPDES permit. Different locations may be used for better access to the sampling point between the final treatment and the discharge outfall, to measure unchlorinated effluents, or to evaluate individual waste streams.

It is important that the sample represent the "normal and typical" discharge and operating conditions of the facility.

Flow-Through Test. If the permittee facility discharges continuously, the effluent should be pumped directly and continuously from the discharge line to the dilutor system for the duration of the test. If the effluent cannot be pumped directly and continuously to the dilutor system, the following alternative methods may be employed for collection of the effluent:

- Where the calculated retention time of the effluent is less than 14 days, one to four grab samples are collected daily approximately 6 hours apart, or a composite sample is taken. Grab samples should not be combined. The previously collected sample is discarded and the container is refilled with the fresh effluent. If the chemical composition or concentration of the effluent does not vary, a single daily grab sample is sufficient.

- Where the calculated retention time is 14 days or longer, a single grab sample or composite sample is collected daily. Here again, the volume of sample remaining from the previous day is discarded and replaced by the fresh sample (static renewal).

If the permittee's discharge is intermittent, one of the following procedures may be appropriate:

- Where a continuous discharge occurs during one or two 8-hour work shifts, collect one grab sample of sufficient volume to supply the dilutor for 24 hours midway during the discharge period, or collect a composite sample.

- Where a facility treats and releases wastewater in a batch discharge, collect a single grab sample.

- Where the facility discharges wastewater to an estuary only during on outgoing tide, collect a single grab sample or composite sample. An alternate sampling method would be to pump effluent from the final waste lagoon adjacent to the discharge pipe continuously.

Static Test. The following effluent sampling methods are recommended for static tests. If the facility discharge is continuous, one of the following approaches is used:

- If the calculated retention time is less than 14 days, collect four grab samples daily and test each separately to determine the variability in toxicity, or collect 24-hour composite samples daily and test them in a static or static renewal test.

- If the calculated retention time is less than 14 days, but the wastewater does not vary in chemical composition or concentration, collect a single grab or composite sample for a static non-renewal test.

- If the calculated retention time of a continuously discharged wastewater is 14 days or greater, only one static test, using a single grab or composite sample, is needed.

If the facility discharge is intermittent, one of the following approaches is used:

- Where the effluent is continuously discharged during one or two 8-hour work shifts, collect one grab sample midway through the shifts.

- Where the facility treats and releases the wastewater as a batch discharge, collect a single grab sample for the test.

- Where the facility discharges wastewater to an estuary only during an outgoing tide, collect a single grab sample.

- At the end of the shift, clean up activities may result in the discharge of a slug of toxic waste. If so, a separate toxicity test may be advisable.

Effluent variability may be estimated from a review of self-monitoring or by continuous monitoring of parameters such as pH or conductivity. From these data one may calculate a mean and variance. If the relative variability $\left(\frac{\text{variance}}{\text{mean}}\right)$ exceeds .5, the wastewater is highly variable.

Effluent grab samples must be stored in covered, unsealed containers. Although it is desirable to refrigerate samples before the test, it is often convenient to store samples in a constant-temperature water bath or controlled-environment room at the temperature at which the test is conducted. The test should be initiated as soon as possible, but no longer than 24 hours after collection of the effluent.

The persistence of an effluent's toxicity may be a factor in determining specific toxicity limits in an NPDES permit, and is determined by measuring its toxicity upon collection and again after holding 96 hours. If after holding the effluent 96 hours its toxicity has not decreased by 50 percent or more, it is classified as persistent. (When special tests such as persistence are conducted, the exact methodology must be detailed in the report.)

Test Organisms

Certain test organism criteria that the inspector should check in the laboratory include the following:

- Age of test organisms: Juvenile fish (15-60 days) are preferred for acute toxicity testing.
- Feed test organisms daily and clean holding tanks at least twice a week.
- A daily log of feeding, mortality, and observations should be kept.
- Follow the following procedures for holding test organisms:
  - Quarantine new test organisms for at least 10 days
  - Acclimation should be gradual. Maximum changes permitted are 3°C in water temperature or 3 0/00 in salinity in a 12-hour period, or total change of 6°C or 6 0/00 salinity
  - Maintain dissolved oxygen levels above 40-percent saturation (warm water species) and above 60-percent saturation (cold water species).
- Record source of the test organisms (hatchery, in-house, or other source).
- Test organisms should be handled as little as possible to minimize stress.
  - Dipnets should be used for large organisms;
  - Pipettes should be used for transferring small organisms such as daphnids and midge larvae.

Facility and Equipment

General Requirements. Effluent toxicity tests may be carried out in a fixed or mobile lab. Depending on the scope of the bioassay program, facilities may include equipment for rearing, holding, and acclimating organisms. Temperature control is achieved using circulating water baths or environmental chambers. Appropriate dilution water may be groundwater, surface water, reconstituted water, or dechlorinated tap water. Holding, acclimation, and dilution water should be temperature-controlled and aerated whenever possible. Air used for aeration must be free of oil and fumes; filters to remove oil in water are desirable. Test facilities must be well ventilated and free of fumes. During holding, acclimating, and testing, test organisms should be shielded from disturbances.

Some organisms may have special environmental requirements such as flowing water, fluctuating water levels, or substrate that must be provided. During holding, acclimating, and testing, immature stream insects should always be in flowing water, as described by Nebeker and Lemke (1968); penaeid shrimp and bottom-dwelling fish should be provided a silica and substrate. Since cannibalism can occur among many species of arthropods, they should be isolated by some means (e.g., with screened compartments), or the claws of crabs and crayfish should be bound.

Construction Materials. Glass, No. 316 stainless steel, and perfluorocarbon plastics (Teflon r) should be used in the construction of the test equipment whenever possible. Linear polyethylene may also be used with some types of effluents but should be avoided with those containing synthetic organic compounds or pesticides. Unplasticized plastics such as polyethylene, polypropylene, TYGON r and fiberglass can be used for holding, acclimating, and dilution-water storage tanks, and in the water delivery system. Copper, galvanized material, rubber, brass, and lead must not come in contact with holding, acclimation, or dilution water, or with effluent samples and test solutions.

Effluent Delivery System (Flow-Through Test Only). The flow-through proportional-dilutor delivery system has proven to be the best and the preferred system for routine effluent toxicity tests conducted in both fixed and mobile laboratories. Dilutors with solenoid valve system are preferred, but the vacuum siphon system is acceptable, if funds are limited.

The flow rate through the proportional dilutor must provide for at least five complete water volume changes in 24 hours in each test chamber, plus sufficient flow to maintain an adequate concentration of dissolved oxygen. The flow rates through the test chambers should not vary by more than 10 percent among test chambers at any time during any test. The dilutor should also be capable of maintaining the test concentration in each test chamber within 5 percent of the starting concentration for the duration of the test. The dilutor should be checked and calibrated before and after each test.

Test Chambers. Test chambers used in flow-through tests are usually constructed of 1/4 inch plate glass held together with clear silicone adhesive. All joints should be smooth. Stainless steel (No. 304 or No. 316) can be used in the construction of test chambers, but must be of welded, not soldered, construction. Plastic chambers can be used but should be discarded after test completion.

The test chambers most commonly used in static tests are wide-mouth, 3.8 liter (1-gallon) or 19.0-liter (5-gallon) soft-glass bottles or aquaria. Containers such as 10- to 20-cm diameter culture dishes or beakers may be more suitable as test chambers for fish eggs and/or larvae and small crustacea. Special glass or stainless steel test chambers can be constructed to accommodate test organisms requiring special physical conditions. These chambers should be covered and provide 5 cm of test solution.

All test chambers, whether new or used, must be washed as described in Methods for Measuring the Acute Toxicity of Effluents to Aquatic Organisms.

Dilution Water. Receiving water is the preferred source. It should be obtained upstream of or outside of the influence of the effluent. In an estuarine environment, the dilution water should have the same salinity as that at the receiving site.

Pretreatment of the dilution water should be limited to filtration through a nylon sieve having 2-millimeter or larger openings to remove debris and/or break up large floating or suspended solids. Dilution water should be collected no earlier than 48 hours before testing.

If the receiving water is unsuitable as dilution water, use "reconstituted" water. This water must have a total hardness, total alkalinity, specific conductance within 25 percent, and pH within 0.2 units of the receiving water. Recommended procedures for preparing "reconstituted" water are given in Methods for Measuring the Acute Toxicity of Effluents to Aquatic Organisms. Salt water media such as INSTANT OCEAN [r] and RILA SALTS [r] are available commercially.

Test Procedures

Range-Finding (Screening) Test. It may be necessary to conduct an abbreviated, preliminary, range-finding or screening test to determine the concentrations that should be used in the definitive tests. The screening can be either a static or flow-through test. Static tests use five organisms in three to five effluent dilutions, and a control for 8 to 24 hours. If the range-finding test is to be conducted with the same sample of the effluent as the definition test, the duration of the range-finding test cannot exceed 24 hours.

Definitive Test. The determination of an LC50 or EC50 must employ a control and at least five concentrations of effluent in an exponential series.

If 100-percent effluent does not kill (or affect) more than 65 percent of the organisms exposed to it, the percentage of organisms killed (or affected) by various levels of the effluent in the receiving water must be reported. A test is not acceptable if more than 10 percent of the organisms die in the control.

Number of Test Organisms. At least 20 organisms of a given species must be exposed to each treatment in two or more replicates. To qualify as true replicates, no water connections can exist between replicate test chambers.

Loading of Test Organisms. For flow-through tests, loading in the test chambers must not exceed 5 grams per liter at temperatures of 20°C or less, or 2.5 grams per liter at temperatures above 20°C.

For static tests, loading in the test chambers must not exceed 0.8 grams per liter at temperatures of 20°C or less and 0.4 grams per liter at temperatures above 20°C.

Water Temperature. Maintain the water temperature within ±2.0°C of the recommended temperature (Table 7-1).

Dissolved Oxygen. Avoid aeration that may alter the results of toxicity tests. However, the dissolved oxygen concentration (DO) in the test solution should not exceed 40-percent saturation for warm water species and 60-percent saturation for cold water species. The turnover rate of the solutions in the test chambers may be increased to maintain acceptable DO levels. If the increased turnover rate does not maintain adequate DO levels, dilution water must be aerated.

Beginning the Test. The test begins when the test organisms are first exposed to the effluent.

- Flow-through test--The dilutor system should be in operation 24 hours before test organisms are added and the test begins. During this period effluent volumes, temperature, and flow rates are adjusted.

- Static test--The effluent is added to the dilution water and mixed well by stirring with a glass rod. The test organisms are placed in the chambers within 30 minutes.

Feeding. Organisms should not be fed during the acute toxicity test unless they are newly hatched or very young. In the case of fish, feeding should be terminated 48 hours before the beginning of the test. Follow the recommendations for other standard toxicity tests.

Duration. The test duration may range from a minimum of 8 hours to 96 hours, depending on the test organism used, the purpose of the test, and whether it is a range-finding test or a definitive test.

Reference Toxicants

Reference toxicants are used to establish the sensitivity of the test organisms. A laboratory performs a definitive 24- or 48-hour static bioassay with the reference toxicant to establish a median response. A variety of compounds are available from U.S. EPA EMSL-Cincinnati. The LC50 of a batch of test organisms can be evaluated. For example, if the LC50 of a reference toxicant does not fall in the recommended range for the test organisms, the sensitivity of the organisms and/or the quality of the bioassays are suspect.

Chain of Custody and Preservation of Documents

Results obtained by persons having expertise in conducting sampling and biomonitoring are valid. Normal EPA chain-of-custody procedures should be used. However, an additional effort in custodial care is absolutely required to ensure the admission of biomonitoring information in enforcement proceedings.

For on-site biomonitoring, chain-of-custody records are those that show the source of the materials tested and that indicate that test results are not rendered inaccurate by deliberate tampering or unintentional error.

For biomonitoring off-site, chain of custody consists of records and/or labels, a field data sheet, and/or a field logbook showing where, when, and by whom a sample was taken and the persons to whom custody was relinquished throughout the sampling and testing process, together with appropriate notations in the laboratory logbook listing the names of sample custodians, as well as notations on the security measures taken to protect the integrity of the sample during testing.

Data Reporting

The primary purpose of a compliance biomonitoring inspection is to establish compliance status with biomonitoring requirements in an NPDES permit and/or to evaluate the effluent's potential for toxicity to aquatic life in the receiving waters. This is accomplished by a thorough evaluation of compliance biomonitoring data and is determined through a comparison of the following parameters:

- Toxicity of the waste (LC50 or EC50) expressed as a percent dilution;
- Instream waste concentration (IWC) of the effluent;
- Potential for chronic and acute toxicity of waste in the receiving water, including persistence, carcinogenicity, mutagenicity, and teratogenicity;
- Permit limits, if contained in the permit; and
- Chemical parameters of effluent measured in conjunction with the bioassay, such as dissolved oxygen, temperature, pH, conductivity, metals, and organics.

Three types of effluent biomonitoring results must be recorded:

- Biological data including length, weight, and/or age of test organisms and number of test organisms affected;

- Physical and chemical data, including dissolved oxygen, temperature, pH, specific conductivity, total alkalinity, hardness, salinity, total ammonia nitrogen; and
- LC50, EC50, and their 95-percent confidence limits.

A report of the results of a biomonitoring test must include the elements listed under Recordkeeping and Data Recording on page 7-7.

References

Davey, E.W., et al. 1970. "Retrieval of trace metals from marine culture media." Limnol. Oceanogr. 15:486-488

Kester, D. R., et al. 1967. "Preparation of artificial seawater." Limnol. Oceanog. 12:176-179

Marking, L.L. and V.K. Dawson. 1973. "Toxicity of quinaldine sulfate to fish." Invest. Fish Contr. No. 48, U.S. F&WS, Washington, D.C. 8pp

Nebeker, A.V. and A.E. Lemke. 1968. "Preliminary studies on the tolerance of aquatic insects to heated waters." J. Kans. Entomol. Soc. 41:413-418

U.S. Environmental Protection Agency (EPA). 1984. Methods for Measuring the Acute Toxicity of Effluents to Aquatic Organisms, EPA 600/4-83-000. In press.

Zaroogian, G.E., G. Pesch and G. Morrison. 1969. "Formulation of an artificial seawater media suitable for oyster larvae development." Amer. Zool. 9:141

Zillioux, E. J., et. al. 1973. "Using Artemia to assay oil dispersant toxicities." J. Water Poll. Fed. 45:2389-2396

Laboratory Quality Assurance

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Laboratory Quality Assurance

Objectives and Requirements

The analytical laboratory provides both qualitative and quantitative information for use in determining the extent of the permittee's compliance. To be valuable, the data must accurately describe the characteristics and concentrations of constituents in the samples submitted to the laboratory. The objectives of laboratory quality assurance are to monitor the accuracy and precision of the results reported and to meet reliability requirements.

Quality assurance (QA) refers to a total program for ensuring the reliability of data and includes administrative procedures and policies regarding personnel, resources, and facilities. Quality assurance is required for all functions bearing on environmentally related measurements. This includes activities such as: project/study definition; sample collection; laboratory analysis; data validation, analysis, reduction, and reporting; documentation; and data storage systems. Thus the QA program is designed to evaluate and maintain the desired quality of data. Quality control (QC), a function of QA, is the routine application of procedures for controlling the accuracy and precision of the measurement process such as the proper calibration of instruments or the use of appropriate analytical grade reagents.

Laboratory quality assurance is required by 40 CFR Section 122.41(e), which states that adequate laboratory and process controls, including appropriate quality assurance procedures, must be provided. Each permittee's laboratory should have a quality assurance program. The QA program should be documented in a written quality assurance manual that is distributed to all personnel responsible for analyses. This manual should clearly identify the individuals involved in the quality assurance program and their responsibilities, and should document the laboratory's standard operating procedures that meet user requirements in terms of specificity, completeness, precision, accuracy, representativeness, and comparability.

The information in this chapter is comprehensive and may not be applicable to every laboratory. The size of the laboratory should be considered in determining the appropriateness of this information.

A Laboratory Quality Assurance Checklist for the inspector's use is included at the end of this chapter. For detailed information concerning laboratory quality assurance, see the EPA Handbook for Analytical Quality Control in Water and Wastewater Laboratories.

Evaluation of Permittee Laboratory Analytical Procedures

It is important that the methods used by permittee laboratories are uniform, thus eliminating the methodology as a variable when data are compared or shared among laboratories. Procedures used by the permittee's laboratory should be selected by consulting 40 CFR 136 or EPA for approval of alternative methods. Alternative test procedures may be implemented only if the required written EPA approval has been obtained, as specified by 40 CFR 136.4 and 136.5, and promulgated under P.L. 92-500.

Standardized test procedures that have been promulgated under 40 CFR 136 are covered in Methods for Chemical Analysis of Water and Wastes (EPA, 1979). Revisions and new additions to this publication are made whenever new analytical techniques or instruments are developed. These are accepted after publication in the Federal Register. Other acceptable sources are the latest approved editions of Standard Methods for the Examination of Water and Wastewater, the ASTM Annual Book of Standards, Part 31, Water, and the USGS Methods for Collection and Analysis of Water Samples for Dissolved Minerals and Gases.

In evaluating laboratory analytical procedures, the inspector should verify the following:

- A QC record is maintained on media preparation, instrument calibration and maintenance, and purchase of supplies;
- QC checks are made on materials, supplies, equipment, instruments, facilities, and analyses;
- Steps and procedures are followed as stated in the method; and
- Documentation is available that explains the rationale and applicable conditions for any deviations from test procedures.

Evaluation of Permittee Laboratory Facilities and Equipment

The maintenance of the laboratory's facilities and equipment is an important factor in laboratory quality assurance.

Laboratory Services

The quality of laboratory services available to the analyst will affect the reliability of the data. The inspector should verify that the following items are provided:

- An adequate supply of distilled water, free from interferences and other undesirable contaminants. Routine water quality checks should be conducted and documented;

- Adequate bench, instrumentation, storage and records-keeping space;

- Adequate lighting and ventilation;

- Dry, uncontaminated compressed air when required;

- Efficient fume hood systems;

- Hot plate, refrigerator for samples, pH meter, thermometer, balance;

- Electrical power for routine laboratory use and, if appropriate, voltage-regulated sources for delicate electronic instruments; and

- Emergency equipment, fire extinguisher, eye wash station, shower, first aid kit, gloves, goggles.

Instruments and Equipment

The analytical laboratory depends heavily on instrumentation. To a certain extent, analytical instrumentation is always in the development stage; manufacturers are continually redesigning and upgrading their products, striving for miniaturization, enhanced durability and sensitivity, and improved automation.

In evaluating laboratory instruments and equipment, the inspector should verify that:

- Standard and specific procedures for cleaning glassware and containers are followed;

- Written requirements for daily operation of instruments and equipment are provided and followed;

- Standards are available to perform standard calibration procedures;

- Written trouble-shooting procedures are available; and

- Written schedules for required or recommended replacement, cleaning, checking, and/or adjustment by service personnel are both available and followed.

Supplies

Chemical reagents, solvents, and gases are available in a wide variety of grades of purity, ranging from technical grade to various ultrapure grades. The purity of the materials required in analytical chemistry varies with the type of analyses. The parameter being measured and the sensitivity and specificity of the detection system are important factors in determining the purity of the reagents required. Reagents of lesser purity than that specified by the method should not be used.

In evaluating laboratory supplies, the inspector should verify that:

- The required reagent purity for the specific analytical method is met;
- Standard reagents and solvents are stored according to the manufacturer's directions;
- Working standards are checked frequently to determine changes in concentration or composition;
- Concentrations of stock solutions are verified before being used to prepare new working standards;
- Laboratory supplies with limited shelf life are dated upon receipt and shelf life recommendations, including the discard date on the container and the storage requirements, are observed;
- Reagents are prepared and standardized against reliable primary standards; and
- Standards and reagents are properly labeled.

Evaluation of the Precision and Accuracy of the Permittee Laboratory

The purpose of laboratory control procedures is to ensure high-quality sampling and analyses by the use of control samples, control charts, reference materials, and instrument calibrations. It is essential that controls are initiated and maintained throughout the analysis of samples. Specifically, each testing batch must contain at least one blank, duplicate, and spiked (as applicable) sample analysis. It is equally important that the type of control sample selected--blank, duplicate, spike, etc.--provide the desired information.

The precision of laboratory findings refers to the reproducibility of replicate observations. In a laboratory quality assurance program, precision is determined by the use of actual water samples that cover a range of concentrations and a variety of interfering materials usually encountered by the analyst. Accuracy refers to the degree of difference between observed values, and known or actual values. The accuracy of a method may be determined by replicate analyses of samples to which known amounts of reference standards have been added (spiked samples).

To determine whether a permittee's laboratory has established the precision and accuracy of its analytical procedures, the inspector should verify that:

- A minimum of seven replicates are analyzed for each type of quality control check (duplicate samples, split samples, spiked samples, and sample preservative blanks), and that this information is on record.

- Precision and accuracy data are plotted by means of quality control charts to determine whether valid, questionnable, or invalid data are being generated from day to day.

In evaluating the precision of the measurement process, the inspector should verify that:

- Control samples are introduced into the train of actual samples to monitor the performance of the analytical system;

- Duplicate analyses are performed with each batch of samples to determine precision;

- Precision control charts for each analytical procedure are prepared and used;

  - Precision limits are established based on standard deviations with upper and lower control limits being established at three times the standard deviation above and below the central line;

  - The upper and lower warning limits are established at twice the standard deviation above and below the central line;

- Corrective actions are taken when data fall outside the warning and control limits; and

- The out-of-control data and the corrective action taken are fully documented.

In evaluating accuracy, the inspector should verify that:

- Control samples are introduced into the train of actual samples to monitor the performance of the analytical system;

- Spiked samples are used to monitor accuracy;
- Accuracy control charts for each analytical procedure are prepared and used;
  - Accuracy limits are established based on standard deviations with upper and lower control limits being established at three times the standard deviation above and below the central line;
  - The upper and lower warning limits are established at twice the standard deviation above and below the central line. (Note: Some parameters have a defined warning limit required by 40 CFR 136.)
- Corrective actions are taken when data fall outside the warning and control limits; and
- The out-of-control data or situation and the corrective action taken are fully documented.

Evaluation of Permittee Data Handling and Reporting

An analytical laboratory must have a system for uniformly recording, processing, and reporting data. In evaluating permittee data handling and reporting, the inspector should verify that:

- Correct calculation formulas are used to reduce numbers to their simplest factors for quick, accurate calculation;
- Round-off rules are uniformly applied;
- Significant figures are established for each analysis;
- Provisions are available for cross-checking calculations;
- Control chart approaches and statistical calculations have been determined for the purposes of quality assurance and reporting;
- The report forms provide complete data documentation and permanent recording, and facilitate data processing;
- The program for data handling provides data in the form/units required for reporting;
- Laboratory records are kept readily available to the regulatory agency for a minimum of three years; and
- Laboratory notebooks or preprinted data forms are permanently bound to provide good documentation.

Evaluation of Permittee Sample Handling Procedures

Proper sample handling procedures are necessary in the laboratory from the time the sample is received until it is discarded. In evaluating laboratory sample handling procedures the inspector should verify that:

- The laboratory has a sample custodian;
- The laboratory area is a secured area and is restricted to authorized personnel only;
- The laboratory has a sample security area that is dry, clean, and isolated, has sufficient refrigerated space, and can be securely locked from the outside;
- Samples are handled by a minimum number of people;
- All incoming samples are received by the custodian, who signs the chain-of-custody record sheet accompanying the samples and retains the sheet as a permanent record;
- The custodian has ensured that samples are properly stored;
- Only the custodian distributes samples to personnel who are to perform analyses;
- The analyst keeps a laboratory notebook or analytical worksheet identifying and describing the sample, the procedures performed, and the results of the testing. The notes are dated, indicate who performed the tests, and include any abnormalities that occurred during the testing procedure. The notes are retained as a permanent record in the laboratory; and
- There are accurate and up-to-date care and custody records for handling samples.

Evaluation of Permittee Laboratory Personnel

Analytical operations in the laboratory vary in complexity. Consequently, work assignments in the laboratory should be clearly defined. All analysts, both professional and subprofessional, should be thoroughly instructed in basic laboratory operations. Those performing complex analytical tasks should be qualified and trained to do so. All of the analysts must follow specified laboratory procedures, and be skilled in using the laboratory equipment and techniques required in the analyses for which they are responsible.

In evaluating laboratory personnel, the inspector should consider the following factors:

- Adequacy of training;
- Skill and diligence in following procedures;
- Skill in using equipment and analytical methods; and
- Precision and accuracy in performing analytical tasks.

References

ASTM. 1975. Annual Book of Standards, Part 31, Water. American Society for Testing and Materials (ASTM), Philadelphia, PA.

AWWA, APHA, and WCPF. Standard Methods for the Examination of Water and Wastewater. Use the most current, EPA-approved edition.

Brown, E., Skougstad, M.W., Fishman, M. J. 1970. Methods for Collection and Analysis of Water Samples for Dissolved Minerals and Gases. U.S. Geological Survey Techniques of Water Resources Inv., Book 5.

Delfino, J. J. 1977. "Quality Assurance in Water and Wastewater Analysis Laboratories." Water and Sewage Works, 124(7): 79-84.

EPA. 1979a. Handbook for Analytical Quality Control in Water and Wastewater Laboratories. EPA-600/4-79-019.

EPA. 1979b. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020.

Plumb, R. H., Jr. 1981. "Procedure for Handling and Chemical Analysis of Sediment and Water Samples." Technical Report EPA/CE-81-1.

Laboratory Quality Assurance Checklist

A. General

Yes No N/A	1. Written laboratory quality assurance manual is available.

B . Laboratory Procedures

Yes No N/A	1. EPA approved analytical testing procedures are used.
Yes No N/A	2. If alternate analytical procedures are used, proper approval has been obtained.
Yes No N/A	3. Calibration and maintenance of instruments and equipment is satisfactory.
Yes No N/A	4. Quality control procedures are used.
Yes No N/A	5. Quality control procedures are adequate.
	6. Duplicate samples are analyzed ____% of time.
	7. Spiked samples are used ____% of time.
Yes No N/A	8. Commercial laboratory is used Name ____________ Address __________ Contact __________ Phone ___________

C. Laboratory Facilities and Equipment

Yes No N/A	1. Proper grade distilled water is available for specific analysis.
Yes No N/A	2. Dry, uncontaminated compressed air is available.
Yes No N/A	3. Fume hood has enough ventilation capacity.
Yes No N/A	4. The laboratory has sufficient lighting.
Yes No N/A	5. Adequate electrical sources are available.
Yes No N/A	6. Instruments/equipment are in good condition.
Yes No N/A	7. Written requirements for daily operation of instruments are available.

C. Laboratory Facilities and Equipment (continued)

Yes No N/A	8. Standards are available to perform daily check procedure.
Yes No N/A	9. Written trouble-shooting procedures for instruments are available.
Yes No N/A	10. Schedule for required maintenance exists.
Yes No N/A	11. Proper volumetric glassware is used.
Yes No N/A	12. Glassware is properly cleaned.
Yes No N/A	13. Standard reagents and solvents are properly stored.
Yes No N/A	14. Working standards are frequently checked.
Yes No N/A	15. Standards are discarded after recommended shelf life has expired.
Yes No N/A	16. Background reagents and solvents run with every series of samples.
Yes No N/A	17. Written procedures exist for cleanup, hazard response methods, and applications of correction methods for reagents and solvents.
Yes No N/A	18. Gas cylinders are replaced at 100-200 psi.

D. Laboratory's Precision, Accuracy, and Control Procedures

Yes No N/A	1. A minimum of seven replicates is analyzed for each type of control check and this information is on record.
Yes No N/A	2. Plotted precision and accuracy control charts are used to determine whether valid, questionable, or invalid data are being generated from day to day.
Yes No N/A	3. Control samples are introduced into the train of actual samples to ensure that valid data are being generated.
Yes No N/A	4. The precision and accuracy of the analyses are good.

E. Data Handling and Reporting

Yes No N/A	1. Round-off rules are uniformly applied.
Yes No N/A	2. Significant figures are estabished for each analysis
Yes No N/A	3. Provision for cross-checking calculation is used
Yes No N/A	4. Correct formulas are used to reduce to simplest factors for quick, correct calculation
Yes No N/A	5. Control chart approach and statistical calculations for quality assurance and report are available and followed
Yes No N/A	6. Report forms have been developed to provide complete data documentation and permanent records and to facilitate data processing
Yes No N/A	7. Data are reported in proper form and units
Yes No N/A	8. Laboratory records are kept readily available to regulatory agency for required period of time
Yes No N/A	9. Laboratory notebook or preprinted data forms are permanently bound to provide good documentation
Yes No N/A	10. Efficient filing system exists enabling prompt channeling of report copies

F. Laboratory Personnel

Yes No N/A	1. The analyst has appropriate training
Yes No N/A	2. The analyst follows the specified procedures
Yes No N/A	3. The analyst is skilled in performing analyses

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