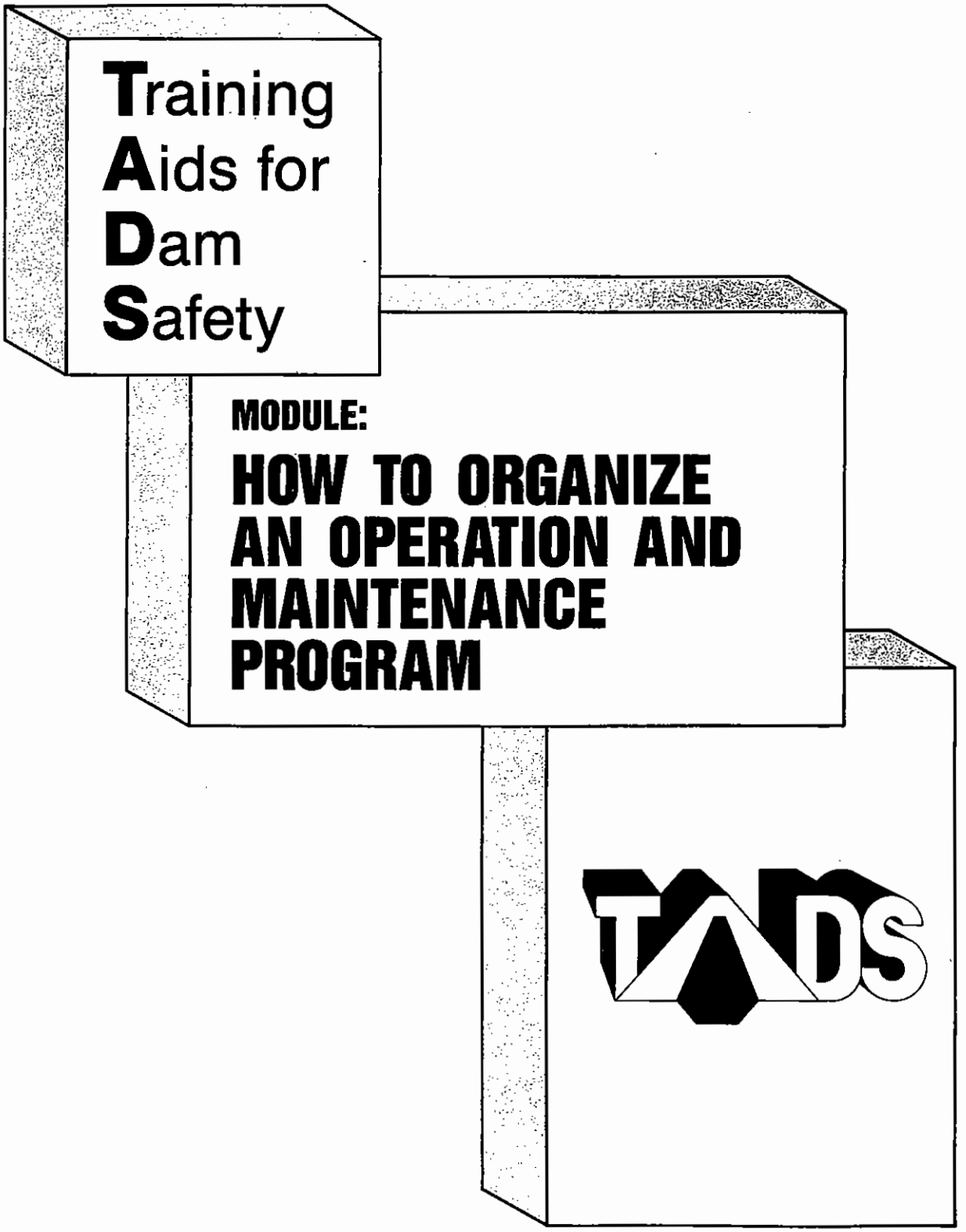
Training
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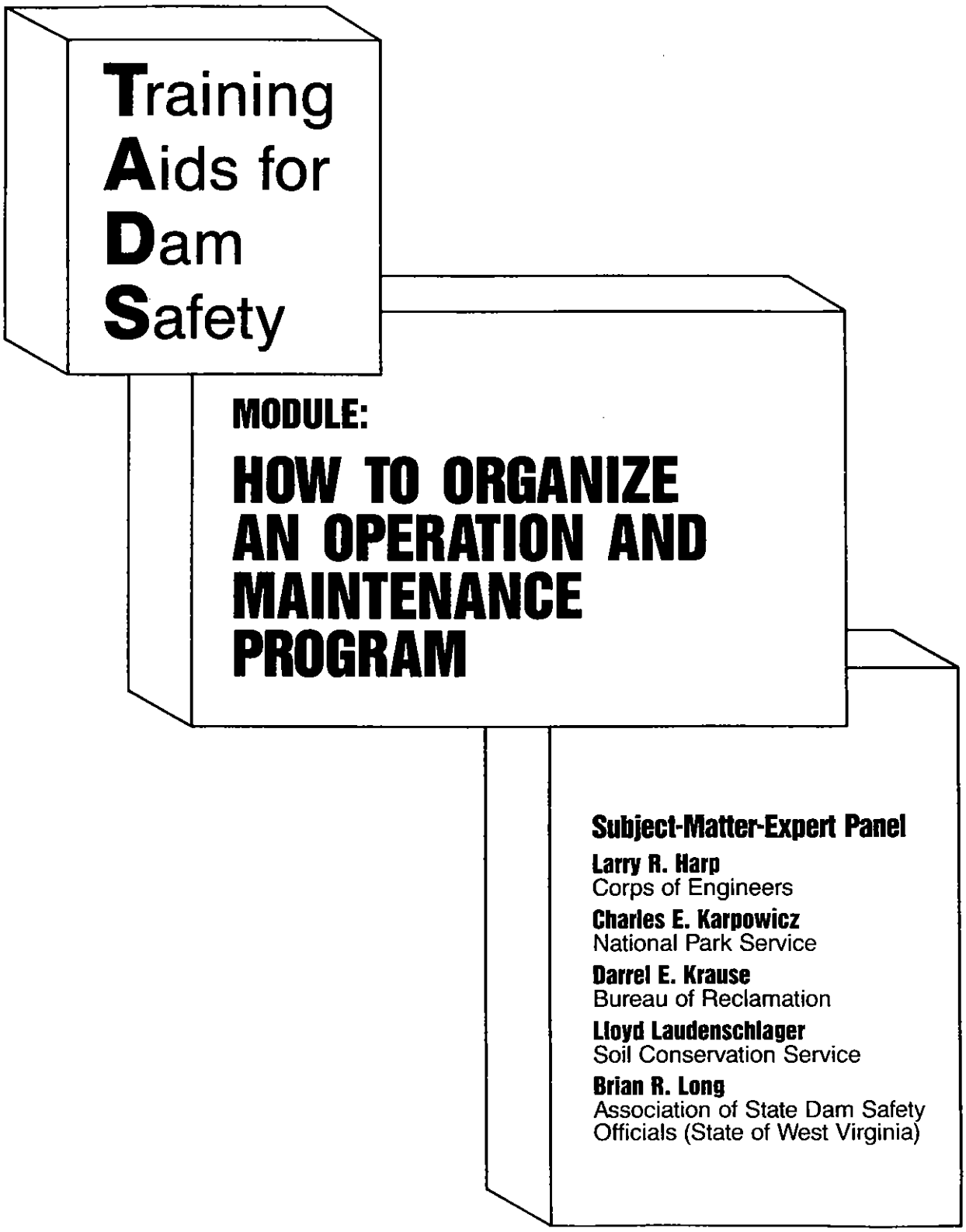
MODULE:
HOW TO ORGANIZE AN OPERATION AND MAINTENANCE PROGRAM
TADS


Training
Aids for
Dam
Safety
MODULE:
HOW TO ORGANIZE AN OPERATION AND MAINTENANCE PROGRAM
Subject-Matter-Expert Panel
Larry R. Harp
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PREFACE

There are presently more than 80,000 dams in use across the United States. Like any engineering works, these dams require continual care and maintenance, first to ensure that they remain operational and capable of performing all intended purposes, and then to preclude endangering people and property downstream.

The safety of all dams in the United States is of considerable national, state, and local concern. Given that, the principal purpose of the TADS (Training Aids for Dam Safety) program is to enhance dam safety on a national scale. Federal agencies have responsibility for the safe operation, maintenance, and regulation of dams under their ownership or jurisdiction. The states, other public jurisdictions, and private owners have responsibility for the safety of non-Federal dams. The safety and proper custodial care of dams can be achieved only through an awareness and acceptance of owner and operator responsibility, and through the availability of competent, well-trained engineers, geologists, technicians, and operators. Such awareness and expertise are best attained and maintained through effective training in dam safety technology.

Accordingly, an ad hoc Interagency Steering Committee was established to address ways to overcome the paucity of good dam safety training materials. The committee proposed a program of self-instructional study embodying video and printed materials and having the advantages of wide availability/marketability, low per-student cost, limited or no professional trainer involvement, and a common approach to dam safety practices.

The 14 Federal agencies represented on the National Interagency Committee on Dam Safety fully endorsed the proposed TADS program and have underwritten the cost of development. They have also made available technical specialists in a variety of disciplines to help in preparing the instructional materials. The states, through the Association of State Dam Safety Officials, also resolved to support TADS development by providing technical expertise.

The dam safety instruction provided by TADS is applicable to dams of all sizes and types, and is useful to all agencies and dam owners. The guidance in dam safety practice provided by TADS is generally applicable to all situations. However, it is recognized that the degree to which the methods and principles are adopted will rest with the individual agency, dam owner, or user. The sponsoring agencies of TADS assume no responsibility for the manner in which these instructional materials are used or interpreted, or the results derived therefrom.

ACKNOWLEDGMENTS

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TADS SUPPORTING ORGANIZATIONS

Association of State Dam Safety Officials
U.S. Committee on Large Dams

TABLE OF CONTENTS

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TABLE OF CONTENTS

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TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

MODULE INTRODUCTION

HOW TO ORGANIZE AN OPERATION AND MAINTENANCE PROGRAM

MODULE INTRODUCTION

OVERVIEW OF THIS MODULE

Are you developing an Operation and Maintenance (O&M) Program for your facility? Or are you in the process of modifying your facility's current O&M Program?

How To Organize An Operation And Maintenance Program is a tool designed to guide you through the process step by step. You will learn how to plan, implement, and evaluate an O&M Program.

HOW TO USE THIS MODULE

This module is designed to be used in conjunction with other Training Aids for Dam Safety (TADS) modules. The TADS Learner's Guide lists all of the TADS modules and presents a recommended sequence for completing the modules. You may want to review the Learner's Guide before completing this module.

CONTENTS OF THIS MODULE

This module is divided into four units, followed by three appendixes:

- **Unit I. What Is An O&M Program?:** Presents information about the major goals of an O&M Program, the importance of O&M Programs, and the phases of organizing an O&M Program.

- **Unit II. Planning An O&M Program:** Describes the steps used to plan an O&M Program including: identifying the O&M activities to be performed, developing operating procedures, establishing recordkeeping systems, and writing an O&M Plan.

- **Unit III. Implementing An O&M Program:** Describes the steps used to implement an O&M Program including: securing resources and administering the O&M Program (i.e., personnel management, resource management, and information management).

- **Unit IV. Evaluating An O&M Program:** Describes the steps used to evaluate an O&M Program including: identifying evaluation standards, collecting evaluation information, and assessing O&M Program effectiveness.

- **Appendix A. Sample O&M Tasks:** Presents a list of sample O&M tasks. The O&M tasks presented are examples of common tasks. The list should not be considered comprehensive. Every facility has site-specific O&M tasks that should be performed.

- **Appendix B. Sample O&M Budgets:** Presents three sample O&M budgets. One sample budget is for a very small O&M Program. The other sample budgets are for larger O&M Programs.

- **Appendix C. References:** Lists recommended references that can be used to supplement this module.

MODULE INTRODUCTION

DESIGN OF THIS MODULE

This module includes text instruction. There is no accompanying video presentation.

UNIT I

OVERVIEW

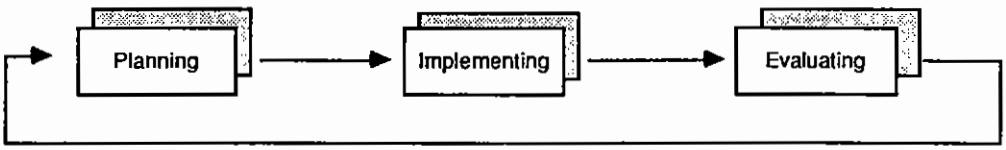
I. OVERVIEW: WHAT IS AN O&M PROGRAM?

INTRODUCTION

An Operation and Maintenance (O&M) Program is a systematic means of ensuring that a dam is operated and maintained adequately. Adequate operation and maintenance is critical for ensuring . . .

- The continued safe operation of the dam.
- The continued productive use of the dam and reservoir.

An O&M Program includes the following major phases . . .



Planning: During the planning phase, the O&M activities to be performed are identified. The frequency of each O&M activity is determined.

Implementing: During the implementation phase, the resource requirements for performing the O&M activities are identified, and the O&M activities are performed. Systems are established for monitoring and tracking O&M activities and expenditures. Finally, information is collected and records are maintained.

Evaluating: During the evaluation phase, the O&M Program is assessed. The costs and benefits of the Program are identified. Program strengths and weaknesses are identified. The assessment information is used to plan new actions for improving the O&M Program.

This module will provide general guidance on how to plan, implement, and evaluate O&M Programs. However, before discussing the nuts and bolts, we will first review some general concepts related to O&M Programs.

WHAT IS OPERATION?

Operation is the administration, management, and performance of necessary actions to keep a facility safe and functioning to achieve its intended purposes. The operation of a dam and its appurtenances is based on an established set of procedures. These procedures may be contained in a Standing Operating Procedures (SOP) manual or some other document. The O&M Program ensures that established procedures are followed.

☞ **EXAMPLE:** Before operating spillway gates, personnel review the SOP to determine the proper sequence in which the gates should be opened and the exact steps to take when opening each gate.

I. OVERVIEW: WHAT IS AN O&M PROGRAM?

WHAT IS MAINTENANCE?

Maintenance is the upkeep of a facility. Maintenance includes the performance of work and the provison of materials in order to:

- **Prevent** the deterioration or damage to the dam and its appurtenances. (Preventive Maintenance)
- **Repair** damage caused by deterioration, flooding, breakdown, vandalism, or failure. (Extraordinary Maintenance)

Preventive Maintenance

Preventive Maintenance is maintenance that is performed routinely. The goal of preventive maintenance is to extend the service life of parts and equipment, and to avoid costly breakdown maintenance. Preventive maintenance can be divided into two basic categories:

- **Scheduled Maintenance:** Scheduled maintenance involves servicing equipment or replacing parts according to an established schedule. Scheduled maintenance may be anything from a monthly lubrication routine to an annual replacement of component parts on a piece of equipment. Scheduled maintenance can be based on time (e.g., days, months, years, etc.) or amount of use (hours of operation, number of cycles, etc.). For example, most of the scheduled maintenance on a car is performed based on the number of miles driven.
- **Monitored Maintenance:** Monitored maintenance involves periodic surveillance and testing of equipment. A surveillance schedule is established based on predictions of the wear rates of certain types of equipment or materials. For example, you may change the oil in your car every 2,000 miles (scheduled maintenance), while you may check the oil level every other week and add oil as needed (monitored maintenance).

All preventive maintenance activities should be recorded along with the observations made by personnel. Routine observations provide the information needed to identify trends that could indicate that serious problems are developing. Identifying problems before they become serious is an important part of preventive maintenance.

Extraordinary Maintenance

Extraordinary Maintenance is maintenance that is performed on an as-needed basis. Extraordinary maintenance includes repairs, rehabilitation, or improvements.

Continued . . .

Extraordinary Maintenance (Continued)

The need for extraordinary maintenance may be identified:

- **During the performance of preventive maintenance.**

  For example, while lubricating the lifting assembly of a gate, you notice that repairs will need to be made because of breakage of a gate stem guide.

- **As a result of a dam safety or O&M inspection/evaluation.**

  For example, a dam safety or O&M inspection/evaluation may identify the need to repair an inoperable spillway gate.

- **After a major event.**

  For example, a large spillway release may erode an earth-lined emergency spillway channel.

Extraordinary maintenance may require that you get outside help from qualified persons. Regulatory agencies often must review and approve major repairs, rehabilitation, or improvements. This approval process helps to ensure that the safety of the dam will not be adversely affected by the repair, rehabilitation, or improvements to be implemented.

Preventive Maintenance vs Extraordinary Maintenance

The need for some extraordinary maintenance can be reduced by an effective preventive maintenance program. One can usually avoid breakdown maintenance by an effective preventive maintenance program.

Extraordinary maintenance can be costly. For example, when a part fails, it may destroy the equipment that is associated with that defective part. If the defective part is changed before the failure occurs, the related equipment will not be damaged. The need to replace or repair major pieces of equipment can be reduced through proper preventive maintenance. Figure I-1 shows the relationship between preventive maintenance expenditures and unanticipated equipment breakdowns.

Preventive maintenance requires that you spend money now to save money in the future. The resources spent on preventive maintenance have been shown to help reduce the costs associated with extraordinary maintenance.

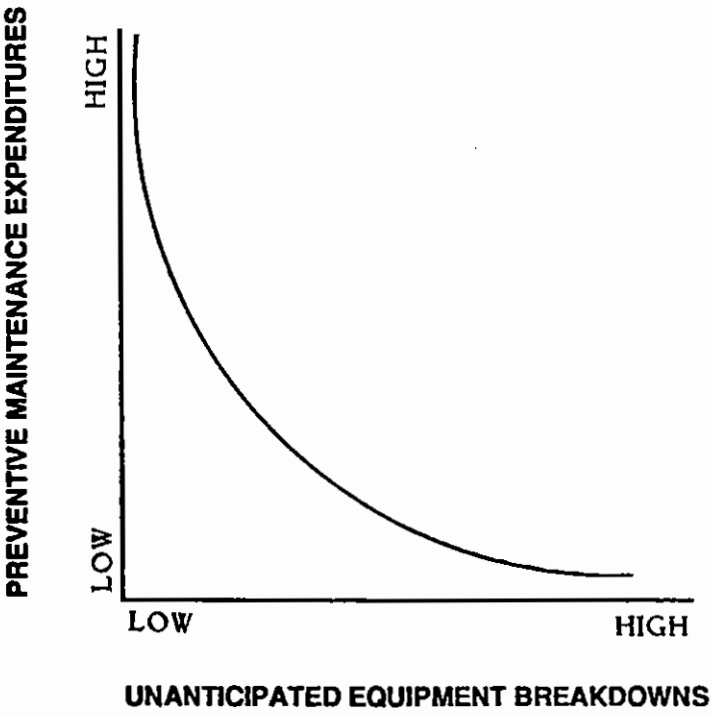
Also, preventive maintenance helps to ensure that your facility is safe for your workers and the public. Safety is an important return-on-investment gained from investing in preventive maintenance.

☞ **Remember . . . An effective O&M Program practices preventive maintenance.**

Continued . . .

Preventive Maintenance vs Extraordinary Maintenance (Continued)

FIGURE I-1. PREVENTIVE MAINTENANCE AND EQUIPMENT BREAKDOWN



HOW ARE OPERATION AND MAINTENANCE RELATED?

Operation and maintenance are related to one another. Improper operation of the dam and its appurtenances can increase the need for preventive maintenance or can require that extraordinary maintenance be performed.

☞ **EXAMPLE:** If a gate is operated incorrectly, the gate structure or hoisting equipment can be damaged. In this case, improper operation may lead to the need for costly repair of the gate.

Conversely, lack of proper maintenance can cause operational problems.

☞ **EXAMPLE:** If the lifting assembly of a gate is not lubricated properly, the gate may not operate when needed. In this case, a lack of maintenance can cause a serious operation problem and may jeopardize the safety of the dam.

I. OVERVIEW: WHAT IS AN O&M PROGRAM?

HOW ARE O&M AND DAM SAFETY RELATED?

O&M helps to ensure dam safety. An effective O&M Program ensures that the dam will be operated and maintained according to design standards and established safety regulations. When a dam is operated and maintained according to standards and regulations, it is a safer dam.

O&M personnel can play an important role in the dam safety process. O&M personnel are in a unique position to observe changing conditions at the dam site. Since O&M personnel are frequently at the site, they often are the first individuals to see changes in conditions.

Also, O&M personnel inspect the dam and its appurtenances as part of their preventive maintenance tasks. Although these inspections are for O&M purposes, dam safety deficiencies may be observed. O&M personnel can contribute to dam safety by recording their observations and informing dam safety inspection personnel or other appropriate authorities of conditions that could indicate potential dam safety deficiencies.

Finally, some O&M personnel have dam safety responsibilities in addition to their O&M responsibilities. O&M personnel may be responsible for conducting routine dam safety inspections. This type of dam safety inspection is often conducted on a set schedule or in conjunction with other routine O&M activities. A routine dam safety inspection is a visual inspection focusing on the current conditions of the dam and its features.

Remember . . . All O&M personnel can contribute to dam safety by following proper O&M procedures and reporting any changes in conditions at the dam site.

For more information on identifying potential dam safety deficiencies, see the TADS module entitled Identification Of Visual Dam Safety Deficiencies.

I. OVERVIEW: WHY ORGANIZE AN O&M PROGRAM?

INTRODUCTION

O&M Programs are important because they protect the dam, downstream communities or area, and personnel who work at the dam. Also, O&M Programs help owners and operators achieve important goals.

WHAT ARE THE GOALS OF AN O&M PROGRAM?

The goals of an O&M Program are to help dam owners and operators to . . .

- Ensure the safe operation of the dam.
- Extend the useful life and achieve the intended purposes of the dam.
- Protect the environment.
- Protect investments.
- Promote cost-efficient operation.
- Meet legal and social obligations.

A review of the goals of an O&M Program and the resulting benefits is presented in this section. Some of the benefits of O&M Programs have been discussed in the previous section of this unit.

Ensure The Safe Operation Of The Dam

An effective O&M Program can help to ensure that the dam is safe. The safe operation of the dam helps to protect life and property downstream of the dam. Also, a well-maintained dam is safer for dam personnel.

Extend The Useful Life And Achieve The Intended Purposes Of The Dam

The reasons for having an O&M Program will vary depending upon the authorized purposes of the dam. Some of the purposes include: recreation, power generation, irrigation, flood control, fish and wildlife management, and municipal/industrial use. An O&M Program can help to ensure that the dam can achieve its intended purposes for as long as practical. These benefits will continue to accrue as a dam's useful life is extended.

Protect The Environment

An O&M Program can help preserve fish and wildlife habitats in the areas that the facility affects. Dam failures are very damaging to the environment. An effective O&M Program can help to prevent dam failures.

Protect Investments

A dam represents an investment and, as such, it should be protected. An effective O&M Program is one means of protecting that investment.

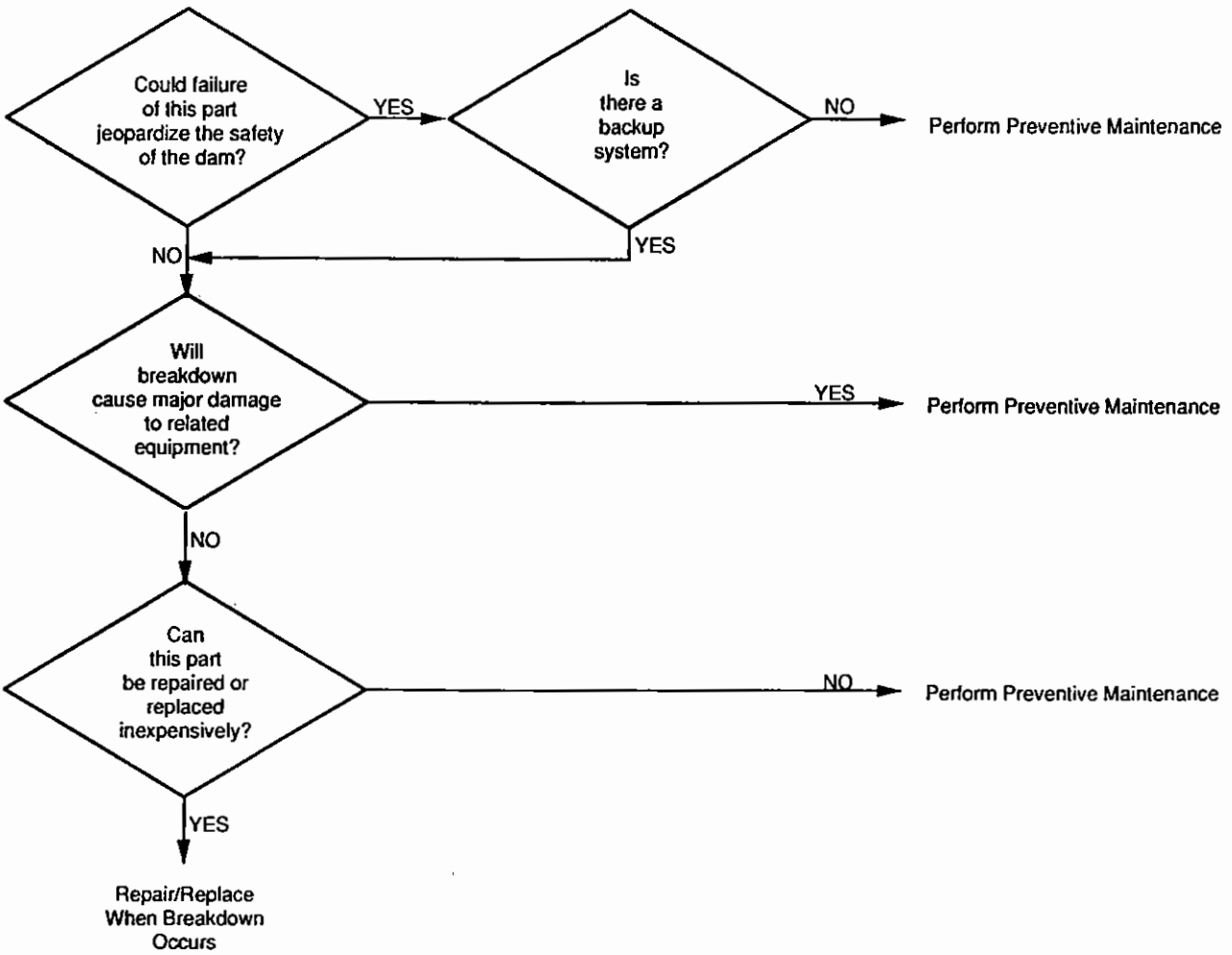
I. OVERVIEW: WHY ORGANIZE AN O&M PROGRAM?

Promote Cost-Efficient Operation

An O&M Program that promotes preventive maintenance can help to avoid some extraordinary maintenance. Avoiding extraordinary maintenance can result in long-term cost savings.

An effective O&M Program ensures that maintenance work is performed economically. Cost-efficient operations balance the costs of preventive maintenance with the costs of repairs or replacement. It would be a waste of time and money to maintain parts that are inexpensive to replace or repair when they fail (as long as their failure does not jeopardize the safety of the dam, personnel, or property). Conversely, it is cost-efficient to maintain parts that are costly to replace or repair. However, regardless of costs, it is imperative to maintain all parts that could jeopardize the safety of the dam if they did not function properly. Figure I-2 shows the factors to consider when judging the cost-efficiency of O&M activities.

FIGURE I-2. MAKING COST-EFFICIENCY DECISIONS



I. OVERVIEW: WHY ORGANIZE AN O&M PROGRAM?

Meet Legal And Social Obligations

Dam owners and operators have certain social and legal obligations that they are required to meet.

- **Legal Obligations:** Owners and operators may have to comply with requirements contained in . . .

  - Federal, State, and local regulations
  - Land and water rights and rules
  - Water service and supply contracts

  In addition, owners and operators are liable for any damage that results from a dam failure. Owners and operators must try to prevent dam failures. An effective O&M Program can help to prevent dam failure by preventing the development of some types of dam safety deficiencies.

- **Social Obligations:** An effective O&M Program will help to maintain a good appearance and enable community members to enjoy the benefits of the dam and the reservoir.

I. OVERVIEW: HOW IS AN O&M PROGRAM ORGANIZED?

INTRODUCTION

You may be saying: "O.K., I'm sold on the idea. How do I begin?" Organizing an O&M Program requires good planning and management skills.

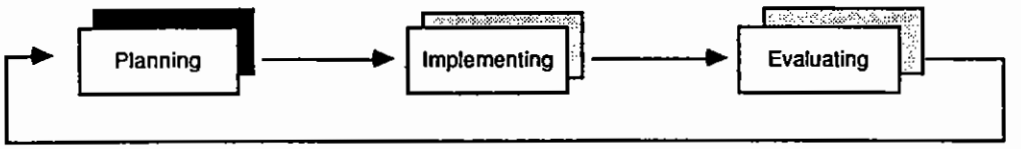
The process presented in this module describes how to organize an "ideal" or model O&M Program. It may not be realistic for every dam owner and operator to implement all aspects of the O&M Program described in this module. Financial constraints may limit the scope of an O&M Program. Or, a simple dam structure with a low hazard rating may warrant that a simplified O&M Program be implemented.

However, all dams--simple or complex, small or large--need to have established O&M Programs! The O&M Program should match the unique requirements of the dam site.

The same process is used to organize an O&M Program for dam sites with different O&M requirements. The steps in the process and resulting documentation may be simpler for a dam site with less complex O&M requirements.

This section presents a brief overview of the process used to organize an O&M Program. The information presented in this section may be sufficient if your O&M requirements are simple. However, if your O&M requirements are not simple, or if you want more information about a specific area, you should read the remaining units. The remaining units will provide guidance on each phase of organizing an O&M Program.

PHASE I: PLANNING AN O&M PROGRAM



The first phase in the process is **Planning.** In the planning phase, the following steps are completed:

Step 1: Identify the O&M activities to be performed.

The first step in the planning process is to identify the O&M activities to be performed. Identifying the O&M activities to be performed involves:

- Reviewing pertinent information in order to identify O&M requirements.
- Developing a description of the dam and its appurtenances in order to gain a full understanding of the dam site and its O&M requirements.
- Identifying the routine O&M tasks to be performed.

Page references: II-2 through II-15
Appendix A presents a list of sample O&M tasks.

I. OVERVIEW: HOW IS AN O&M PROGRAM ORGANIZED?

PHASE 1: PLANNING AN O&M PROGRAM (Continued)

Step 2: Develop operating procedures.

The second step in the planning process is to develop operating procedures. Operating procedures are step-by-step instructions for operating the dam and reservoir. Operating procedures are developed for both normal operations and emergency operations.

The operating procedures developed for normal or "day-to-day" operations include the following:

- Instructions for operating all operable mechanisms.
- Instructions for operating the reservoir.
- General instructions for the safe operation of the facility.

Operating procedures used to handle emergency situations may be contained in a separate document called an Emergency Action Plan.

Page references: II-16 through II-27

Step 3: Establish recordkeeping systems.

The third step in the planning process is to establish an O&M recordkeeping system. Typically, records maintained by O&M Programs include:

- O&M activities completed by O&M personnel
- Observations made by O&M personnel
- Data collected by O&M personnel
- Equipment, tools, and spare parts inventories
- Budget data
- Personnel records
- Visitor records

The most common types of recordkeeping systems include: checklists, logs, card files, and computerized records.

Page references: II-28 through II-40

Examples of checklists, logs, and card files are presented on pages II-30, II-33, II-34, and II-36.

I. OVERVIEW: HOW IS AN O&M PROGRAM ORGANIZED?

PHASE 1: PLANNING AN O&M PROGRAM (Continued)

Step 4: Write an O&M Plan.

The final planning step is to write an O&M Plan. An O&M Plan should include:

- O&M tasks to be performed and the frequency with which the tasks will be performed.
- The operating procedures to be followed.
- Records to be maintained.

O&M personnel should have quick access to the O&M Plan. All O&M personnel should review the O&M Plan at least once per year.

Page references: II-41 through II-45

PHASE 2: IMPLEMENTING AN O&M PROGRAM

The second phase in the process is **Implementation.** In the implementation phase, the following steps are completed:

Step 1: Secure resources.

The first step in implementing an O&M Program is to secure the resources needed to accomplish the O&M Plan. Securing resources involves:

- Estimating costs, including . . .
  - Annual costs (e.g., personnel, equipment, etc.)
  - Repair, replacement, and overhaul costs
  - Emergency and unanticipated costs
- Developing an O&M budget.
- Securing funding from sources such as . . .
  - Your agency/organization
  - User fees
  - Tax or membership assessments

I. OVERVIEW: HOW IS AN O&M PROGRAM ORGANIZED?

PHASE 2: IMPLEMENTING AN O&M PROGRAM (Continued)

Step 1: Secure resources. (Continued)

Your agency or State dam safety program may be able to help you identify potential O&M funding sources.

Page references: III-2 through III-7

Appendix B presents three sample O&M budgets. These budgets may include more items than are needed to meet the unique O&M requirements of your facility. The budgets can be used to make you aware of all the possible costs that can be associated with the operation of an O&M Program.

Step 2: Administer the O&M Program.

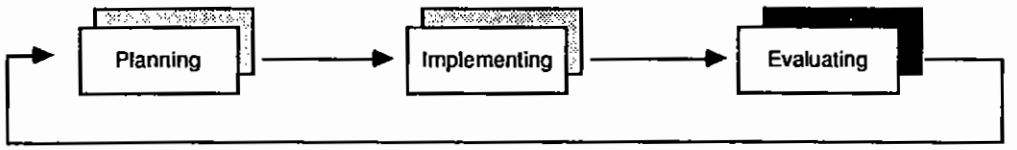
The second step in implementing an O&M Program is to administer the O&M Program. Administering an O&M Program involves the management of:

- In-house and contract personnel, including . . .
  - Assigning work
  - Scheduling work
  - Monitoring work performance
  - Troubleshooting work performance problems
  - Training personnel
- Resources, including purchasing and controlling . . .
  - Tools
  - Equipment
  - Supplies
- Information, by keeping the records and systems current.

Page references: III-8 through III-19

I. OVERVIEW: HOW IS AN O&M PROGRAM ORGANIZED?

PHASE 3: EVALUATING AN O&M PROGRAM



The third phase in the process is **Evaluation.** In the evaluation phase, the following steps are completed:

Step 1: Identify evaluation standards.

The first step in the evaluation process is to develop the standard or "yardstick" against which you measure the effectiveness of your O&M Program.

Page references: IV-2 through IV-3

Step 2: Collect evaluation information.

The second step in the evaluation process is to collect information in order to determine how well your O&M Program has met the selected evaluation standards. You should be able to collect most of the needed information from your O&M records.

Page references: IV-4 through IV-5

Step 3: Assess O&M Program effectiveness.

The final step in the evaluation process is to assess how effective your O&M Program was at meeting the evaluation standards.

Page references: IV-6 through IV-7

Remember, if your O&M requirements are not simple, or if you want more information about a specific area, you should read the remaining units. If you do not plan to read the remaining units, you should skim through the entire text and read those areas that are relevant to your O&M needs. Although the information presented in this module may be representative of the "ideal" O&M Program, there is no reason that all O&M Programs should not strive to achieve the "ideal."

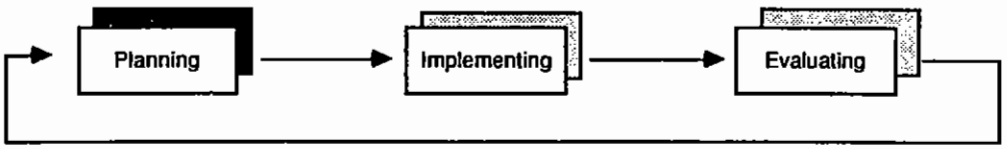
UNIT II

PLANNING AN O&M PROGRAM

II. PLANNING AN O&M PROGRAM: OVERVIEW

INTRODUCTION

"Plans are nothing; planning is everything."
- Dwight D. Eisenhower



The first phase of organizing an O&M Program is **Planning.** Good planning is a key to an effective O&M Program. Although it is important to document your O&M Program in a plan, the thinking that goes into developing the plan is far more important than the plan itself.

This unit will present guidance on how to plan an O&M Program. If you already have an O&M Program, the material presented in this unit can be used to help you revise or update your program.

O&M PLANNING STEPS

The following steps are used to plan an O&M Program . . .

Step 1: Identify the O&M activities to be performed.

Step 2: Develop operating procedures.

Step 3: Establish recordkeeping systems.

Step 4: Write an O&M plan.

Next, each step will be discussed.

II. PLANNING AN O&M PROGRAM: IDENTIFY THE O&M ACTIVITIES

INTRODUCTION

The first step in the planning process is to identify the O&M activities to be performed. Identifying the O&M activities to be performed involves . . .

- Reviewing pertinent information.
- Developing a description of the dam and its appurtenances.
- Identifying the routine O&M tasks to be performed.

REVIEWING PERTINENT INFORMATION

The planning process begins by assembling and reviewing all pertinent information that is available about the dam. The information that is available may vary from dam to dam. The following list includes examples of the types of materials you may want to review.

Source . . .	Information Provided . . .
Plans, Design Specifications, and Drawings	. Descriptions of the dam and its appurtenances. . Types and location of equipment and instrumentation.
Construction Records and Photographs	. Descriptions of materials used during construction. . Descriptions of the methods used to build the dam and install equipment. . Descriptions of problems encountered during construction. . As-built drawings of the dam and its appurtenances.
Repair and Modification Records	. Descriptions of all post-construction repairs or changes made to the dam and its appurtenances.
Equipment Operating and Maintenance Instructions (Manufacturers' Instructions)	. Descriptions of the equipment installed at the dam site. . Instructions for operating and maintaining the equipment.
Designers' Operating Criteria (DOC)	. Criteria for operating the dam and its appurtenances established by the designers. . Any operating restrictions imposed by the designers.

Continued . . .

II. PLANNING AN O&M PROGRAM: IDENTIFY THE O&M ACTIVITIES

REVIEWING PERTINENT INFORMATION (Continued)

Source . . .	Information Provided . . .
Standing Operating Procedures (SOP)	. Procedures for maintaining and operating equipment at the dam. . Operating procedures to be used in case of an emergency.
Reservoir Operation Records	. Data about the reservoir elevation, inflow, and releases.
Dam Safety Inspection and O&M Inspection Reports	. Descriptions of past dam safety deficiencies and corrective actions taken. . Descriptions of past O&M deficiencies and corrective actions taken. . Recommended corrective actions yet to be taken.
Correspondence Pertaining to O&M Activities	. Miscellaneous information about operation of equipment and other post-construction maintenance problems.

Reviewing available information can help you begin to develop a picture of the O&M needs of the dam site. When reviewing the information, you may want to ask yourself:

☞ **Are there any special O&M requirements . . .**

- Based on the dam's design?
- Because of the construction methods or types of materials used?
- Due to the past or current conditions of the dam and its appurtenances?
- Because of the types of equipment or instrumentation installed at the dam site?
- Based on the established operating procedures or emergency operating procedures?

☞ **What other information should I know before identifying the O&M activities to be performed? Where can I get this information?**

Once you are confident that you are familiar with the dam and its operation, then you are ready to complete the next activity.

II. PLANNING AN O&M PROGRAM: IDENTIFY THE O&M ACTIVITIES

DEVELOPING A DESCRIPTION OF THE DAM AND ITS APPURTENANCES

The next activity is to develop a comprehensive description of the dam and its appurtenances. Developing a description of the dam and its appurtenances allows you to gain an understanding of the potential O&M needs. An effective O&M program is based on a complete and accurate understanding of the structures and equipment to be maintained and operated.

There may be an existing description of the dam. If a description of the dam already exists, you should use the information presented in this section to review the description of the dam and to make sure it is complete and accurate.

The description of the dam should include the following information:

The Dam . . .

- Age of the dam.
- Type of dam (e.g., embankment, concrete gravity, etc.).
- Exterior dimensions and configuration.
- Location of the dam and access routes.
- Hazard classification.

The Appurtenant Structures . . .

- Types of appurtenant structures (e.g., spillways, outlet works, and gates/valves).
- The location of each appurtenant structure.
- Description of the physical characteristics and dimensions of each appurtenant structure.
- Flow capacities of each appurtenant structure.

Mechanical Systems . . .

- Electrical System
- Hydraulic System
- Heating and Ventilation System
- Cathodic Protection System

The Reservoir . . .

- Reservoir areas and associated storage capacities.
- Reservoir operating elevations.

Table II-1 on the following pages presents sample descriptions of two dams and their appurtenant structures.

Continued . . .

II. PLANNING AN O&M PROGRAM: IDENTIFY THE O&M ACTIVITIES

DEVELOPING A DESCRIPTION OF THE DAM AND ITS APPURTENANCES (Continued)

TABLE II-1a. SAMPLE DESCRIPTION OF A LARGE DAM AND ITS APPURTENANCES

THE DAM: BIG CREEK DAM

Age: Big Creek Dam was constructed from 1970 to 1973.

Type Of Dam: The dam is a zoned embankment-type structure with a maximum height of approximately 231 feet and has a deep cut-off trench along its axis which has a maximum depth of 75 feet. The crest length of the dam is approximately 5,000 feet and it is at elevation 9,031.00. The upstream slope is 2.5:1 and the downstream slope is 2:1. The embankment consists of an impervious core, an upstream shell of pervious material, and a downstream shell of semipervious material.

Location And Access: Big Creek Dam is located on the McGee River approximately 35 miles west of Weltsville, and approximately 34 miles southeast of Charleston, Colorado. Access to Big Creek Dam from Charleston is as follows:

(1) Country Route 333, an all-weather, well-maintained, paved road to Burton.
(2) Burton Road, an all-weather, well-maintained, paved road through the town of Clinton to Barnum Junction.
(3) At Barnum Junction take the Low Road, a gravel-surfaced road, to the dam.

A municipal airport operates in the north part of Charleston County. Helicopter access to the dam site is possible. A helicopter can be leased at the Charleston County Airport.

Hazard Classification: Big Creek Dam is classified as having a high hazard potential for both loss of life and economic loss in the event of failure.

Continued . . .

DEVELOPING A DESCRIPTION OF THE DAM AND ITS APPURTENANCES (Continued)

TABLE II-1a. SAMPLE DESCRIPTION OF A LARGE DAM AND ITS APPURTENANCES (Continued)

BIG CREEK DAM: APPURTENANT STRUCTURES

Outlet Works: Intake

The intake to the outlet works consists of a concrete structure and a fixed-wheel gate which is located in the bottom of the reservoir near the original bed of the McGee River.

The concrete structure is about 60 feet long, 25 feet wide, and 53 feet high. The top of the structure is at elevation 8,844.00 and the tracks for the gate are at elevation 8,816.50. The opening to the structure is in the horizontal plane at elevation 8,829.00 and is enclosed by vertical and horizontal trashracks.

The fixed-wheel gate is 15 feet 6 inches square and effects closure of the 15-foot diameter circular opening in the intake structure. The gate is of welded construction, is supported by twelve fixed wheels running on tracks rigidly attached to the gate frame, and is mounted in the horizontal position. The concrete compartment housing the gate and its hydraulic hoist is covered on top with precast concrete slabs.

Outlet Works: Tunnel And Gates

The tunnel is a concrete-lined structure 15 feet in diameter and approximately 1,825 feet long. It extends westward from the intake structure to the left abutment of the dam where it makes a 90-degree bend and then goes northward to the stilling basin that connects to the McGee River downstream of the dam. The tunnel passes directly under the Gate Chamber where it is divided into three channels in which the outlet gates and penstock gates are positioned. These outlet gates are operated by means of integral hydraulic hoists connected through piping to the hydraulic power unit located in the Control House. The shaft spillway intersects the tunnel just downstream of the Gate Chamber.

The outlet gates consist of four high-pressure slide gates of which two are used as control gates and two as guard gates. They are installed in series in two outlet conduits in the tunnel. The four outlet gates are 4 feet by 5 feet in size and the gate sets are installed in each of the outside tunnel channels. These gates may be operated from both the Control House Control Cabinet and the Gate Chamber Control Cabinet.

Continued . . .

DEVELOPING A DESCRIPTION OF THE DAM AND ITS APPURTENANCES (Continued)

TABLE II-1a. SAMPLE DESCRIPTION OF A LARGE DAM AND ITS APPURTENANCES (Continued)

BIG CREEK DAM: APPURTENANT STRUCTURES

Outlet Works: Tunnel And Gates (Continued)

The penstock guard gate and control gate are each 2 feet 3 inches square and are both installed in series in the center tunnel channel with the guard gate located on the upstream side of the control gate.

All 3 sets of gates are provided with 2-inch fill lines to equalize pressure on both sides of each guard gate. The two 4-foot x 5-foot control gates are each provided with a 6-inch bypass line. In addition, each 4-foot x 5-foot control gate is provided with a feed line to allow insertion of sawdust or other suitable sealant agent on the upstream side of each control gate.

A 24-inch diameter, No. 7 U.S. Standard gauge air vent pipe is installed from the Control House to the tunnel between the Gate Chamber and in the intersection of the spillway with the tunnel. Air is provided through the vent pipe to the tunnel wall and in the gate recesses to prevent cavitation and subsequent structure damage which would otherwise occur under some operating conditions. The schematic diagram of this piping is shown on Drawing S1-21, and the piping layout in the gate chamber is shown on Drawings DR247 No. 4 sheets 5, 7, and 9.

Outlet Works: Control House, Access Shaft, And Gate Chamber Structure

The Control House is a concrete building approximately 18 feet by 21 feet and 15 feet high. The building floor is at elevation 9031.5 and it is located on the left abutment of the dam between Highway 1 and the reservoir a short distance upstream of the axis of the dam. The Control House contains the electrical cabinet, the hydraulic cabinet, and the ventilating unit together with their associated control equipment.

The entrance to the access shaft is inside the Control House and extends downward to elevation 8804.60 where it continues horizontally about 50 feet eastward to the Gate Chamber. The access shaft is concrete lined and contains a ladder with landings about every 29 feet, the hydraulic piping, the electrical wiring, the Gate Chamber ventilation duct, the tunnel vent pipe, riser pipe for the reservoir water level indicator, and a cable-hoisted elevator with a 1200-lb capacity. The vertical portion of the shaft is 8 feet in diameter while the horizontal portion is 6 feet wide by 8 feet high at the center having a 3-foot radius arch above the 5-foot high vertical walls.

Continued . . .

DEVELOPING A DESCRIPTION OF THE DAM AND ITS APPURTENANCES (Continued)

TABLE II-1a. SAMPLE DESCRIPTION OF A LARGE DAM AND ITS APPURTENANCES (Continued)

BIG CREEK DAM: APPURTENANT STRUCTURES

Outlet Works: Control House, Access Shaft, And Gate Chamber Structure (Continued)

The Gate Chamber is 30 feet by 22 feet with the floor at elevation 8796.33. The Gate Chamber contains the gate hoists and the electrical control cabinet together with the hydraulic and electrical connections to the equipment.

Outlet Works: Return Channel

The stilling basin transition connects to the downstream terminus of the tunnel and is a concrete structure 62 feet long by 26 feet wide and varies from 21 feet to 38 feet in depth. The stilling basin is constructed just downstream of, and is connected to, the transition section. It is a concrete structure 80 feet long by 22 feet wide and varies in depth from 36 feet to 25 feet. The sides of the stilling basin are formed by concrete gravity walls which vary in thickness from 2 feet at the top to 26 feet at the bottom. A channel has been constructed to connect the stilling basin to the original bed of the McGee River and is some 200 feet in length joining the original watercourse at its first bend below the dam.

Spillway

The spillway is of the shaft type with an uncontrolled crest at elevation 9017.00. The spillway has a hydraulic capacity of 15,000 cfs at a reservoir elevation of 9025.0. It is concrete lined, has an inside diameter of 15 feet, and extends vertically downward to elevation 8866.32 where it makes a 90-degree bend northward to intersect the tunnel just downstream of the Gate Chamber.

MECHANICAL SYSTEMS

Electrical System

The electrical system consists of the main power supply, the branch circuit wiring, the lighting system, the control system wiring, and the grounding installation.

Continued . . .

DEVELOPING A DESCRIPTION OF THE DAM AND ITS APPURTENANCES (Continued)

TABLE II-1a. SAMPLE DESCRIPTION OF A LARGE DAM AND ITS APPURTENANCES (Continued)

BIG CREEK DAM: MECHANICAL SYSTEMS

Hydraulic System

The hydraulic system consists of a hydraulic power unit and the necessary piping to connect to the cylinder of each gate hoist. The power unit is contained in a metal cabinet and includes the electrical motor and pump as well as the required piping, valves, fittings, gauges, and electrical components.

BIG CREEK DAM: RESERVOIR

The reservoir formed by Big Creek Dam, when at full level, will extend approximately 1-1/2 miles southward from the dam and will be approximately 3 miles wide; however, fingers will protrude along the bed of the Snake River, the McGee River, and Ten-Mile Creek for additional distances as shown on Drawing S1-1. The reservoir has a total storage capacity of 261,800 acre-feet, of which 254,036 acre-feet will form operating storage above the level of the intake to the tunnel. With this capacity, the full reservoir water surface will be at an elevation of 9,017 feet above sea level, which is 14 feet below the crest of the dam.

Reservoir-Level Gauge

The reservoir-level measuring equipment consists of a riser pipe, two 3/4-inch copper intake pipes, and a measuring instrument.

The 3/4-inch intake pipes originate near the intake gate on the side of the concrete structure just below the trashrack. The openings are covered with screens to help prevent debris from entering and clogging the pipes. The pipes extend to the Gate Chamber where each is equipped with two gate valves with a blow-out tee between and are then routed to the bottom of the access shaft where they connect to the 3-inch riser pipe at elevation 8810.20.

The riser pipe extends upward through the access shaft to elevation 9032.00 where it connects to a 4-inch pipe stand that supports the measuring instrument which is at elevation 9035.00 in the Control House. The instrument consists of a step-down transformer and ammeter, a resistor, and a conducting tape and weight which extend downward into the 3-inch riser pipe.

II. PLANNING AN O&M PROGRAM: IDENTIFY THE O&M ACTIVITIES

DEVELOPING A DESCRIPTION OF THE DAM AND ITS APPURTENANCES (Continued)

TABLE II-1b. SAMPLE DESCRIPTION OF A SMALL DAM AND ITS APPURTENANCES

THE DAM: LITTLE CREEK DAM

Age: Little Creek Dam was constructed in 1960.

Type Of Dam: The dam is a homogeneous embankment type dam with a maximum height of approximately 45 feet. The embankment crest is at elevation 2021.0 with a crest length of approximately 500 feet. The upstream slope is 2.5:1 and the downstream slope averages 2:1. The embankment consists of a silty-clay borrowed from the reservoir area and nearby hillside slopes.

Location And Access: Little Creek Dam is located on the Little Creek tributary of Little Sandy Run approximately 2 miles northwest of Smalltown, Virginia. Access to Little Creek Dam from Smalltown is as follows:

(1) Country Route 111, an all-weather, well maintained, paved road to Smalltown.
(2) Sandy Run Road, a two-lane, medium duty road, north one mile to Little Creek Road.
(3) Turn west on Little Creek Road, a poorly maintained gravel road, to the dam.

Hazard Classification: Little Creek Dam is classified as having a high hazard potential for both loss of life and property in the event of failure.

LITTLE CREEK DAM: APPURTENANT STRUCTURES

Primary Spillway: Intake

The inlet to the primary spillway pipe is located at the top of a concrete riser in the reservoir about 40 feet upstream of the reservoir waterline near the right abutment of the dam (looking downstream). The concrete riser is a square box measuring 5 feet by 5 feet with a trash rack and anti-vortex plate located above the inlet weir. A sliding gate exists on the riser at the elevation of the original streambed on the upstream face of the riser. The gate measures 3 feet by 3 feet when fully opened and is operated by a wheel stem located on the upstream crest of the riser.

Continued . . .

DEVELOPING A DESCRIPTION OF THE DAM AND ITS APPURTENANCES (Continued)

TABLE II-1b. SAMPLE DESCRIPTION OF A SMALL DAM AND ITS APPURTENANCES (Continued)

LITTLE CREEK DAM: APPURTENANT STRUCTURES

Primary Spillway: Conduit And Plunge Pool

The primary spillway conduit is a 36 inch concrete pipe jointed every 4 feet and is approximately 240 feet long. The pipe discharges into a riprap lined plunge pool at the downstream toe near the right abutment of the dam. The plunge pool measures approximately 30 feet by 50 feet and is lined with 30 inch average diameter size sandstone riprap.

Auxiliary (Emergency) Spillway

An auxiliary spillway open channel exists at the left abutment of the dam. The invert of the channel is at elevation 2017.5. The channel has 2:1 side slopes, is cut in the natural rock of the hillside and is grass lined. The auxiliary spillway outlets into a natural drainway below the downstream toe of the dam.

LITTLE CREEK DAM: RESERVOIR

The reservoir formed by the Little Creek Dam, at normal reservoir level, extends approximately 6000 feet northwest from the dam and is approximately 400 feet wide, tapering to a 10 foot wide stream channel at the upstream end. The reservoir has a normal reservoir storage capacity of 60 acre-feet and a maximum storage capacity at the top of the dam of 90 acre-feet. Normal reservoir elevation is 2016.0 and maximum reservoir elevation is 2021.0.

Reservoir-Level Gauge

The reservoir measuring equipment consists of a wooden staff gauge bolted to the downstream side of the concrete riser tower and is calibrated in feet above sea level.

II. PLANNING AN O&M PROGRAM: IDENTIFY THE O&M ACTIVITIES

IDENTIFYING THE ROUTINE O&M TASKS TO BE PERFORMED

After you have a complete picture of the dam and its appurtenant structures and are familiar with the past and current conditions of the dam, you are ready to identify the routine O&M tasks to be performed.

Routine O&M tasks should be identified for all of the components of the dam. As an example, the O&M tasks identified for the Hydraulic System used at Big Creek Dam and the Riser System at Little Creek Dam are presented in Table II-2.

TABLE II-2. SAMPLE O&M TASKS

EXAMPLE #1

COMPONENT: HYDRAULIC SYSTEM

Tasks	Frequency
Monitored Maintenance: Check visible portions of the hydraulic piping, valves, connections, and power unit for signs of leaking, damage, or deterioration. Make any necessary repairs.	Quarterly
Monitored Maintenance: Open the oil tank to check for dirt, moisture, or other foreign materials. Filter the oil and replace the oil filter if contaminated.	Annually
Scheduled Maintenance: Remove and clean (or replace) all filters and strainers.	Annually
Open the hydraulic cabinet and remove all dust and dirt from all equipment and wiring inside the unit. Cleaning of electrical components should be done with low air pressure. Check the condition of all electrical components while cleaning inside the cabinet.	
Operational Testing: Operate all valves through full travel and flow conditions. Check the flow of oil. Start the pump and check all pump operation controls. Check hydraulic lines and connections for leaks and excessive air. All electrical relays should be operated several times, under load if possible.	Annually

Continued . . .

II. PLANNING AN O&M PROGRAM: IDENTIFY THE O&M ACTIVITIES

IDENTIFYING THE ROUTINE O&M TASKS TO BE PERFORMED (Continued)

TABLE II-2. SAMPLE O&M TASKS
(Continued)

EXAMPLE #2

COMPONENT: RISER SYSTEM

Tasks	Frequency
Monitored Maintenance: Check and clean trashrack and riser area.	Monthly
Monitored Maintenance: Check concrete riser for cracking, spalling, or deflection. Make any necessary repairs using approved sealants or concrete.	Quarterly
Scheduled Maintenance: Lubricate all grease fittings on the drain gate operating mechanism.	Semi-Annually
Operational Maintenance: Exercise drain gate by opening fully and maintaining full pipe flow for 10 minutes.	Annually

II. PLANNING AN O&M PROGRAM: IDENTIFY THE O&M ACTIVITIES

Resources

There are several resources available to help you identify the routine O&M tasks to be performed. These resources include:

Reference Materials . . .

- **Appendix A Of This Document:** Appendix A of this document presents a list of sample O&M tasks. The tasks included in Appendix A are examples of common O&M tasks. Every facility has site-specific O&M tasks that should be performed. Also, you may want to be more specific about the procedures to be used at your facility.

- **Equipment Operating And Maintenance Instructions (Manufacturer's Instructions) And Standing Operating Procedures:** You should check the information presented in these documents when identifying routine O&M tasks.

- **Project Operation Maintenance Guide:** The Corp of Engineers has a document titled Project Operation Maintenance Guide (ER 1130-2-303, 15 DEC 67) that provides a comprehensive list of O&M tasks to be performed.

- **Operation And Maintenance Guidelines For Small Dams:** The Bureau of Reclamation has a document titled Operation And Maintenance Guidelines For Small Dams (December 1982) that provides minimum standards for performing O&M tasks on embankment, concrete, and masonry dams up to a maximum of about 75 feet in height.

- **National Operation And Maintenance Manual:** The Soil Conservation Service provides guidelines for developing O&M plans in their National Operation And Maintenance Manual (180-V).

Technical Assistance . . .

If your organization does not have O&M expertise, you may want to get assistance from the following sources:

- **State Dam Safety Program:** Personnel in your state's dam safety program are available to help you plan your O&M program.

- **Soil Conservation Service:** Also, you may want to contact the nearest Soil Conservation Service field office for assistance.

II. PLANNING AN O&M PROGRAM: IDENTIFY THE O&M ACTIVITIES

Checking Your O&M Tasks

Make sure that your list of O&M tasks is comprehensive. Make sure that you have . . .

- ✓ Considered the O&M needs of the entire dam site.
- ✓ Included O&M tasks that will help to ensure the safety of the dam, downstream communities and area, and operating personnel.

Also make sure that each task . . .

- ✓ Is clear and specific.
- ✓ Includes a frequency and timeframe for completing the task.

DEVELOPING O&M PROCEDURES

After the O&M tasks have been identified, the next step is to develop operating procedures. Maintenance procedures are specific to the equipment and site. Therefore, the development of maintenance procedures is not covered in this module.

II. PLANNING AN O&M PROGRAM: DEVELOP OPERATING PROCEDURES

INTRODUCTION

Operating procedures are step-by-step instructions for operating the dam and reservoir. Operating procedures are developed based on:

- The Designers' Operating Criteria (DOC)
- Equipment Operating and Maintenance Instructions (Manufacturers' Instructions)

Operating procedures are developed for both normal operations and emergency operations.

DEVELOPING OPERATING PROCEDURES: NORMAL OPERATIONS

The operating procedures developed for normal or "day-to-day" operations include the following . . .

- Instructions for operating all operable mechanisms.
- Instructions for operating the reservoir.
- General instructions for the safe operation of the facility.

Develop Instructions For Operating All Operable Mechanisms

Instructions should be developed for operating all operable mechanisms at the facility. These instructions must be based on the instructions provided by manufacturers and the information contained in the DOC.

The operating instructions should. . . .

- State the proper sequences to be followed when operating each mechanism and identify all buttons to be pushed, handles to be cranked, switches to be activated, etc.

- Provide special instructions for operating mechanisms affected by different conditions (e.g., opening gates when the reservoir is high).

- Indicate what the operator should do if problems are encountered when operating a mechanism (e.g., if a gate fails to open).

- Include the description, location, and operating instructions for all backup equipment.

Operating instructions must be clear and easy to understand. It may be helpful to use sketches, drawings, and photographs to help operators identify the location of buttons, cranks, switches, etc.

Continued . . .

II. PLANNING AN O&M PROGRAM: DEVELOP OPERATING PROCEDURES

Develop Instructions For Operating All Operable Mechanisms (Continued)

After you have completed your operating instructions, they should be tested the next time the mechanism is operated. To test the operating instructions, watch the operation carefully. Are the steps taken the same as those described in the instructions? Are there steps that need to be added?

Operating instructions should be posted in cabinets or near the mechanisms to be operated. Posting operating instructions:

- Ensures that operating personnel will operate the equipment according to established procedures.
- Allows authorized personnel to operate equipment in an emergency in the absence of regular operating personnel.

☞ **If posted operating instructions could make equipment more susceptible to operation by unauthorized personnel who gain illegal entry, the security of the site should be improved to preclude break-ins.**

The posted instructions may be simplified versions of the full operating instructions. All operators should have access to the complete set of operating instructions. Also, operating personnel should be trained on how to follow the established instructions.

If operating instructions already exist for your facility, you should make sure that operating instructions . . .

- ✓ Exist for all of the mechanisms that are operated at your dam.
- ✓ Are complete and accurate.
- ✓ Are accessible and easy to understand.
- ✓ Are posted near mechanical systems.

Examples of the instructions used for operating two different types of gates are presented on the following pages in Table II-3.

Continued . . .

Develop Instructions For Operating All Operable Mechanisms (Continued)

TABLE II-3a. SAMPLE INSTRUCTIONS FOR OPERATING HYDRAULIC GATES

OPERATING INSTRUCTIONS: GUARD GATES - NORMAL OPERATION

Gate Opening Sequence

The Guard Gates can be opened from either the Electrical Cabinet in the Control House or the Control Cabinet in the Gate Chamber by completing the following steps:

1. Start the Hydraulic Unit by depressing the "START" push button. A red light will come on to confirm operation.

2. Depress the Guard Gate "OPEN" push button and hold in to open the gate to the desired position.

   The operator should monitor the gate position indicator to determine the gate opening position. The gate position lights will indicate the position of the gate as follows:

Lights	Gate Position
Both Red and Green	Mid-position
Only Red	Full-open position
Only Green	Full-closed position

   The gate will not open if the gate "full-open" limit interlock is engaged. The gate can be stopped in any intermediate position, and re-started in either the open or close direction.

3. Stop the Hydraulic Unit by depressing the "STOP" push button. The red indicating light will go out to confirm that the Hydraulic Unit has stopped.

Continued . . .

Develop Instructions For Operating All Operable Mechanisms (Continued)

TABLE II-3a. SAMPLE INSTRUCTIONS FOR OPERATING HYDRAULIC GATES (Continued)

OPERATING INSTRUCTIONS: GUARD GATES - NORMAL OPERATION (Continued)

Gate Closing Sequence

The Guard Gates can be closed from either the Electrical Cabinet in the Control House or the Control Cabinet in the Gate Chamber by completing the following steps:

1. Start the Hydraulic Unit by depressing the "START" push button. A red light will come on to confirm operation.

2. Depress the Guard Gate "CLOSE" push button and hold in to close the gate to the desired position.

OPERATING INSTRUCTIONS: GUARD GATES - EMERGENCY DURING NORMAL OPERATION

The emergency operation of the Guard Gate is only possible from the Emergency Panel of the Control House Control Cabinet. It is not possible to reverse direction of a Guard Gate through the use of the Control Cabinet in the Gate Chamber.

IF . . .	THEN . . .
A gate "full-open" or "full-close" limit switch contact malfunctions and stops the gate during operation	Complete the gate operation through the use of the Emergency Panel push buttons.
The Guard Gate is required to change directions during normal operations due to an emergency situation	Use the Emergency push buttons in the Control House. These buttons bypass the gate full-open and gate full-close limit switch interlocks, allowing the operator to change gate direction without regard to gate limit switch interlocks.

Continued . . .

Develop Instructions For Operating All Operable Mechanisms (Continued)

TABLE II-3a. SAMPLE INSTRUCTIONS FOR OPERATING HYDRAULIC GATES (Continued)

OPERATING INSTRUCTIONS: GUARD GATES - EMERGENCY DURING NORMAL OPERATION (Continued)

Emergency Sequence

To **close** the gate immediately due to an emergency condition occurring during normal operation when the gate is in mid-position:

1. Depress the Guard Gate "CLOSE" push button located in the Emergency Panel and hold in to operate the gate to the closed position.

2. Observe the indicating lights on the Control House Cabinet to determine the position of the Guard Gate. When the gate is fully closed, the green indicating light will come on.

3. Stop the Hydraulic Unit by depressing the "STOP" push button.

Continued . . .

Develop Instructions For Operating All Operable Mechanisms (Continued)

TABLE II-3b. SAMPLE INSTRUCTIONS FOR OPERATING A MANUALLY OPERATED GATE

OPERATING INSTRUCTIONS: DRAIN GATE - NORMAL OPERATION

Gate Opening Sequence

The drain gate may be opened by placing the drain gate wheel on the gate stem and rotating the wheel clockwise. Approximately 60 turns of the wheel are required to fully open the gate.

Gate Closing Sequence

The drain gate may be closed by placing the drain gate wheel on the gate stem and rotating the wheel counter-clockwise. Approximately 60 turns of the wheel are required to fully close the gate from the fully open position.

Note: Should the wheel become difficult to turn, particularly when the gate is near closure, do **NOT** force the wheel in the close direction. Reverse the wheel to reopen the gate approximately 10 turns, then attempt to re-close the gate. In no case should the wheel be forced toward the closed position with more than normal effort. Should resistance to closing occur, stop closure of the gate when resistance begins and seek professional assistance.

OPERATING INSTRUCTIONS: DRAIN GATE - EMERGENCY OPERATION

Emergency operation or opening of the drain gate is required when lowering of the reservoir elevation is necessary to relieve hydrostatic pressure on the dam, such as during a potential piping failure of the embankment. The gate should be fully opened and the reservoir drained as quickly as watershed inflow will allow.

Emergency operation of the gate is **NOT** recommended during dangerously high reservoir levels. The primary spillway pipe will already be flowing at maximum capacity and opening of the drain gate will not increase the pipe discharge.

II. PLANNING AN O&M PROGRAM: DEVELOP OPERATING PROCEDURES

Develop Operating Instructions For The Reservoir

Instructions should be developed for operating the reservoir under normal (non-emergency) situations. The instructions for operating the reservoir should . . .

- State the maximum reservoir level to be allowed at different times of the year.
- State the maximum and/or minimum releases permissible.
- Describe any operating restrictions (e.g., rate of drawdown).
- Describe measures to be taken to avoid excessive spillway flow.
- Describe the method and frequency for drainage of the reservoir to permit a thorough inspection of the outlet works, gates, valves, and upstream face/slope.
- Describe the procedures for informing the public of water releases.

If reservoir operating instructions already exist for your facility, you should make sure that operating instructions . . .

- ✓ Provide for all reservoir operation contingencies.
- ✓ Are accessible and easy to understand.

Excerpts from the instructions used at Ski Lake Dam for operating the reservoir are presented on the following pages in Table II-4.

Note: A small dam owner/operator would not operate the reservoir for flood control as shown in the example. **However, a set of reservoir operating procedures are needed even if the procedures are very simple.**

The dam owner/operator should develop a written record of rainfall versus reservoir elevation and spillway discharge for future reference. The amount of flow through seepage measurement weirs will also prove very useful for future correlations. Figure II-2 on page II-33 contains an example log.

Continued . . .

Develop Operating Instructions For The Reservoir (Continued)

TABLE II-4. SAMPLE RESERVOIR OPERATING INSTRUCTIONS

Flood Control

Ski Lake will be regulated for optimum flood reductions. During flood control regulation, the conduit gates are to be operated in a uniform setting with no more than 1 foot difference in opening among the gates. The following regulations govern releases from Ski Lake:

Reservoir Stage	Reservoir Conditions	Regulation
Below 714.0	--	Releases will be made as needed to maintain elevation 714.0.
714.0 - 729.0	Rising	Make releases according to the following schedule:

Reservoir Stages	Maximum Allowable Release Rates (cfs)
714.0 - 715.0	1,000
715.0 - 716.0	2,000
716.0 - 718.5	3,000
718.5 - 729.0	4,000

The combined intervening flow downstream shall not exceed:

- 4,000 cfs on Homey Creek below the dam, or
- 21.0-foot stage on Chicken Creek at the Perry gauge.

If flow exceeds any of the limits listed above, no release will be made until the flow recedes below flood stage.

Continued . . .

Develop Operating Instructions For The Reservoir (Continued)

TABLE II-4. SAMPLE RESERVOIR OPERATING INSTRUCTIONS
(Continued)

Flood Control (Continued)

Reservoir Stage	Reservoir Conditions	Regulation
729.0 - 732.0	Rising	If the forecasted reservoir level will crest at or below elevation 732.0, a maximum release of 4,000 cfs will be made. If the forecasted reservoir level will crest above elevation 732.0, the flood control conduit gates will be opened in increments of 750 cfs each hour until both are fully opened or until the reservoir begins falling.

Water Quality

The conservation storage of Ski Lake will provide a maximum dependable yield of 62 mgd toward meeting the water quality needs of the area. Water quality profiles will be made of the lake on an as-needed basis in order to determine which selective wet well inlet level should be used for water quality releases. All low flow releases shall be regulated to achieve, as nearly as possible, the objective water temperature as shown on Plate 7-1. All reasonable efforts will be made to limit extreme variations in release temperatures. The 233,000 acre-feet of ultimate water quality storage in Ski Lake, based on 20-year frequency drought, has an average yield of 62 mgd (96 cfs). Releases from Ski Lake for water quality control will be made together with releases from Birch Lake and runoff from the uncontrolled drainage areas below Birch and Ski to meet the flow schedule at the Perry gauge as shown in Table 7-3 or as modified by field evaluation to the extent possible. Except for emergencies, water quality and water supply releases shall not be made that will reduce the reservoir elevation in Ski Lake below elevation 657.0. Additional releases shall be made as necessary to alleviate or respond to emergency conditions such as fish kills and flow augmentation for pollution abatement or aesthetics.

Continued . . .

Develop Operating Instructions For The Reservoir (Continued)

TABLE II-4. SAMPLE RESERVOIR OPERATING INSTRUCTIONS
(Continued)

Water Quality (Continued)

TABLE 7-3. MINIMUM LOW-FLOW SCHEDULE
(Perry Gauge)

Water Year	Period (Flow in cfs.)				
	Oct 1 - Oct 15	Oct 16 - Mar 31	Apr 1 - May 31	Jun 1 - Sep 30	Annual Average
1988	148.0	49.0	122.0	134.0	93.6
1989	148.0	49.0	122.0	134.0	93.6
1990	148.0	49.0	122.0	134.0	93.6
1991	148.0	49.0	122.0	134.0	93.6
1992	148.0	49.0	122.0	134.0	93.6
1993	148.0	49.0	122.0	134.0	93.6
1994	148.0	49.0	122.0	134.0	93.6
1995	148.0	49.0	122.0	134.0	93.6
1996	148.6	49.4	122.8	134.8	94.2
1997	149.2	49.8	123.6	135.6	94.8
1998	149.8	50.2	124.4	136.4	95.5
1999	150.4	50.6	125.2	137.2	96.1
2000	151.0	51.0	126.0	138.0	96.7
2001	151.6	51.4	126.8	138.8	97.3
2002	152.2	51.8	127.6	139.6	97.6
2003	152.8	52.2	128.4	140.4	98.5
2004	153.4	52.6	129.2	141.2	99.1
2005	154.0	53.0	130.0	142.0	99.7

II. PLANNING AN O&M PROGRAM: DEVELOP OPERATING PROCEDURES

Develop General Instructions

General instructions should be developed for ensuring the safe operation of the facility. The Federal Guidelines For Dam Safety state:

"Public safety is of paramount importance at all dams and reservoirs."

These general operating instructions should . . .

- State procedures for restricting access to the dam or confining traffic to designated areas. Indicate the procedures to follow when persons visit the facility.
- Designate speed limits to keep traffic within acceptable and safe limits.
- Establish standards for maintaining sanitary conditions.
- Prevent contamination or pollution of all water for human consumption and/or recreational use.
- Eliminate safety hazards by . . .
  - Posting warning signs.
  - Removing unsafe conditions where possible.
  - Restricting public access to chutes, stilling basins, and control houses.
  - Posting safety instructions at highly visible and key locations.
  - Maintaining warning buoys upstream of the dam.
  - Providing adequate security.

If general operating instructions already exist for your facility, you should make sure that operating instructions . . .

- ✓ Adequately protect the public and operating personnel.
- ✓ Are accessible and easy to understand.

DEVELOPING OPERATING PROCEDURES: EMERGENCY OPERATIONS

Operating procedures are also developed for handling emergency situations. Emergency situations require that special operating procedures be followed. The operating procedures to be followed in an emergency situation may be contained in a separate document called an Emergency Action Plan or EAP.

If your facility does not have an EAP, it is important that a plan be developed. EAP's have been shown to reduce the loss of life and extent of property damage in case of a dam failure. For more information about developing EAP's, see the TADS module titled How To Develop And Implement An Emergency Action Plan.

Continued . . .

II. PLANNING AN O&M PROGRAM: DEVELOP OPERATING PROCEDURES

DEVELOPING OPERATING PROCEDURES: EMERGENCY OPERATIONS (Continued)

If your facility already has an EAP, you should make sure that the plan includes . . .

- ✓ A clear description of the circumstances under which a warning is issued, and a list of individuals to whom the warning is issued.

- ✓ The names, organizations, telephone numbers (day/night), and alternate communication means for individuals responsible for operating the dam, and the sequence by which these individuals should be contacted.

- ✓ The names, titles, telephone numbers (day/night), and alternate communication means for representatives of local, State, and Federal agencies, and other officials to be contacted, including:

  - Law enforcement officials.
  - Operators of other dams or water retention facilities.
  - Managers/operators of recreational facilities.

- ✓ The materials and equipment used for performing emergency dam repairs, including:

  - The description and intended use of the materials.
  - The description and location of equipment, and the names or titles of the operators.
  - The procedures to be used for contacting equipment operators.

The EAP should contain a directory with names, titles, telephone numbers, and addresses of persons, authorities, and agencies to notify if an emergency develops at the dam. Make sure that all the names and telephone numbers are up to date. Also, make sure that the plan is accessible and can be located quickly if an emergency develops. All dam personnel should be familiar with the EAP and know where the plan is located.

II. PLANNING AN O&M PROGRAM: ESTABLISH RECORDKEEPING SYSTEMS

INTRODUCTION

Information about the dam's operation and maintenance is important to . . .

- **O&M Program Managers:** O&M managers need information to track the completion of specified O&M activities and to control the operation of the dam.
- **Dam Safety Inspectors:** Dam safety inspectors need information to help them identify potential dam safety deficiencies and to analyze trends developing in known deficiencies. Also, dam safety inspectors may not be able to observe the operation of mechanical equipment first-hand. Therefore, inspectors need to rely on operation records to gather information about some equipment.

To establish an O&M recordkeeping system, you should . . .

- Determine what information should be recorded.
- Select a system for recording the information.

DETERMINE WHAT INFORMATION SHOULD BE RECORDED

The process of establishing a recordkeeping system begins with determining what information should be recorded in that system. First, ask yourself: "Who will need O&M information about my dam?" Develop a list of potential O&M information users. Potential users of O&M information may include: owners, operators, O&M personnel, dam safety inspectors, regulatory agency personnel, local government personnel, and anyone else who has an interest in the safe operation of the dam.

Next, ask yourself: "What types of information will these individuals need or require?" Listed below are examples of the information that might be required by O&M information users. You should modify this list based on the needs or requirements of the actual individuals who will be using your O&M information.

- **O&M Activities Completed By O&M Personnel**
  - Operation and exercising of mechanical equipment
  - Maintenance tasks completed (both routine maintenance and extraordinary maintenance)
- **Observations Made By O&M Personnel**
  - Potential dam safety deficiencies
  - Emergency or unusual conditions
  - O&M deficiencies and conditions

Continued . . .

II. PLANNING AN O&M PROGRAM: ESTABLISH RECORDKEEPING SYSTEMS

DETERMINE WHAT INFORMATION SHOULD BE RECORDED (Continued)

- **Data Collected By O&M Personnel**
  - Reservoir inflow data
  - Reservoir elevation
  - Weather conditions and rainfall
  - Reservoir drawdown (amount, rate, and reason for drawdown)
  - Spillway and outlet works discharges
  - Drain flows (foundation, toe drains, relief wells, seepage measurement devices, etc.)
  - Instrumentation readings
- **Equipment, Tools, And Spare Parts Inventories**
  - Description of all major pieces of equipment (date furnished, supplier, manufacturer, type, size, model or style number) and location
  - List of all tools and any heavy equipment
  - List of spare parts and supplies to be kept on hand
- **Budget Data**
  - Amount of hours used to complete O&M activities
  - Cost of materials and parts
  - Contract expenditures
- **Personnel Records**
  - Background and training of all O&M personnel
- **Visitor Records**
  - Names and addresses of all visitors to the facility

At this point, you should have a list of the information that will be collected and recorded in your O&M recordkeeping system.

SELECT A SYSTEM FOR RECORDING THE INFORMATION

Once you have determined what information will be recorded, then you need to select the best system for recording the information. The most common types of recordkeeping systems used in O&M Programs include . . .

- Checklists
- Logs
- Card Files
- Computerized Records

Each type of recordkeeping system is described below.

II. PLANNING AN O&M PROGRAM: ESTABLISH RECORDKEEPING SYSTEMS

Checklists

Records must be kept on each piece of equipment or structure that requires preventive maintenance. Checklists can be used to keep track of the work completed and the observations made by O&M personnel. Also, checklists can serve as work schedules. Figure II-1 shows an example of an O&M checklist.

FIGURE II-1. SAMPLE O&M CHECKLIST

QUARTERLY O&M CHECKLIST

Name Of Dam: _____

Tasks	Date Completed	Completed By	Observations	Actions: Repair	Actions: Monitor	Actions: Report
Spillways						
Check condition of concrete surfaces.	/ /					
Check condition of metal features.	/ /					
Check for and remove debris.	/ /					
Clean drains.	/ /					
Gates And Valves						
Check condition of hydraulic power units.	/ /					
Check hoist control cabinet.	/ /					
Check gate air vents.	/ /					

Continued . . .

Checklists (Continued)

Checklists should not be used to replace more detailed descriptions of O&M activities, operating instructions, or manufacturers' instructions.

Logs

An operating log is a chronological record of all important O&M activities that have occurred at the facility. Typical information entered into O&M logs includes . . .

Spillways And Outlet Works Information

- Normal and emergency operation of outlet works and/or spillways including the gate position changes and discharges for each gate.
- Flow measurements through pipe and open channel spillways that do not contain gate structures.

Reservoir Information

- Reservoir elevation.
- Weather conditions. (Including total rainfall within the past 24 hours.)

Mechanical Equipment Operation And Testing Information

- Starting and stopping of all mechanical equipment.
- Tests of control devices (gates and valves).
- Tests of standby equipment or gate controls.

Other Flow Measurements

- Foundation drain discharge amounts.
- Weir readings for seepage measurements.

O&M Activities Completed

- O&M activities performed.
- Observations made by O&M personnel.

Continued . . .

Logs (Continued)

Miscellaneous Information

- Acts of vandalism.
- Names and addresses of visitors.

Logs can be used in conjunction with checklists or instead of checklists. Figure II-2, on the following page, shows an example of a structured O&M log. A less structured O&M log is shown in Figure II-3.

Continued . . .

II. PLANNING AN O&M PROGRAM: ESTABLISH RECORDKEEPING SYSTEMS

Logs (Continued)

FIGURE II-2. STRUCTURED O&M LOG

OPERATION, MAINTENANCE, RAINFALL & POOL LEVEL RECORDS	NAME OF DAM ______ NORMAL POOL ELEVATION ______

DATE	TIME	RAIN (inches)	POOL LEVEL	WEATHER CONDITIONS	GENERAL OBSERVATIONS OR COMMENTS	RECORDED BY

DATE	MAINTENANCE PERFORMED	COMMENTS	RECORDED BY

DATE	EQUIPMENT OPERATED	COMMENTS	RECORDED BY

	FLOW AMOUNTS				WEATHER & COMMENTS	RECORDED BY
DATE	Left Toe Drain	Right Toe Drain	Weirs	Other		

Continued . . .

Logs (Continued)

FIGURE II-3. OPEN-ENDED O&M LOG

Date	Time	Name Of Recorder	Reservoir Elevation	Discharge	Remarks
04-06-82	9:00 a.m.	J. Doe	4360.1	Gate open 6 inches.	Visited dam. Everything appeared okay.
04-15-82	10:15 a.m.	J.Doe	4362.0	Gate open 10 inches.	Opened gate. Reservoir rising.
04-19-82	8:00 a.m.	J.Doe	4363.5	Gate open 10 inches.	4.5 Richter Scale earthquake reported 30 miles from dam. No damage seen at dam.
04-26-82	2:00 p.m.	J.Doe	4365.0	Gate fully open.	2 inches of water going over spillway. New wet area (5'x5') noted at bottom of left abutment looking downstream. One gallon per minute of water flowing from left toe drain and right toe drain dry.
05-03-82	11:00 a.m.	J.Doe	4365.2	Gate fully open.	4 inches of water going over spillway. Minor erosion occurring in spillway channel. Wet area at bottom of left abutment unchanged from 04-26-82. 1-1/2 gallons per minute of water flowing from left toe drain. Right toe drain dry.

Card Files

Card files can be used to manage the preventive maintenance of equipment. A card is established for each specific piece of equipment. The card can be used to . . .

- Record pertinent data about that piece of equipment.
- Schedule preventive maintenance tasks.
- Record the repair and maintenance work performed.

The cards are placed in a rotating file system in sequential order by when preventive maintenance tasks should be performed. The cards in the front of the file are those requiring work to be performed during the current preventive maintenance time interval. The cards in the front are removed as the work is performed. After the work is completed, the card is filled in, signed, and placed toward the back of the file at the next designated preventive maintenance time interval. The card file should be checked at least monthly to determine what work needs to be performed. Figure II-4, on the following page, shows an example of a card file for a gate operator.

Continued . . .

Card Files (Continued)

FIGURE II-4. SAMPLE CARD FILE FOR A GATE OPERATOR

EQUIPMENT GAS POWER GATE OPERATOR

FACILITY LEE DAM LOCATION West Bank of River at Dam Site INSPECTION FREQUENCY 6 months

EQUIPMENT DATA

Specification/Solicitation 336855 Date Furnished 4-24-84

Supplier serial no. 5088934 Type Wisconsin air cooled

MFR Teledine Size 4 cylinder - 8 cycle

Model or Style No. VH4D

FRONT

INSPECTION AND MAINTENANCE RECORD				
DATE	INSPECTED BY	CONDITION FOUND OR DESCRIPTION OF WORK DONE	HOURS	MATERIAL
12-4-84	M. SIERRA	PROCEDURE 1.06	1	NONE
6-1-85	T. ORTEGA	NO ADJUSTMENT REQUIRED	1/2	—
12-10-85	B. JONES	PROCEDURE 1.06 - NEEDS LUBRICATION	1	—

BACK

II. PLANNING AN O&M PROGRAM: ESTABLISH RECORDKEEPING SYSTEMS

Computerized Records

Computers can simplify the process of storing and analyzing O&M information. You should consider using a computerized recordkeeping system if you . . .

- Manage a complex O&M Program at a large facility.
- Operate several different facilities.

Computers can . . .

- **Help you manage the work to be accomplished by . . .**
  - Developing work schedules based on the identified O&M activities.
  - Reporting the status of all work in progress.
- **Help you manage financial and personnel resources by . . .**
  - Comparing the actual costs of performing preventive maintenance with the costs of making repairs.
  - Developing budget estimates based on historical costs and anticipated breakdowns.
  - Tracking expenditures and making comparisons to budget estimates.
  - Estimating staffing needs at different times of the year.
  - Comparing staff abilities with work to be accomplished.
- **Help you maintain equipment by . . .**
  - Creating equipment history records.
  - Establishing equipment and parts inventories.
  - Automating the ordering of spare parts based on inventory levels.

O&M records can be automated using commercial software packages. The following three types of commercial software packages could be used to automate O&M records . . .

- **Data Base Programs:** A data base program allows you to store, sort, organize, and recall information. A data base program is similar to the manual card file described earlier in this section. You can enter information about equipment and have the computer recall it as needed.
- **Spreadsheet Programs:** A spreadsheet program allows you to enter data and to do "what if" projections. Spreadsheets are very helpful in developing budgets, projecting needed resources, and tracking expenditures.
- **Project Management Programs:** A project management program allows you to schedule and track work. Project management programs can create schedules, calendars, timelines, checklists, and other time management aids.

Continued . . .

II. PLANNING AN O&M PROGRAM: ESTABLISH RECORDKEEPING SYSTEMS

Computerized Records (Continued)

In addition, O&M records can be automated through the development of a job-specific software program. These software programs can be developed to meet the unique needs of a particular O&M Program. However, job-specific software programs may be costly to develop.

Figure II-5, on the following page, shows an example of a report generated by a computerized O&M recordkeeping system.

Continued . . .

Computerized Records (Continued)

FIGURE II-5. SAMPLE REPORT GENERATED BY A COMPUTERIZED O&M RECORDKEEPING SYSTEM

MAINTENANCE INSPECTION RECORDS

15 APR 1988 PAGE 1

MAINTENANCE NUMBER	DESCRIPTION OF WORK	FREQ MO	LAST COMP YR	MO	DA	MAN-HRS AVE	HOURS	TIMES
01 001	VISUALLY INSPECT CONCRETE AND MASONRY FOR DETERIORATION MOVEMENT OR LEAKS.	01	88	03	16	1.1	050.08	0046
01 002	CHECK WHEN POSSIBLE FOR PROPER ALIGNMENT.	06	88	03	16	.8	008.42	0010
01 003	INSPECT FOR SETTLEMENT CRACKING SPALLING ABRASION AND CAVITATION-REPORT.	12	87	09	02	1.0	000005	0005
02 002	INSP. STRUC. AFTER EACH PERIOD OF HIGH WATER - REPORT FINDINGS.	01	88	03	16	.8	035.66	0044
03 001	INSPECT WEIRS AND PIERS FOR SETTLEMENT CRACKING SPALLING ABRASION.	12	88	02	18	.6	003.58	0006
03 001	SWEEP BRIDGE DECK.	01	88	03	16	.9	024.72	0028
04 001	INSPECT SPILLWAY BRIDGE FOR FREE DRAINAGE & DETERIORATION OF ANY KIND.	12	88	02	18	.7	004.78	0007
05 001	CLEAN SPRAY SEAL CONCRETE LINED DITCHES QUARTERLY OR AS NEEDED.	03	88	02	18	.6	006.16	0010
01 001	INSPECT FOR SPALLING LEAKS AND FOR FOREIGN MATTER.	12	87	07	06	.5	0003.1	0006
01 001	INSPECT FOR UNUSUAL LEAKAGE STOPPED DRAINS.	01	88	03	16	.7	032.62	0044
01 002	WEEKLY INSP. GALLERIES SHAFTS FOR UNUSUAL LEAKAGE STPD. DRAINS.	01	88	03	16	.7	033.08	0045
01 003	CHECK DRAINAGE SYSTEM-UNPLUG STOPPED DRAINS-MAKE CAREFUL CHECK.	24	87	08	03	.7	000002	0003
01 004	CK CLEAN GALLERY DRAIN OF CALCITE. CLEAN WEEP HOLES AND WALKWAY DRAINS.	06	88	02	18	1.0	0010.5	0010
02 001	CLEAN GALLERY FLOORS.	01	88	03	17	1.2	030.68	0025
04 001	CLEAN WEEP HOLES.	01	88	03	07	1.8	042.08	0024
04 002	CLEAN CROSS DRAINS IN GALLERY.	01	88	03	07	.5	013.66	0025
01 001	INSPECT BASIN WALLS FOR CRACKING.	06	88	03	16	.5	004.52	0010
01 002	INSPECT STILLING BASIN WALLS FOR CRACKING SPALLING AND SETTLEMENT.	06	88	03	16	.4	005.35	0013
01 003	DEWATER AND CLEAN STILLING BASIN. INSPECT FOR DETERIORATION.	60	84	10	23	6.5	000013	0002
01 001	MAKE DETAILED CHECK FOR EXCESSIVE EROSION BELOW SPILLWAY OR AT ABUTMENTS.	12	88	02	18	.6	003.33	0006
01 002	WEEKLY INSP. FOR EROSION-SLIDES-BOILS-IMPROPER DRAINAGE.	01	88	03	10	1.5	067.11	0045
01 003	DETAILED INSP. FOR EXCESSIVE EROSION/LACK OF VEG./ANY OTHER DETERIORATION.	12	88	02	18	1.4	009.55	0007
02 001	INSP/REPAIR ALL CONCRETE SURFACE DRAINS.	12	88	02	18	.9	005.25	0006
03 001	INSP/REPAIR SLOPE PROTECTION-RIP RAP DETER.-WOODY GROWTH-RODENT DAMAGE.	06	88	03	10	1.0	009.53	0010
04 001	REMOVE DEBRIS LARGER THAN 2 INCHES IN DIA.	01	88	03	10	1.4	027.83	0020
01 001	GREASE SUMPS CLEAN STRAINERS AND FLUSH PITS.	01	88	03	16	.5	018.67	0039
01 002	CLEAN SUMP AREA. KEEP METAL PAINTED AND RUST FREE.	01	88	03	16	.5	020.72	0040
01 003	CK. FLOAT SWITCHES SUMP AREA.	01	88	03	16	.2	010.23	0042
01 004	TEST SUMP ALARM SYSTEM REPAIR AS NECESSARY	01	88	03	16	.3	011.66	0044
02 001	CLOSE PETCOCK ON SUMP.	06	88	03	16	.2	001.46	0009
02 002	OPEN PETCOCK ON SUMP.	06	87	12	08	.3	001.67	0005
01 002	INSP BOLTS/WELDS FOR DISREPAIR.	12	88	02	18	.4	001.83	0005
01 003	INSP HOIST EQUIP.	03	88	03	16	.4	006.05	0017
01 004	INSP SHAFTS-COUPLINGS-BEARINGS FOR WEAR.	03	88	03	16	.3	0005.8	0017
01 005	CK SHAFTS COUPLINGS FOR ALIGNMENT AND LUBE.	06	88	03	16	.3	002.67	0009
01 007	LISTEN TO ENCLOSED GEARS FOR INDICATION OF WEAR.	06	87	12	08	.3	003.62	0011
01 008	LUBE GATE TRUNNION PINS/SLIDES AND SIDE ROLLERS.	06	87	11	04	.4	0003.5	0008
01 009	CHECK OPEN GEARS FOR WEAR MISALIGNMENT AND LUBE.	06	88	03	16	.3	0002.8	0010
01 009	LUBE MOTORIZED BRAKE AS REQUIRED.	06	88	03	16	.3	0002.8	0009
01 010	LUBE LIMIT SWITCHES.	06	88	03	16	.3	002.69	0010
01 011	CK FOR MOISTURE AND LUBE ON ALL GEAR BOXES.	02	88	02	18	.3	007.93	0025
01 012	CK HEATERS FOR PROPER OPERATION.	06	88	03	16	.4	0003.7	0010
01 013	CK HOIST BRAKE FOR WEAR.	06	88	03	16	.4	003.85	0010
01 014	OPERATE AND CK HOIST CONTROL.	06	87	11	04	.4	003.23	0009

Continued . . .

Computerized Records (Continued)

To Automate Or Not

To decide whether or not to automate your O&M records, you should consider the following points . . .

- **Availability Of Computer Programs:** Is there a computer program available that meets your data storage, analysis, and reporting needs?

  If yes . . . How costly is this program?
  If not . . . How costly will it be to develop a program?

- **Cost Of Computer Equipment:** What type of computer equipment is needed to run the computer programs that you select or will develop? How much will it cost to purchase and maintain this equipment?

- **Support:** What type of support (e.g., training, consulting, troubleshooting, etc.) will be needed to ensure that the selected system can be used by O&M personnel? How much will it cost to support the implementation of the system?

- **Costs vs Benefits:** How much will it cost to automate? Will automating save money in the long term? Are there other benefits that will result from automating? Are the costs outweighed by the benefits that will result?

Technical assistance is available to help you automate your O&M records. Assistance may be obtained within your organization, from your State dam safety program, or through private consultants.

II. PLANNING AN O&M PROGRAM: WRITE AN O&M PLAN

INTRODUCTION

The final planning step is to write an O&M Plan. During this step, you will compile the information developed in the previous three steps into a plan. An O&M Plan is important since it can help to ensure that . . .

- O&M tasks are performed based on an established schedule or on the results of routine O&M monitoring or inspection.
- Approved operating procedures will be followed.
- New operating personnel will be trained to follow approved procedures.
- Authorized personnel can operate the dam and reservoir during emergencies when regular operating personnel may not be available.

In this section, the following topics will be discussed . . .

- Drafting an O&M Plan
- Reviewing and updating an O&M Plan
- Getting an O&M Plan approved
- Making the O&M Plan accessible

DRAFTING AN O&M PLAN

The content, organization, and format used for drafting an O&M Plan varies from one agency to another. Listed below are the typical sections contained in an O&M Plan.

Section . . .	Information Presented . . .
General Information	. General description of the dam and reservoir. . Authorized purposes. . Location and access to the dam. . Project history. . Assignment of responsibilities. . Agreements with other agencies. . References to other documents.
Operation And Maintenance Of The Dam Structure	. Description of the dam structure. . O&M monitoring (inspection) to be performed. . O&M tasks to be performed.

Continued . . .

II. PLANNING AN O&M PROGRAM: WRITE AN O&M PLAN

DRAFTING AN O&M PLAN (Continued)

Section . . .	Information Presented . . .
Operation And Maintenance Of Spillways And Outlet Works Structures	. Description of the spillways and outlet works structures. . O&M monitoring to be performed. . O&M tasks to be performed.
Operation And Maintenance Of The Mechanical And Electrical Systems	. Description of the mechanical and electrical systems. . O&M monitoring to be performed. . O&M tasks to be performed. . Operating instructions.
Operation And Maintenance Of Instrumentation	. Types and locations of instrumentation. . Reading schedules. . Reporting procedures. . O&M monitoring to be performed. . O&M tasks to be performed.
Operation And Maintenance Of The Reservoir	. Description of the reservoir. . O&M monitoring to be performed. . O&M tasks to be performed. . Operating instructions.
Safety And Health	. Description of potential safety hazards to the public and workers. . Operating procedures to be used to protect the public and workers.
Recordkeeping And Reporting Requirements	. Description of records to be kept. . Description of reports to be written.

Your O&M Plan may not include all of the sections listed above. Also, your plan may be organized differently. For example, some agencies describe all of the operation activities for the entire dam and then describe all of the maintenance activities.

☞ **It is important that you review your agency's and/or your regulatory agency's guidelines for writing an O&M Plan before you draft your plan.**

Continued . . .

II. PLANNING AN O&M PROGRAM: WRITE AN O&M PLAN

DRAFTING AN O&M PLAN (Continued)

Listed below are some general guidelines for improving the quality of your O&M plan.

Guideline . . .	Explanation . . .
Be Clear	. Make sure to identify who is responsible for O&M activities by using the exact titles of dam operating personnel. . State timeframes by which O&M activities should be performed. Avoid using indefinite words such as on a regular basis, frequently, periodically, etc. . Supplement step-by-step instructions by using labeled photographs and drawings. Identify valves and switches through the use of color coding and/or numbering systems.
Be Concise	. Use lists rather than narrative text to present information whenever possible. . Use simple, short sentences that can be read quickly.
Be Complete	. Review your plan. Ask yourself: "Could someone who is familiar with dam operations, but unfamiliar with the operation and maintenance of my dam, successfully and safely operate and maintain the dam, its appurtenances, and related equipment?" If not, your plan may be incomplete. . Get feedback on the contents of the plan from experienced and recently trained personnel. Add any content areas that they think are missing from the O&M Plan.

II. PLANNING AN O&M PROGRAM: WRITE AN O&M PLAN

UPDATING AN O&M PLAN

To be effective, an O&M Plan must be reviewed and updated. A new O&M plan should be reviewed and updated after the first full seasonal cycle. Existing O&M plans should be reviewed periodically (i.e., annually), and updated if . . .

- There are personnel changes.
  - Key staff members change positions or leave.
  - Positions are added or eliminated.
- There are changes or modifications made to the dam, its appurtenances, or the mechanical and electrical systems.
- There are changing requirements for operating the reservoir due to changing conditions upstream and downstream of the dam.

An O&M Plan may also need to be reviewed and updated in response to findings from a dam safety inspection or an O&M inspection.

☞ **Remember . . . It is important to keep your O&M Plan up-to-date. An out-of-date O&M Plan does not serve its intended purpose.**

GETTING AN O&M PLAN APPROVED

In some cases, your O&M Plan will need to be reviewed and approved within your organization and/or by a regulatory agency before it can be implemented.

Regulatory agencies often check to see that the O&M Plan covers all potential hazards. Also, regulatory agencies may require assurances that the O&M activities will continue throughout the life of the dam.

Revisions to an existing O&M Plan may need to be reviewed and approved.

☞ **It is important that you review your agency's and/or your regulatory agency's guidelines to determine who must review and approve your plan and any subsequent revisions.**

MAKING THE O&M PLAN ACCESSIBLE

Once written and approved, copies of the O&M Plan should be distributed to key personnel. In addition, a copy of the O&M Plan should be stored in a location at the dam site that can be accessed easily by all operating personnel. For example, if the O&M Plan is stored in a locked file, all operating personnel should have keys to the file.

Continued . . .

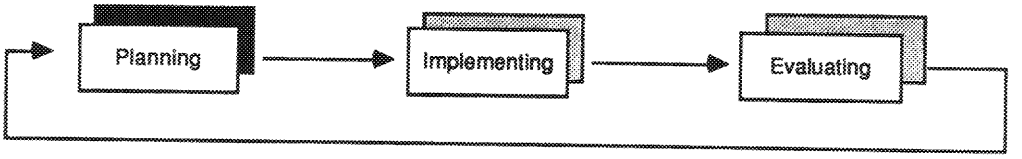
II. PLANNING AN O&M PROGRAM: WRITE AN O&M PLAN

MAKING THE O&M PLAN ACCESSIBLE (Continued)

All operating personnel should be informed of the location of the O&M Plan. An effort should be made to make sure that the O&M Plan is not removed from its designated location.

☞ **To be effective, all operating personnel must have quick access to the O&M Plan. All other personnel should review the O&M Plan at least once per year.**

II. PLANNING AN O&M PROGRAM: SUMMARY



In this unit, we discussed **Planning,** the first phase of organizing an O&M Program. The planning process includes the following steps . . .

#	STEP	EXPLANATION
1	Identify the O&M activities to be performed.	Identifying the O&M activities to be performed involves: • Reviewing pertinent information. • Developing a description of the dam and its appurtenances. • Identifying the routine O&M tasks to be performed.
2	Develop operating procedures.	Developing operating procedures involves: • Developing operating procedures for normal operations, including: - Instructions for operating all operable mechanisms. - Instructions for operating the reservoir. - Instructions for general operations. • Developing operating procedures for emergency operations.
3	Establish recordkeeping systems.	Establishing recordkeeping systems involves: • Determining what information should be recorded. • Selecting a system for recording the information.
4	Write an O&M Plan.	Writing an O&M Plan involves: • Drafting the O&M Plan. • Reviewing and updating the O&M Plan. • Getting the O&M Plan approved. • Making the O&M Plan accessible.

UNIT III

IMPLEMENTING AN O&M PROGRAM

III. IMPLEMENTING AN O&M PROGRAM: OVERVIEW

INTRODUCTION

The second phase of organizing an O&M Program is **Implementation.** Implementing O&M Programs requires hard work and good management skills.

This unit will present guidance on how to implement an O&M Program. The process of implementing an O&M Program can be very complex. You may need to supplement the general advice provided in this unit with additional training programs or by receiving technical assistance from your agency or State dam safety program.

O&M IMPLEMENTATION STEPS

The following steps are used to implement an O&M Program . . .

Step 1: Secure resources.

Step 2: Administer the O&M Program.
- Personnel management.
- Resource management.
- Information management.

Next, each step will be discussed.

III. IMPLEMENTING AN O&M PROGRAM: SECURE RESOURCES

INTRODUCTION

The first step in implementing is to secure the resources needed to accomplish the O&M Plan. Securing resources involves . . .

- Estimating costs.
- Developing an O&M budget.
- Securing funding.

ESTIMATING COSTS

Developing cost estimates requires that you identify all the possible costs associated with implementing your O&M Program. Typical categories of O&M costs include . . .

- Annual costs
- Repair, replacement, and overhaul costs
- Emergency and unanticipated costs

Estimating Annual Costs

Each year you may have the same types of O&M costs. Examples of these annual O&M costs include . . .

Item . . .	Examples Of Costs Included . . .
Personnel	Salaries, overtime, benefits, and training.
Contracts	Contracted labor and services.
Facility	Rent, utilities, and debt service.
Equipment	Leased equipment and service contracts.
Materials And Supplies	Office supplies, first-aid kits, gasoline, lubricants, batteries, cleaning solvents, paints, fertilizers, etc.
Fees	Licenses and registrations.
Travel	Per diem and transportation.

The amounts spent on these items will fluctuate from year to year depending on the conditions at your facility and changes in the costs of these items.

Continued . . .

III. IMPLEMENTING AN O&M PROGRAM: SECURE RESOURCES

Estimating Annual Costs (Continued)

If you are managing an existing O&M Program, you can use historical cost data as your basis for developing cost estimates. To develop cost estimates using historical data . . .

1 Begin by establishing the amount that was spent on these types of items during the previous 12 months. Make sure that you exclude expenditures for other types of items such as purchase of equipment, major repair work, etc.

2 Review the amounts spent and make estimates based on anticipated changes in:

- The prices of purchased materials and services.
- Requirements for purchased materials and services.
- Changes in direct and indirect costs of in-house labor.
- Changes in the requirements for in-house labor.

If you are managing a new O&M Program, you can estimate costs by . . .

- Using historical data from a similar facility.
- Identifying the potential costs of performing each O&M activity identified in your plan.

To identify potential costs of performing <u>each</u> O&M activity, you can use the formula on the following page.

Continued . . .

III. IMPLEMENTING AN O&M PROGRAM: SECURE RESOURCES

Estimating Annual Costs (Continued)

PERSONNEL COSTS . . .

Number of hours required to perform the activity		HOURS
		x
Number of times per year the activity will be performed		TIMES PER YEAR
		=
Total hours required		TOTAL HOURS PER YEAR
		x
Average cost per hour to perform this activity (salary and benefits)		AVERAGE COST PER HOUR
		=
Total personnel costs		TOTAL PERSONNEL COSTS PER YEAR

SUPPLY COSTS . . .

Costs of the supplies used to perform this activity during the year		TOTAL SUPPLY COSTS

OTHER COSTS . . .

Other costs associated with performing this activity during the year		TOTAL OTHER COSTS

III. IMPLEMENTING AN O&M PROGRAM: SECURE RESOURCES

Estimating Repair, Replacement, And Overhaul Costs

The costs associated with major repair, replacement, and overhaul work can be substantial. Unanticipated costs in this category can cause you to have a budget deficit. It is important to try to anticipate as many of these costs as possible. To estimate repair, replacement, and overhaul costs . . .

1 Estimate the service life of equipment and materials.

Appendix A of this document provides examples of overhaul schedules for mechanical systems. Manufacturers and project engineers can provide data on the anticipated service life of equipment and materials at your facility.

2 Estimate the repair, replacement, and overhaul costs.

Remember, you should estimate what the costs will be when the work is most likely to be performed. (Not what it would cost you to do the work today!)

3 Develop a schedule of repair, replacement, and overhaul costs by year.

Identify the estimated repair, replacement, and overhaul costs to be paid each year of the project's anticipated life. Next, determine if:

- These costs will be absorbed in the year that they are scheduled for payment, or

- Annual contributions will be made to a fund that will accumulate the needed resources for paying these costs.

Estimating Emergency And Unanticipated Costs

Even if you have made very careful budget estimates, costs associated with emergencies and other unanticipated events may result. For example, severe weather can cause you to perform some O&M activities more frequently than you anticipated. Also, seismic activity can damage structures and require that you make unanticipated repairs.

Many dam owners and operators establish Emergency Reserve Funds to deal with emergency and unanticipated costs. To determine how much money should be set aside in your Emergency Reserve Fund, consider the following factors . . .

- Annual O&M expenditures
- Site conditions (topography, weather, watershed, seismic activity, etc.)
- Condition and vulnerability of project features

The amount of money set aside in an Emergency Reserve Fund can range from 10 percent to 100 percent of your annual O&M budget.

Continued . . .

Estimating Emergency And Unanticipated Costs (Continued)

Accumulation of the Emergency Reserve Fund should begin as soon as possible. The Emergency Reserve Fund should be fully funded within the first 10 years of the project. As money is withdrawn from the fund, it should be replaced as soon as possible. Your annual budgets should include provisions for the initial establishment of the Fund and for the replacement of money withdrawn from the fund.

DEVELOPING AN O&M BUDGET

After establishing cost estimates, you are ready to develop an O&M budget. Developing an O&M budget involves . . .

- Presenting the cost estimates.
- Writing justifications.

Your organization may require that budget information be presented using a standard format.

☞ **It is important that you review your agency's guidelines for writing O&M budgets before you develop your budget.**

Your budget should include an explanation of how you arrived at your cost estimates. You may want to include a rationale for the purchase of each major item or for unusually large expenses. It is important that you explain major changes in funding levels.

☞ **A thorough budget answers all the questions a reviewer may have about the resources you need to accomplish your O&M Program.**

Three sample O&M budgets are presented in Appendix B. The first sample O&M budget is for managing a very small O&M Program. The other sample budgets are for managing larger O&M Programs.

SECURING FUNDING

One problem that dam owners and operators face is securing funds to perform O&M activities. Listed below are several sources from which O&M funds may be secured . . .

- **Your Agency**

  If you work within a large agency, you may be able to secure O&M funds through your agency's budgetary process.

- **User Fees**

  O&M funds can be generated through recreational and water-usage fees.

Continued . . .

III. IMPLEMENTING AN O&M PROGRAM: SECURE RESOURCES

SECURING FUNDING (Continued)

Tax Or Membership Assessments

Tax or membership assessments can provide a continuing means of funding for O&M costs.

Several regulatory agencies require that you identify sources for funding your O&M Program before they will grant you required permits or licenses.

Your agency or State dam safety program may be able to help you identify potential O&M funding sources.

III. IMPLEMENTING AN O&M PROGRAM: ADMINISTER THE O&M PROGRAM

INTRODUCTION

The second step in implementation is to administer the O&M Program. Administering an O&M Program involves the management of . . .

- Personnel
- Resources
- Information

MANAGING PERSONNEL

Effective management of personnel is an important aspect of implementing an O&M Program. An O&M Program can be staffed using in-house personnel or contracted personnel. Next, the management of in-house personnel and contracted personnel will be discussed.

Managing In-House Personnel: Overview

Managing in-house personnel involves . . .

- Assigning work.
- Scheduling work.
- Monitoring work performance.
- Troubleshooting work performance problems.
- Training personnel.

Managing In-House Personnel: Assigning Work

Managing in-house personnel begins by assigning the work to be performed.

One method for assigning work is a work-order system. Work orders for scheduled preventive maintenance activities can be generated in advance. If you have an automated recordkeeping system, the computer system can be programmed to generate routine work orders. In addition, work orders can be used to assign O&M activities that are not routine in nature. Figure III-1 shows an example of a work order for an O&M activity that is not a routine O&M activity.

In a small facility, work may be assigned by giving verbal direction. For example, a card system may be used to indicate when work should be accomplished. Personnel are then given verbal direction on how and when to complete the work assignment.

Continued . . .

Managing In-House Personnel: Assigning Work (Continued)

FIGURE III-1. SAMPLE WORK ORDER

Work Action No. 153
Work Order No. 149 & 150

Priority Code: 3
(1) Emergency
(2) Urgent (within 1 week)
(3) Normal-Date Required: 10/31/89
(4) Next shutdown (Winter Maintenance)
(5) Inclement Weather Activities

Work Location: McGee Diversion Dam

Description Of The Work To Be Performed: ① Install first-aid kit and fire extinguisher on wall in McGee Block House.
② Paint meter housing yellow & black strips @ 45°.

Work Authorized By: M Walls Date: 9/26/89

Maintenance Actions Taken, Recommendations, Problems Encountered (Include number of people, hours worked, craft used, etc.):

Painted meter box with yellow and black stripes. Let the meter box dry. Installed the first-aid kit and fire extinguisher bracket. Two workers worked 3 hours each (including travel to the dam.) Equipment and materials used included: hand tools, paint, and provided screws.

Completed By: J. P. Bailey Date Completed: 10/3/89

Continued . . .

III. IMPLEMENTING AN O&M PROGRAM: ADMINISTER THE O&M PROGRAM

Managing In-House Personnel: Assigning Work (Continued)

There are many other methods that can be used to make work assignments. No matter which method is used, work assignments should state . . .

- ✓ What is to be done.
- ✓ When the work is to be completed.
- ✓ Where the work is to be accomplished.
- ✓ How the quality of the work is to be judged.

Managing In-House Personnel: Scheduling Work

O&M activities should be scheduled in a way that . . .

- Makes the best use of available personnel.
- Takes weather conditions into account.
- Minimizes problems encountered due to equipment outages.

To schedule O&M activities, begin by dividing the activities into the following groups . . .

- O&M activities that can be done at any time of the year.
- O&M activities that can be done only at certain times of the year.

Next, schedule those activities that must be accomplished at certain times of the year. Finally, spread the remaining O&M activities throughout the year. Scheduling can be done manually using charts and calendars. A sample manual scheduling system appears in Figure III-2. In addition, computer programs can be used to develop O&M work schedules.

Continued . . .

FIGURE III-2. SAMPLE SCHEDULING SYSTEM

Red ✱ Annual Blue ● Semi-Annually Green ◆ Quarterly	January	February	March	April	May	June	July	August	September	October	November	December
Hot Water Pump #1	● 1/10			◆ 4/18		✱ 6/15				◆ 10/1		
Chiller #1		✱ 2/15										
Air Handler #1			● 3/10			◆ 6/10			✱ 9/15			◆ 12/18
Roof Top Air Cond.#1	◆ 1/10			● 4/10			◆ 7/15			✱ 10/10		

III. IMPLEMENTING AN O&M PROGRAM: ADMINISTER THE O&M PROGRAM

Managing In-House Personnel: Monitoring Work Performance

It is important to monitor the quantity and quality of work being performed. Monitoring work performance involves . . .

- Selecting O&M activities to monitor that are the most important to monitor. There is no point in monitoring O&M activities where nothing much can go wrong.
- Setting up specific standards for the quantity and quality of work to be performed.
- Allocating some of your own time for monitoring work performance.
- Making monitoring "rounds" from time to time. Vary the time when you make your rounds. It is better to be somewhat unpredictable when it comes to monitoring work performance.
- Check the work performance against specified standards. Provide feedback to personnel on all work that meets or exceeds standards. Also provide feedback to personnel on all work that fails to meet standards by . . .

  (1) Getting the worker's point of view on how well the job meets standards.
  (2) Giving the worker your point of view on how well the job meets standards.
  (3) Agreeing on the corrective measures to be taken to bring the work up to standards.

Managing In-House Personnel: Troubleshooting Work Performance Problems

Troubleshooting work performance problems involves identifying the reasons for the problems. Listed below are some common reasons for performance problems and suggested strategies for improving performance . . .

Reasons . . .	Strategies . . .
Unclear Expectations	. Explain what is expected to each worker. . When work is unacceptable, make sure that the workers concerned know what is wrong and exactly what is expected of them.
Inadequate Tools And Equipment	. Make sure that workers have the tools and equipment they need to perform job tasks.

Continued . . .

III. IMPLEMENTING AN O&M PROGRAM: ADMINISTER THE O&M PROGRAM

Managing In-House Personnel: Troubleshooting Work Performance Problems (Continued)

Reasons . . .	Strategies . . .
Lack Of Clear Procedures	. Clarify standing operating procedures. . Post operating instructions near operable equipment.
Lack Of Motivation	. Develop systems for getting suggestions from your workers on improving working conditions. . Reward good work performance. . Establish consequences for poor work performance.
Inadequate Skills Or Knowledge	. Provide training. . Provide troubleshooting guides and other reference tools to help workers perform their jobs.

Managing In-House Personnel: Training Personnel

O&M personnel need to receive adequate training. New O&M personnel should be trained when they are hired. Incumbent personnel should be trained on a periodic basis (e.g., every 3 years) or whenever the O&M Plan is updated or significantly modified. If the O&M Plan is unchanged, incumbent personnel should be required to review the Plan on an annual basis.

O&M personnel should be thoroughly trained in all aspects of the O&M Plan. Hands-on training should be provided in how to operate all mechanical equipment. Inexperienced personnel should be required to operate mechanical equipment in the presence of an experienced operator during the training period.

All O&M personnel should receive training in safety procedures and in working with any hazardous materials used on the job.

Training can include . . .

- **Classroom Training:** Classroom training sessions can be used to provide personnel with information on how to perform their jobs.

Continued . . .

III. IMPLEMENTING AN O&M PROGRAM: ADMINISTER THE O&M PROGRAM

Managing In-House Personnel: Training Personnel (Continued)

- **Structured On-The-Job Training:** During structured on-the-job training, an inexperienced worker is paired with an experienced worker. The experienced worker supervises the inexperienced worker as he or she completes a series of structured work activities that are designed to teach.

- **Coaching:** Coaching is similar to on-the-job training. In a coaching arrangement, the experienced worker provides guidance and feedback to the inexperienced worker as he or she performs routine job functions.

Managing Contracted Personnel

The advantages and disadvantages of using contracted personnel are . . .

Advantages

- **Flexibility:** You can use contracted personnel to supplement your own in-house personnel during peak workload periods without having to add full-time positions.

- **Cost:** Some organizations find that it is less expensive to contract for personnel than to carry O&M personnel on their own payrolls.

Disadvantages

- **Lack Of Control:** When you use contracted personnel, you may have to accept the personnel provided by the vendor. It may be more difficult to control the quality produced by contracted workers.

- **Union Problems:** The use of contracted personnel may cause problems with unions. Problems can occur when contracted personnel are used to reduce the amount of overtime provided to full-time, unionized workers. Problems can also occur when the full-time workers are not unionized and the contracted workers are unionized. The labor union situation should be analyzed before contracting for personnel services.

Managing contracted personnel involves . . .

- Writing contract specifications.
- Selecting a contractor.
- Monitoring the contractor's performance.

☞ **It is important to review your agency's contracting policies and procedures.**

If your agency does not have contracting policies and procedures, you may want to get technical assistance from your State dam safety program on how to develop and manage contracts.

III. IMPLEMENTING AN O&M PROGRAM: ADMINISTER THE O&M PROGRAM

MANAGING RESOURCES

In addition to personnel, there are many other resources that are used by O&M Programs. These resources include: tools, equipment, supplies, and other items that may be kept in your inventory. The acquisition and use of these resources must be managed.

Managing resources involves . . .

- Purchasing resources.
- Controlling resources.

Purchasing Resources

Purchasing resources requires that you have a system in place for . . .

- **Identifying potential sources.**

  Even if your facility does not routinely purchase items, a list of potential sources should be maintained for use in case of an emergency situation. You should check the reliability of the sources on your list. It is important to establish that the vendors can deliver the items on time and for the price quoted.

- **Getting competitive price quotations.**

  If you were about to replace the roof on your home, you would get several price quotes from different contractors. You may be able to save several hundred dollars by getting competitive quotes. The same is true for the resources needed to operate your O&M Program.

- **Issuing purchase orders or some other authorization.**

  A system needs to be in place for authorizing purchases. All personnel involved in purchasing should know who is required to authorize purchases.

- **Inspecting purchased items and approving payments.**

  When items are received from vendors, they should be inspected. Payments should not be made until there is verification that the order includes the quantity and quality of items ordered.

Your agency may have specific policies and procedures governing the purchase of resources.

☞ **It is important to review your agency's purchasing policies and procedures.**

III. IMPLEMENTING AN O&M PROGRAM: ADMINISTER THE O&M PROGRAM

Controlling Resources: Overview

O&M managers must guard against vandalism, theft, loss, and breakage of tools, equipment, and supplies. Controlling resources can reduce costs. Without an effective resource control system, O&M personnel may not be able to locate the resources they need to complete assigned work.

Two methods for controlling O&M resources are . . .

- Establishing A Stockroom
- Using A Tool Crib

Controlling Resources: Establishing A Stockroom

Most O&M Programs need to keep a supply of materials and parts on hand. Establishing a stockroom system can help to control the purchase and use of these types of items.

A stockroom operation may categorize items as follows . . .

- **Standard Stock:** Standard stock includes items that are continuously used (e.g., nuts, bolts, screws, nails, and other hardware) and high-usage materials (e.g., lubricants, paints, wire, metals, wood, etc.). For these items, a minimum quantity is established. A standard stock item is replenished when the quantity on hand reaches the minimum quantity.

- **Special-Buy Items:** Special-buy items are not part of the standard stock inventory. These items are obtained to meet special job requirements. There is no provision for a minimum quantity or for automatic stock replenishment.

Standard stock items may be further classified as . . .

- **Open Stock:** Open stock includes low-value, high-usage stock items. O&M personnel can obtain these items directly from bins without the use of a stock requisition form. There is no control over who takes the stock or record of what job it was used on.

- **Closed Stock:** Closed stock requires that O&M personnel complete a stock requisition form to receive items. The closed-stock area is more expensive to administer than the open-stock area. However, open-stock areas tend to have a higher pilferage rate.

Continued . . .

Controlling Resources: Establishing A Stockroom (Continued)

The responsibilities assumed by stockroom personnel may include the following . . .

- Issuing stock.
- Processing returned stock.
- Receiving standard stock and special-buy materials and supplies from vendors.
- Certifying receiving and invoicing documents.
- Stocking shelves and bins.
- Conducting physical inventories.
- Reporting low levels of standard-stock items.
- Initiating stock replenishment orders.
- Identifying and disposing of surplus items.
- Ensuring that items are used before their shelf-lives expire.
- Identifying items that should be added to, or removed from, the standard-stock inventory list.

Controlling Resources: Using A Tool Crib

The purpose of a tool crib is to provide a storage area and an inventory control method for portable tools and equipment that are not assigned to individual O&M personnel on a permanent basis. Typically, a tool crib is a restricted area with an attendant who signs out items to an individual O&M worker. The worker uses the item and returns it upon completion of the job.

The sign-out system should provide a record of who has the item, when it was signed out, and when it will be returned. The O&M worker is accountable for the item until it is returned to the crib. If the signed-out item is needed for another job, the record makes it possible for that item to be located.

The responsibilities assumed by the tool-crib attendant may include the following . . .

- Issuing items.
- Maintaining sign-out records.
- Receiving and inspecting returned tool-crib items.
- Initiating action to service or repair tool-crib items.
- Initiating action to retire or replace tool-crib items.
- Obtaining additional tool-crib items.

In small facilities, the stockroom and tool crib may be combined into a single operation.

Continued . . .

III. IMPLEMENTING AN O&M PROGRAM: ADMINISTER THE O&M PROGRAM

MANAGING INFORMATION

O&M Program managers use information to carry out all of their management functions. Accurate and timely information is a key ingredient of an effective O&M Program.

Information is like any other resource--it needs to be managed. Without good management, your information resources may become unreliable.

Managing information involves . . .

- Keeping recordkeeping systems current.
- Reviewing information systems.
- Updating information.

Keeping Recordkeeping Systems Current

In the previous unit, establishment of recordkeeping systems was discussed. Once a recordkeeping system has been established, the difficult job of keeping the system current begins.

The key to maintaining a recordkeeping system is to be disciplined about completing the needed paperwork and making required entries into the system. As an O&M manager, you need to be a good model. If you fail to do your end of the paperwork, everyone else will follow suit.

O&M personnel are more likely to complete paperwork if they understand why it is important. Your O&M training program should explain why each type of record is required. Also, O&M personnel should be told exactly how to complete each type of record. Examples of completed records should be provided.

Part of your monitoring of work performance should include a review of the records completed by workers. You should provide feedback on the accuracy and timeliness of the workers' records.

Reviewing Information Systems

Periodically you should review the systems used to collect, store, analyze, and report information. To review your information systems, ask yourself . . .

- Is any of the information being collected unnecessary?
- Is there any information not being collected that should be collected?
- Are the methods used to collect information efficient? Are there more efficient methods for collecting needed information?

Continued . . .

Reviewing Information Systems (Continued)

- Is information stored in a way that allows for quick access? Are there more efficient ways to store and retrieve information?
- Are there analyses being done that are unnecessary? Would new or different types of analyses be beneficial? Are there more efficient ways to analyze information?
- Are all of the reports generated being used? Can some of the reports be eliminated? Should new or different types of reports be generated? Are there more efficient ways to generate reports?
- How much is it costing to collect, store, analyze, and report information? Do the benefits justify this level of expenditure?

Information systems can be outdated. Information needs can change over time. Information systems that are not reviewed periodically may collect information that is no longer needed. It is important to review and modify your information systems based on changing needs.

Updating Information

The main information source for an O&M Program is the O&M Plan. Some agencies require that the O&M Plan be reviewed on an annual basis to determine if modifications are needed.

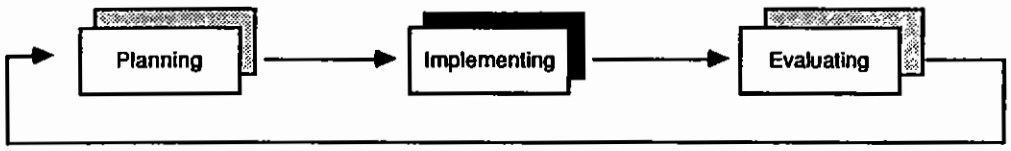
In addition to an annual review, the O&M Plan should be reviewed and updated if there are significant . . .

- Personnel changes.
- Changes or modifications made to the dam, its appurtenances, or the mechanical and electrical systems.
- Changes in requirements for operating the reservoir due to changing conditions upstream or downstream of the dam.

After the O&M Plan has been revised, other related information may need to be updated. For example, if the instructions for operating a hydraulic unit are changed, then the posted instructions for the hydraulic unit must also be changed. Also, the preventive maintenance instructions for the hydraulic unit may need to be modified.

☞ **Remember . . . When updating information, make sure to change all related information that may appear in other documents.**

III. IMPLEMENTING AN O&M PROGRAM: SUMMARY



In this unit, we discussed **Implementation,** the second phase of organizing an O&M Program. The implementation process includes the following steps . . .

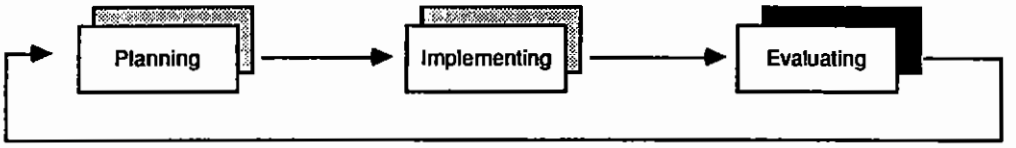
#	STEP	EXPLANATION
1	Secure resources.	Securing resources involves: . Estimating costs, by . . . - Estimating annual costs. - Estimating repair, replacement, and overhaul costs. - Estimating emergency and unanticipated costs. . Developing an O&M budget. . Securing funding.
2	Administer the O&M Program.	Administering an O&M Program involves: . Managing personnel, by . . . - Managing in-house personnel. . Assigning work. . Scheduling work. . Monitoring work performance. . Troubleshooting work performance problems. . Training personnel. - Managing contracted personnel. . Managing resources, by . . . - Purchasing resources. - Controlling resources. . Establishing a stockroom. . Using a tool crib. . Managing information, by . . . - Keeping recordkeeping systems current. - Reviewing information systems. - Updating information.

UNIT IV

EVALUATING AN O&M PROGRAM

IV. EVALUATING AN O&M PROGRAM: OVERVIEW

INTRODUCTION



The third phase of organizing an O&M Program is **Evaluation.** Many O&M Programs are not routinely evaluated. Rather, O&M Programs are changed as a result of emergencies or accidents.

Evaluating your O&M Program is important. A thorough program evaluation can help you to improve the efficiency and effectiveness of your O&M Program. Also, O&M Program evaluation is a form of "PM" — Preventive Management. An O&M Program evaluation can uncover problems before they become full-blown crises.

O&M EVALUATION STEPS

The following steps are used to evaluate an O&M Program . . .

Step 1: Identify evaluation standards.

Step 2: Collect evaluation information.

Step 3: Assess O&M Program effectiveness.

Next, each step will be discussed.

IV. EVALUATING AN O&M PROGRAM: IDENTIFY EVALUATION STANDARDS

INTRODUCTION

Before evaluating your O&M Program, you must develop your own standards or criteria for judging the effectiveness of your program. A standard is the "yardstick" against which you measure your program's effectiveness.

Identifying evaluation standards involves . . .

- Developing a list of evaluation standards.
- Selecting evaluation standards.

DEVELOPING A LIST OF EVALUATION STANDARDS

To develop a list of possible evaluation standards, ask yourself, "What would happen or not happen if my O&M Program was effective?"

Some possible evaluation standards for measuring the effectiveness of an O&M Program are as follows . . .

EXAMPLES OF POSSIBLE O&M EVALUATION STANDARDS

- The dam is operational and fulfilling its intended purpose(s).
- O&M expenditures are within budgeted amounts and quality has not been sacrificed.
- Extraordinary maintenance work is kept to a minimum.
- No significant deficiencies related to O&M are found during dam safety or O&M inspections/evaluations.
- The O&M Plan and operating instructions are comprehensive and up-to-date.
- No safety accidents have occurred that involve dam personnel and/or the public.

It is important that you develop your own list of evaluation standards. The evaluation standards should reflect the unique requirements of your O&M Program. Also, evaluation standards should be consistent with the goals of your O&M Program.

IV. EVALUATING AN O&M PROGRAM: IDENTIFY EVALUATION STANDARDS

SELECTING EVALUATION STANDARDS

After developing a list of possible evaluation standards, review your list. Select those evaluation standards that will provide the best overall assessment of your O&M Program.

All of the individuals who have a role in assessing the effectiveness of your O&M Program should review your list of evaluation standards.

IV. EVALUATING AN O&M PROGRAM: COLLECT EVALUATION INFORMATION

INTRODUCTION

Next, you need to collect information in order to determine how well your O&M Program has met the selected evaluation standards. You should be able to collect most of the needed information from your O&M records.

Collecting evaluation information involves . . .

- Identifying what information needs to be collected.
- Determining how to collect the information.

IDENTIFYING WHAT INFORMATION NEEDS TO BE COLLECTED

For each evaluation standard, you must identify what information should be collected. The example presented below illustrates how to identify possible information sources for an evaluation standard.

EXAMPLES OF POSSIBLE INFORMATION SOURCES

Evaluation Standard: O&M expenditures are within budgeted amounts and quality has not been sacrificed.

Possible Information Sources:

- Budget Information: Budget information will be reviewed to determine the projected levels of expenditures.
- Expenditure Information: Actual levels of expenditures will be compared to projected levels of expenditures. Also, a comparison will be made between expenditures for preventive maintenance and extraordinary maintenance.
- Dam Safety Inspection Reports: Dam safety inspection reports will be reviewed to determine if there are any significant deficiencies related to the quality of the O&M Program.
- O&M Inspection Reports: O&M inspection reports will be reviewed to determine if there are any significant problems with the quality of the O&M Program.
- O&M Logs: O&M logs will be reviewed to determine if work is being completed on a timely basis.
- Current Work Orders: Current work orders will be reviewed to determine if there are significant delays in getting work accomplished.

IV. EVALUATING AN O&M PROGRAM: COLLECT EVALUATION INFORMATION

DETERMINING HOW TO COLLECT THE INFORMATION

After you have identified what information needs to be collected, then you will need to determine how the information should be collected. The example presented below illustrates how information can be collected for an evaluation standard.

EXAMPLES OF POSSIBLE METHODS FOR COLLECTING INFORMATION

Evaluation Standard: O&M expenditures are within budgeted amounts and quality has not been sacrificed.

Information Collection Methods:

- Computer Analysis: The O&M Program computer system will be used to generate the following information . . .
  - (1) A bar graph comparing actual and projected expenditures by month for the past 18 months.
  - (2) A bar graph comparing preventive maintenance expenditures with extraordinary maintenance expenditures by month for the past 18 months.
  - (3) A list of budget accounts that exceeded projected expenditures during the past 18 months.
  - (4) A list of budget accounts that had budget surpluses greater than 15 percent during the past 18 months.
- Document Review: The following documents will be reviewed and analyzed by the evaluator . . .
  - (1) Inspection reports for the past 18 months.
  - (2) O&M logs for the past 18 months.
  - (3) All current work orders.
- Interviews: The evaluator will interview a random sample of O&M personnel regarding their knowledge of the O&M Plan and use of operating instructions.

IV. EVALUATING AN O&M PROGRAM: ASSESS O&M PROGRAM EFFECTIVENESS

INTRODUCTION

The final step in evaluating an O&M Program is to assess how effective the program was at meeting the evaluation standards. Using the established "yardstick," you determine . . .

- How well your program measures up.
- What should be done to improve or maintain the effectiveness of your program.

Assessing O&M Program effectiveness involves . . .

- Drawing conclusions.
- Identifying followup actions to be taken.

DRAWING CONCLUSIONS

Drawing conclusions requires that you judge how well your O&M Program met the evaluation standards. Your judgments should be based on the information collected.

☞ **Avoid drawing conclusions based purely on opinions.**

IDENTIFYING FOLLOWUP ACTIONS TO BE TAKEN

After drawing conclusions about the effectiveness of your O&M Program, you need to identify the followup actions to be taken. Followup actions can be taken to improve or maintain your program's effectiveness.

Improving Your Program's Effectiveness

If you conclude that your O&M Program has not met an evaluation standard, then you should . . .

- **Define The Problem**

  First, develop a clear statement of the problem. Try to stay away from vague, general statements such as "poor communication." Use a specific statement of the problem such as, "Operating personnel do not know who to contact in an emergency situation."

- **Identify The Reasons For The Problem**

  Next, identify the reasons why the problem is occurring. For example, personnel may need to receive training, information in the O&M Plan may be out-of-date or incomplete, and so forth.

Continued . . .

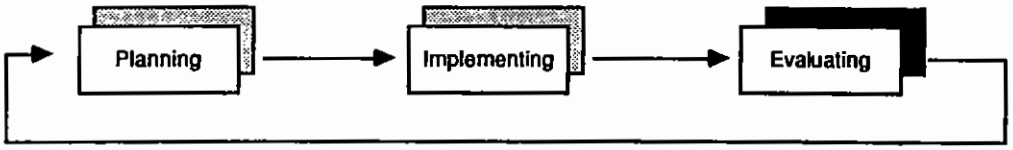
Improving Your Program's Effectiveness (Continued)

- **Select Followup Actions To Address The Reasons**

  Finally, select the followup actions to be taken in order to address the reasons for the problem. Examples of possible followup actions include:

  - Revising the O&M Plan.
  - Clarifying operating instructions.
  - Providing training and feedback to O&M personnel.
  - Improving recordkeeping systems.

IV. EVALUATING AN O&M PROGRAM: SUMMARY



In this unit, we discussed **Evaluation,** the third phase of organizing an O&M Program. The implementation process includes the following steps . . .

#	STEP	EXPLANATION
1	Identify evaluation standards.	Identifying evaluation standards involves: . Developing a list of evaluation standards. . Selecting evaluation standards.
2	Collect evaluation information.	Collecting evaluation information involves: . Identifying what information needs to be collected. . Determining how to collect the information.
3	Assess O&M Program effectiveness.	Assessing O&M Program effectiveness involves: . Drawing conclusions. . Identifying followup actions to be taken, by . . . - Defining the **Problem.** - Identifying the **Reasons.** - Selecting followup **Actions.**

APPENDIX A

SAMPLE O&M TASKS

Note: The tasks listed in this appendix are examples of common O&M tasks. This is not a comprehensive list. Every facility has site-specific O&M tasks that should be performed. **DO NOT LIMIT YOUR O&M ACTIVITIES TO THOSE LISTED IN THIS APPENDIX!**

A suggested frequency for completing each task is presented as a guideline. You will need to determine the frequency for performing each O&M task based upon the conditions at your facility. Make sure to consult other sources such as manufacturers' instructions, designers' criteria, etc. before establishing how often an O&M task is to be performed.

APPENDIX A: SAMPLE O&M TASKS

Embankment Dam Crest And Slopes

Tasks	Frequency
Erosion Control:	
Repair erosion gullies by removing loose materials and replacing them with compacted fill. Gravel and cobbles or planted grass should be added as appropriate to the damaged area to prevent future erosion.	Check for erosion quarterly and after severe weather.
Vegetation Control:	
Cut grass at least twice annually or more frequently to allow for visual surveillance of the embankment surfaces. Maximum grass height should not exceed 8 inches.	At least twice annually.
Remove small trees and bushes. **DO NOT REMOVE TREES LARGER THAN 6 INCHES IN DIAMETER WITHOUT ADVICE FROM A QUALIFIED ENGINEER!**	Check vegetation monthly.
Control Of Burrowing Animals:	
Repair animal burrows by compacting fill into the excavated areas. If the burrowing is extensive, seek the advice of a qualified engineer.	Check for burrows monthly.
Eliminate burrowing animals to control this problem.	Take measures to remove or eradicate animals, as needed.
Debris Removal:	
Remove debris on the upstream slope, spillway entrance, and conveyance channels and dispose of it.	Check for debris monthly.
Maintain Slope Protection:	
Riprap: Repair beaching of riprap by re-grading the slope to original lines and replacing the bedding material and riprap. Repair voids in the riprap by adding or moving riprap.	Check slope protection annually.
Soil-Cement: Repair damaged soil-cement by patching areas with concrete.	

Continued . . .

Embankment Dam Crest And Slopes (Continued)

Tasks	Frequency
Maintain Slope Protection: (Continued)	
Note: If slope protection problems keep recurring, get engineering guidance on redesigning the slope protection system.	
Maintain Drainage Structures:	
Clean out clogged drain outfalls. Remove any vegetation or sloughed soil that may be blocking the drains. Maintain guards or screens at drain outlets to prevent entry by animals.	Check drains monthly.
Note: If a drain is blocked other than at the outfall, get the advice of an engineer to determine the cause and remedy.	
Maintain embankment seepage measuring devices (such as weirs). Measure flow through devices or weirs.	Check measuring devices monthly.
Maintain Roadway On Crest:	
Asphalt Roadways: Seal cracks resulting from normal wear and aging. Inform an engineer of any new cracks or cracks that are increasing in size.	Check the crest monthly.
Gravel Roadways: Regrade eroded areas. Add gravel as needed.	
Guardrails: Repair damaged portions and paint metal surfaces, as needed. Report any misalignment of guardrails not caused by impact damage to an engineer.	
General: Remove snow and debris, as needed.	
Maintain Design Elevation:	
Maintain the design elevation of unimproved crest surfaces by leveling and grading the crest to design specifications. Fill in any ruts or minor depressions.	Check the crest visually monthly.
Report significant or recurring settlement to an engineer.	Perform a survey of the crest annually.

APPENDIX A: SAMPLE O&M TASKS

Concrete Dam Crest And Faces

Tasks	Frequency
Maintain Concrete Features:	
Make repairs to concrete surfaces and joints, including: . Patching spalled areas with a bonding agent. . Strengthening areas by applying coatings or by adding reinforcements. . Repairing minor cracks with an adhesive or epoxy injection.	Check condition of concrete quarterly.
Note: Get assistance from a qualified engineer before making repairs to concrete surfaces and joints. Concrete problems may be an indication of a serious dam safety problem.	
Keep concrete joints free of vegetation.	
Report any new or changing (increasing or decreasing) cracks to an engineer.	
Maintain Metal Features:	
Paint metalwork, and check that guardrails and walkways are solid.	Check condition of metal quarterly.
Maintain Galleries:	
Test and operate ventilation and lighting equipment.	Check galleries monthly.
Clean debris from sump pits, gutters, and drains that affect proper functioning.	
Maintain metalwork by removing mineral deposits and diverting seepage to drain or by loosely covering metal structures to protect them from seepage. Paint rod connections, pumps, stairwells, lighting fixtures, conduits (where exposed), and other metal equipment.	
Rod out and ream foundation and form drains.	Rod out and ream drains annually.

APPENDIX A: SAMPLE O&M TASKS

Reservoir Operation

Tasks	Frequency
Record the following information: . Reservoir elevation. . Reservoir inflow. . Spillway and outlet works discharges. . Rainfall and other weather information.	Record daily.
Make required adjustments to gates and valve settings and test operate equipment in accordance with operating instructions or SOP.	As required by operating instructions or SOP.

Spillways And Outlet Works

Tasks	Frequency
Maintain Concrete Features:	
Make repairs to concrete surfaces and joints, including: . Patching spalled areas with a bonding agent. . Strengthening areas by applying coatings or by adding reinforcements. . Repairing minor cracks with an adhesive or epoxy injection.	Check condition of concrete quarterly.
Note: Get assistance from a qualified engineer before making repairs to concrete surfaces and joints. Concrete problems may be an indication of a serious dam safety problem.	
Keep concrete joints free of vegetation.	
Maintain Metal Features:	
Remove mineral deposits and paint metal features, as needed.	Check condition of metal quarterly.
Check to see that the cathodic protection system is performing adequately.	
Restore corroded metal to original condition by welding on new metal.	

Continued . . .

Spillways And Outlet Works (Continued)

Tasks	Frequency
Maintain Vegetated Earth Features:	
Cut grass.	At least annually.
Remove small trees and bushes that would affect flows now or in the future if left to grow.	Check annually.
Repair animal burrows by excavating the loose soils around the hole and compacting suitable fill into the excavated areas.	Check for burrows annually.
Eliminate burrowing animals.	Take measures to remove or eradicate animals, as needed.
Maintain protective covering by repairing and/or replacing materials (e.g., grass, riprap, etc.) lost due to erosion or deterioration.	Check for erosion monthly and after severe weather.
Maintain Intake Structures:	
Clean trashracks by removing debris.	Check intakes monthly, if observable.
Maintain logbooms and safety buoy lines by: . Repairing them to functioning condition. . Replacing waterlogged or submerged logboom members. . Repairing or replacing loose or missing anchors.	
(See earlier sections on maintaining concrete and metal features.)	
Maintain Spillway Channels:	
Remove any obstructions or debris from spillway channels.	Check for obstructions and debris monthly.
Keep drains clean and clear. Periodically rod and ream internal drains to keep them functioning.	Check drains monthly.
(See earlier sections on maintaining concrete and vegetated features.)	

Continued . . .

Spillways And Outlet Works (Continued)

Tasks	Frequency
Maintain Conduits/Penstocks:	
(See earlier section on maintaining metal features.)	
Maintain Energy Dissipators:	
Remove visible and accessible obstructions to outfalls (e.g., large rocks, debris, vegetation, etc.).	Check energy dissipators annually.
Keep plunge pool cleaned out.	
Maintain stilling basin by removing riprap and other significant rock debris. (It may be necessary to dewater the stilling basin to remove debris. The stilling basin may need to be dewatered and cleaned approximately every 5 years, depending on the previous condition of the stilling basin and the amount of use since it was last dewatered.)	
Maintain Return Channel:	
Remove obstructions within the return channel.	Check return channel annually.
(See earlier sections on maintaining concrete and vegetated features.)	

Gates, Valves, And Other Mechanical Equipment

Tasks	Frequency
Note: Gates and valves should be maintained according to the manufacturers' instructions. Listed below are sample tasks. **You should follow the guidelines specified by the manufacturer.**	
Maintain Gates And Valves:	
Daily Tasks . . .	
Check equipment for oil leaks and evidence of tampering or vandalism.	Check daily.

Continued . . .

Gates, Valves, And Other Mechanical Equipment (Continued)

Tasks	Frequency
Maintain Gates And Valves: (Continued)	
Weekly Tasks . . .	
Hydraulic Hoist Rooms: Check for leaks and rodent invasion. Clean room floor with broom or floor brush.	Check weekly.
Hydraulic Hoist Cylinders: Check oil leaks and condition of piston rod. Note the gate position. Clean, add oil, and lubricate, as needed.	
Hydraulic Power Units: Check for oil leaks. Clean units with a dry cloth. Check pressure gauges. Check control cabinet for cleanliness, damaged fuses and wires, and insect infestation.	
Monthly Tasks . . .	
Hydraulic Power Units: Check oil filters, and replace oil filters, if needed. Check the charge accumulator. Check oil level of accumulator. Add oil, if required.	Check monthly.
Quarterly Tasks . . .	
Operating Instructions: Make sure that operating instructions are up-to-date and legible.	Check instructions quarterly.
Hydraulic Power Units: Check oil heater. Check for oil leaks. If oil level is low enough, remove heater and check condition of heating elements. Check hydraulic valves for burnt coils and proper operation.	Check quarterly.
Hoist Control Cabinets: Check for physical damage, signs of tampering, cleanliness, loose or burnt connections, and damaged contacts.	
Gate Air Vents: Check gate air vents. Make sure the air vents are kept clear. Remove obstructions from where the vents exit at the top of the dam.	

Continued . . .

Gates, Valves, And Other Mechanical Equipment (Continued)

Tasks	Frequency
Maintain Gates And Valves: (Continued)	
Annual Tasks . . .	
Hydraulic Hoist Cylinders: Check for deterioration of finish on cylinder and of the plating on the cylinder piston rod. Check for and release air trapped in oil lines. Check piston velocity. Check performance of cylinder. Check for noise, vibrations, or jerky piston travel.	Check annually.
Hydraulic Power Units: Check oil for presence of water, sediments, turbidity, and unusual odor. Replace oil if odorous. Remove oil for filtration and drying. Drain sump free of sediment and accumulated water. Check and clean oil pump inlet filters or strainers. Replace filters and strainers, if necessary. Recalibrate controls and instrumentation.	
Pillow Block Bearings: Remove housing cap and clean bearing free of caked or hardened grease. Grease the bearings.	
Manual Gate And Valve Operators: Check gears and thrust bearings for wear. Clean gears and bearings and apply grease.	
Intake Gates: Check and clean gate cathodic protection system. Repair cathodic protection system, if necessary.	
Radial Gates: Check seals, protective coating, and cathodic protection system for deterioration. Check trunnion bearings for excessive wear. If wear is excessive, check geometry of gate frame, and its alignment between gate guides. Repair bearing and adjust gates, as needed.	
Slide Gates: Check for cleanliness, proper operation, deterioration of finish, damaged parts, and condition of anchorage. Operate gate without water discharge to check operation performance, and check for signs of wear.	
Tasks Performed According To Designers' Operating Criteria (DOC), Standing Operating Procedures (SOP), And Manufacturers' Instructions . . .	
Exercise Gates And Valves: Exercise gates and valves according to the DOC, SOP, and manufacturers' instructions.	As required.

Continued . . .

Gates, Valves, And Other Mechanical Equipment (Continued)

Tasks	Frequency
Maintain Electrical System And Equipment:	
Monthly Tasks . . .	
Operate the standby gasoline-engine-driven generator for a minimum of 1 hour. Keep battery charged. Check the gasoline supply.	Check and operate monthly.
Check light bulbs and replace, as needed.	Check monthly.
Semiannual Tasks . . .	
Change oil in standby gasoline-engine-driven generator.	Change oil semi-annually.
Check exposed electrical wiring in the outlet works valve house, gate hoists, and spillway bridge.	Check semi-annually.
Annual Tasks . . .	
Check electrical conduits, pull-boxes, and switches in the outlet works valve house, gate hoists, spillway, and galleries.	Check annually.
Replace generator fuel supply annually.	
Replace And Overhaul Gate And Valve Equipment:	
Note: Gate and valve equipment should be replaced and overhauled according to the DOC, SOP, and manufacturers' instructions. Listed below are sample tasks. **You should follow the guidelines specified by the DOC, SOP, and manufacturer.** **Following an established frequency may not be sufficient to keep the equipment operating properly.** However, you should anticipate needed replacement and overhauling in order to budget for them.	
Every 2 Years . . .	
Replace all oil filters.	Every 2 years.

Continued . . .

APPENDIX A: SAMPLE O&M TASKS

Gates, Valves, And Other Mechanical Equipment (Continued)

Tasks	Frequency
Replace And Overhaul Gate And Valve Equipment: (Continued)	
Every 4 Years . . .	
Conduct operational tests of gantry cranes.	Every 4 years.
Every 5 Years . . .	
Overhaul gate position indicators.	Every 5 years.
Every 8 Years . . .	
Replace gate seals. Clean and repaint gates. Clean and repaint valve operators and gate hoists.	Every 8 years.
Every 10 Years . . .	
Overhaul hydraulic hoist cylinders. Replace electric coils of hydraulic valves. Replace pressure switches. Replace gate position limit switches.	Every 10 years.
Every 15 Years . . .	
Replace oil pump or hydraulic power units. Replace pressure gauges. Replace pressure relief valves. Replace accumulator of hydraulic power units. Replace hydraulic valves.	Every 15 years.
Every 20 Years . . .	
Overhaul or replace rollers on wheel assemblies of gates. Overhaul or replace electric motors.	Every 20 years.

APPENDIX A: SAMPLE O&M TASKS

Instrumentation

Tasks	Frequency
Take Instrumentation Readings:	
Take all required instrumentation readings according to an established schedule.	Take readings, as required.
Maintain Instrumentation	
Check instrumentation for damage from weather, traffic, or vandalism. (Mowers can damage instrumentation.)	Check instruments prior to taking readings.
Be sure that permanent survey points are not loose or disturbed. If necessary, add flags, signs, or otherwise protect the survey points.	
Keep seepage weirs clean and free of obstructions.	
Be sure all instrumentation is clean.	
Check exposed metal to see if it is corroded. Apply proper protective coatings to avoid corrosion of exposed metal.	
Replace all caps and covers on instruments if they have been removed or damaged.	

Communication Equipment

Tasks	Frequency
Maintain Communication Equipment:	
Check to see that communication equipment is in working condition. Periodically replace batteries in walkie-talkies.	Check equipment monthly.
Test operate communication equipment on a weekly basis to ensure reliability.	Test weekly.

Auxiliary Power Equipment

Tasks	Frequency
Maintain Auxiliary Power Equipment:	
Check to see that auxiliary power equipment is in working condition.	Check equipment monthly.
Test-operate auxiliary power equipment on a weekly basis to ensure reliability.	Test weekly.

Safety And Security Equipment

Tasks	Frequency
Maintain Safety And Security Equipment:	
Check the condition of fences, barriers, buoys, and other devices provided to protect the public.	Check monthly.
Fix or replace broken or missing safety and security equipment.	
Paint metalwork, as needed.	
Check all locks and replace missing or rusted locks, as needed.	
Restrict access to areas of the dam that are unsafe for public access or to areas that may be damaged by unrestricted access.	
Maintain Sirens:	
Check condition of warning sirens. Periodically test operate sirens to ensure their reliability.	Check and test semi-annually.
Maintain Fire Equipment:	
Check the condition of sprinklers and fire extinguishers. Periodically recharge extinguishers.	Check semi-annually.
Maintain Intrusion Systems:	
Check condition of intrusion systems. Periodically test-operate the systems to ensure their reliability.	Check and test semi-annually.

Continued . . .

Safety And Security Equipment (Continued)

Tasks	Frequency
Prevent/Remove Encroachments:	
Prevent construction or negotiate the removal of encroachments (e.g., poles, buildings, fences, etc.) that affect proper operation and maintenance of the dam.	Check for encroachments semi-annually.

Access Roads

Tasks	Frequency
Maintain Access Roads:	
Check condition of access roads. Make sure that access roads are kept clear. Make repairs as needed.	Check access roads monthly.

APPENDIX B

SAMPLE O&M BUDGETS

Note: Three sample O&M budgets are presented in this appendix. Example #1 is an O&M budge for a very small program with an annual budge of $910. Example #2 is an O&M budget for a program with an annual budget $14,840. Example #3 is an O&M budget for a much larger program with an annual budget of $2,540,000.

EXAMPLE #1

APPENDIX B: SAMPLE O&M BUDGETS - EXAMPLE #1

Operation		Amount
Inspection by engineer		$ 300.00
Annual Maintenance		
1.	Mowing - 20 acres @ $10.00	$ 200.00
2.	Removing animal burrows	$ 100.00
3.	Lubricating drain gate mechanism	$ 10.00
4.	Removal of trash from spillways	$ 100.00
5.	Repair of concrete	$ 200.00
	TOTAL BUDGET	**$ 910.00**

EXAMPLE #2

APPENDIX B: SAMPLE O&M BUDGETS - EXAMPLE #2

Operation		Amount
1.	Inspections and Supervision 7 days/yr. @ $60 -	$ 420
2.	Administration Ditch rider - 3 months @ $1,000 Office supplies and mailing - Secretary - 5 days/yr. @ $40 -	$ 3,000 $ 50 $ 200
3.	Pumping - 400 hr. @ $10 1/ -	$ 4,000
4.	. . . . . Other	$ ____
	Subtotal, Annual Operation Cost	**$ 7,670**
Annual Maintenance		
1.	Mowing - 200 ac. @ $8.00 2/ -	$ 1,600
2.	Hand Cutting and Spraying Labor - 10 days @ $40 Supplies and Equipment -	$ 400 $ 200
3.	Servicing 10 flowmeters - 2 hrs. each @ $8.00	$ 160
4.	. . . . . Other	$ ____
	Subtotal, Annual Maintenance Cost	**$ 2,360**
Periodic Maintenance		
1.	Debris removal Assume required first year and every fourth year thereafter at 3 bridges in project	
	Labor, 3 bridges x 3 days per bridge @ $40 per day	$ 360
	Tractor with winch. 3 bridges x 8 hrs. per bridge x $25 per hour	$ 600
	One-time cost	**$ 960**
	Amortize over 4-year measure life (not project life)	
	Annual cost = 960 x .29773 3/ =	$ 286

1/ Includes fuel, routine maintenance and repair, and operator.
2/ Custom rate.
3/ Amortized 4 years @ 7-3/8 percent

APPENDIX B: SAMPLE O&M BUDGETS - EXAMPLE #2

Periodic Maintenance (Continued)	**Amount**
2. Clean 3 mi. canal @ $750 per mi. each year (Cleaning to be rotated around project)	$ 2,250
3. Fertilize grass (5-year interval) First application 5 years after installation	
200 ac. @ $12 per ac. = $2,400 (200 lbs. of 20-20-20 custom applied)	
Discount to annual cost	
$2400 x 0.70062 1/ x 0.24634 2/ =	$ 414
Subtotal, Annual Cost of Periodic Maintenance	**$ 2,950**
Restoration Or Replacement	
1. Overhaul Pump and Motor (10-yr. interval - replace @ 50 years)	
Overhaul each 10 years $4,000 Discount to annual cost	
$4,000 x 0.49087 3/ x 0.14486 4/ =	$ 284
Replace at 50 years - $25,000	
Discount to annual cost -	
$25,000 x 0.02850 5/ x 0.07591 6/ =	$ 54

1/ Present value of 1, 5 years hence @ 7-3/8 percent.
2/ Amortized 5 years @ 7-3/8 percent.
3/ Present value of 1, 10 years hence @ 7-3/8 percent.
4/ Amortization 50 years @ 7-3/8 percent.
5/ Present value of 1, 50 years hence @ 7-3/8 percent.
6/ Amortization 50 years @ 7-3/8 percent.

APPENDIX B: SAMPLE O&M BUDGETS - EXAMPLE #2

Restoration Or Replacement (Continued)	**Amount**
2. Replace Side Inlet Structures 20-year interval	
1200 ft. of CMP @ $10.00 -	$12,000
Equipment rental	
Front end loader - 200 hr. @ $38.00 -	7,600
Operator - 200 hr. @ 7.00	1,400
Laborers - 500 hr. @ 5.00	2,500
Miscellaneous -	500
	$24,000
Discount to annual cost -	
$24,000 x 0.24096 7/ x 0.09716 8/ =	$ 562
3. . . . . Other	$ ____
Subtotal, Annual Cost - Restoration or Replacement	**$ 900**
TOTAL BUDGET	**$14,840**

7/ Present value of 1, 20 years hence @ 7-3/8 percent.
8/ Amortization 20 years @ 7-3/8 percent.

EXAMPLE #3

APPENDIX B: SAMPLE O&M BUDGETS - EXAMPLE #3

SUMMARY BUDGET DATA

Item		Amount
AE	A-E Contracts	- 0 -
AW	Awards	5,500
CN	Contracts	768,200
CO	Commercial Communications	25,000
HL	Hired Labor	1,164,500
HO	Overtime	11,000
OA	By Other Agencies	- 0 -
OE	Miscellaneous	315,600
PE	Plant & Equipment	123,400
RU	Rent & Utilities	60,000
SM	Materials & Supplies	52,800
TN	Training	500
TR	Travel	13,500
	Total Operating Budget	**2,540,000**

APPENDIX B: SAMPLE O&M BUDGETS - EXAMPLE #3

A-E CONTRACTS

AEC	Description	Amount
298	Architect-Engineer contract cost	- 0 -

AWARDS

AEC	Description	Amount
225	Incentive awards	5,500

CONTRACTS

AEC	Description		Amount
284	Negotiated or sealed bid contracts		- 0 -
285	Other contractual services, i.e., purchase orders		768,200
	Mowing	130,500	
	Lawn maintenance	0	
	Cleaning	207,000	
	Janitorial	20,200	
	Gate attendant	120,000	
	Law enforcement	50,000	
	Miscellaneous purchase orders	240,500	

COMMERCIAL COMMUNICATIONS

AEC	Description	Amount
280	Commercial communications including local & long distance, rental, installation, and repair	25,000

APPENDIX B: SAMPLE O&M BUDGETS - EXAMPLE #3

HIRED LABOR

AEC	Description	Amount
226	Regular labor	1,164,500
228	Regular labor by other TDO	- 0 -
230	Regular labor by other FOA's	- 0 -

OVERTIME LABOR

AEC	Description	Amount
227	Regular overtime	11,000
229	Regular overtime by other TDO	- 0 -
231	Regular overtime by other FOA's	- 0 -

OTHER AGENCIES

AEC	Description	Amount
322	Work performed by other agencies	- 0 -

OTHER EXPENSE (MISCELLANEOUS)

AEC	Description	Amount
251	Chartered air services	3,000
252	Real estate & misc. expenses associated with PCS	8,000
254	Movement of household goods for PCS	7,000
255	Storage of household goods & temp. housing for PCS	2,300
256	Freight not related to PCS	2,000
273	Library and subscription costs	500
281	Leasing commercial vehicles except on travel	- 0 -
283	Equipment rental	26,000
320	All other costs not otherwise identifiable	261,800
331	Purchase of tools, furniture, and equipment	5,000

APPENDIX B: SAMPLE O&M BUDGETS - EXAMPLE #3

PLANT AND EQUIPMENT

AEC	Description	Amount
326	Vehicle charges for sedans & pickups	102,400
333	Plant & equipment charges other than sedans & pickups	21,000
345	Vehicle rental	- 0 -

RENT AND UTILITIES

AEC	Description	Amount
282	Rent & utility cost other than AEC 280	60,000
339	Office space rental	- 0 -

MATERIAL AND SUPPLIES

AEC	Description	Amount
272	Imprest fund purchases	36,000
275	Office, first aid & computer supplies	3,500
277	Gasoline & diesel for vehicles & boats	12,000
278	Lubricants, e.g., oil, grease, etc.	1,300

TRAINING

AEC	Description	Amount
274	Tuition, books, material, instructor, classroom, etc.	500

TRAVEL

AEC	Description	Amount
250	Regular per diem & transportation	12,500
253	Per diem & transportation	1,000

MISCELLANEOUS PURCHASE ORDERS

AEC CODE	DESCRIPTION	AMOUNT
285	Waterborne Shower/Toilet Lakeside	50,000
285	Waterborne Shower/Toilet Platter	50,000
285	Electrical Hookups W Burns Run	23,000
285	Herbicide Embankment	15,000
285	Herbicide Levees	10,000
285	Install Waterlines Lakeside & E Juniper	32,000
285	Boundary Fence Washita Area	7,500
285	Establish New Trees	5,000
285	Establish Wildlife Food Plots	2,000
285	Fog Seal Roads Various Locations	14,000
285	Crack Seal Roads Various Locations	8,000
285	Chip & Seal Roads Various Locations	24,000
	TOTAL	**240,500**

APPENDIX B: SAMPLE O&M BUDGETS - EXAMPLE #3

ALL OTHER COSTS NOT OTHERWISE IDENTIFIABLE

AEC CODE	DESCRIPTION	RESOURCE	O&M	REHAB	AMOUNT
320	Asphalt		4,300		4,300
320	Building Supplies		18,200	18,500	36,700
320	Buoys, Chains & Clamps		9,500		9,500
320	Cement/Concrete		500	5,000	5,500
320	Electrical Supplies		1,200	500	1,700
320	Fencing Material	1,000	1,000	2,000	4,000
320	Fertilizer		7,500	500	8,000
320	Fire Protection Supplies		1,500		1,500
320	Generator & Turbine Parts				
320	Gravel		7,000	43,000	50,000
320	Hardware		1,000	1,000	2,000
320	Horticulture Supplies	6,000	500	500	7,000
320	Lumber		3,000	3,000	6,000
320	Office Supplies				
320	Oil, Grease & Lubricants				
320	Painting Supplies		5,300	500	5,800
320	Pesticides		4,000		4,000
320	PCMC Supplies & Materials				
320	Photo Supl & Process	500	500		1,000
320	Railroad Ties		2,000	19,000	21,000
320	Recorder Charts & Parts				
320	Rock		12,000	20,000	32,000
320	Safety Items	4,500	4,000	1,500	10,000
320	Sand		500	1,000	1,500
320	Steel & Iron		200	2,000	2,200
320	Switchyard & OCB Parts				
320	Vehicle Fuel				
320	Vehicle Parts (Proj Owned)		7,300	5,000	12,300
320	Water System Supplies		12,300	2,000	14,300
320	Welding Supplies		500	500	1,000
320	Other Materials & Supl	500	5,000	5,000	10,500
320	Signs		10,000		10,000
	TOTALS	**12,500**	**118,800**	**130,500**	**261,800**

EQUIPMENT RENTAL

AEC CODE	DESCRIPTION	AMOUNT
283	Equipment Rental Scrapper - E Juniper	15,000
283	Equipment Rental Scrapper - Lakeside	5,000
283	Equipment Rental Scrapper - W Juniper Ramp	4,000
283	Equipment Rental Scrapper - Buncombe Ramp	2,000
	TOTAL	**26,000**

APPENDIX C

REFERENCES

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