Management Training Manual

For Board Members and Water Treatment Plant Operators of Public Water Association

State Ministry of Land, housing and Public utilities, Unity State, Government of South Sudan

unicef

Concern worldwide

Management Training Manual for Board Members of Public Water Associations

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Table of Contents

List of Tables:

Table of Figures

List of Abbreviations

CAFs	Capacity Assessment Forms
CIP	Capital Improvement Plan
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GPM	Gallons per minute
JICA	Japan International Cooperation Agency
MEDIWR	Ministry of Electricity, Dams, Irrigation and Water Resources
O-M	Operations and Maintenance
Ppb	Parts per billion
ppm	Parts per million
psi	pound per square inch
PWS	Power Supply
PWS	Public Water System
SSP	South Sudan Pound
SSUWC	South Sudan Urban Water Corporation
SUWASA	Sustainable Water and Sanitation in Africa
UNICEF	United Nations Children' Fund
USAID	United States Agency for International Development

An Introductory Training Program for Board Members of Public Water Systems:
An adequate, safe water supply is essential to the very lives of our people. Water is a commodity that is critical to the human and economic development of our communities. Governing bodies of public water systems in South Sudan find it difficult to meet the demands brought on them by increased legal mandates and regulations that require expertise that is more technical and increase the costs of doing business.

Not only are there potential legal problems concerning the quality of water supplies, but there also are potential legal problems with the way boards conduct business. Consumers have increased fears about the presence of harmful chemicals and bacteria in their water supplies. Boards of public water systems face the problems of retaining trained technical personnel who are needed to maintain the systems, keep users satisfied and informed, conduct business in the proper legal manner, and make long-range plans that will keep the system updated. Many of these people perform the tasks while receiving little or no compensation.

In 2013, USAID contracted Tetra Tech International Development to undertake Water and Sanitation Sector reforms in a number of countries – including the Republic of South Sudan. The program was called SUWASA and the South Sudan chapter was titled, “South Sudan water sector reforms”. The objectives were two-pronged: (1) Development of a framework for local government participation in management of the local water stations in line with policy; and (2) Support preparedness at the state, municipal and local government level to progressively assume the responsibility for the management of water supply service provision. This culminated to the Urban Water Sector Reform Initiative, which was signed on November 3, 2011 by MEDIWR and the SSUWC with GIZ, JICA and SUWASA as witnesses. The order cited as “Presidential order No. 20/2012 for the formation of Directors of South Sudan Water Corporation, 2012 A.D.” This calls for board member training program package because of growing concerns about maintaining safe water supplies and the increasing technical and legal responsibilities assumed by the board members of public water systems. This legislation affect board operations. These land-mark activities in South Sudan water governance have been the fore-runners to hand-over of the Bentiu and Rubkona Water Utilities to the Government, through respective water-board, which now need to build their capacity in Water Utility Management.

Needs For Human Resource Development

Adequate and safe drinking water supplies and appropriate sanitation facilities form a sound basis for improvement in community health. Maximum health benefits will be achieved only when the water supply and sanitation facilities operate continuously and to full capacity in conformity with the acceptable standards of quantity and quality. If the O&M tasks are to be carried out effectively and efficiently there is a need for strengthening the technical, operational and managerial capabilities of the O&M managers and staff. The management orientation shall change and the management shall become service oriented and be prepared to run the organization on a commercial basis. The management must be able to motivate the staff to perform better. It is essential that the organization responsible for O&M has well qualified, experienced, efficient staff. Human resource development through training programmes, career plans and adequate salary system should be given special emphasis to improve the knowledge and skills of the staff. This objective is achieved by first developing proper job description and undertaking training schemes for the O&M managers and personnel. This chapter covers the following topics on Human Resources Development in water supply sector:

- Job description
- Training needs assessment
- Training for capacity building
- Training for refreshing skills
- Training of trainers
- Training in outside institutions
- Long term training needs
- Short term training needs
- On-the-job training
- Quantification of training
    - Categories
    - Number
    - Frequency
    - Duration
    - Training Schedule
    - Yearly programme
    - Institutions
    - Training budget

Job Description

Category Of Staff

The O&M function is performed by (a) operating staff and (b) supervisory staff. While the former actually runs the system, the latter monitor the operations and provide managerial support. The O&M staff should know the procedures for routine tasks to be performed by them and supervision and inspection managers should know the checks and inspections to be carried out by them at specified intervals to monitor and evaluate the status of operation and maintenance. The supervision or inspecting officers have to ensure that the operation and maintenance staffs perform their assigned duties promptly and properly. While in most of the cities, a large work force has been already created over a number of years and is being used for O&M of the systems; the suitability of skills and experience has not necessarily been tested.

Job Description

The managers of water utilities deal with planning, organization and finance in water supply and sanitation. They will also be required to formulate programmes and implement activities aimed at improving the effectiveness of operation and maintenance practices. This job description is quite general in nature and the water utilities should have well defined duties and responsibilities at various levels of employees.

As a first step to preparation of job descriptions, an O&M plan or programme containing procedures to be adopted or actions to be taken is prepared for each piece of equipment in the system and the person to carry out this action is to identify. The job description of operating personnel shall clearly define the limits up to which these personnel can carry out normal maintenance. The job description of the Supervisor/Manager shall include the requirement that they shall ensure that the operating personnel conform to these limits and thus ensure the safety of the equipment. (Sample job requirements are given in Annexure).

Training Needs Assessment

Training

Training is a planned process to modify attitude, knowledge or skill through learning experience to achieve effective performance in activity and to develop abilities of the individual to satisfy the current and future needs of the organization.

The personnel who are already available or chosen to carry out the actions contained in the O&M programme may have to be trained through special courses or by "on the job training" to ensure that these personnel are thoroughly trained to carry out the actions listed in the plan of maintenance. This training is essential to prevent experimentation by operating personnel to meddle with equipment since often these operating personnel may not be capable to take up the required maintenance. On the job training is preferred to classroom training.

The supervisors can be trained initially; they can later train their operators. A systematic plan of action of any training programme include:

- Identification and assessment of the need for planned training.
- Defined training objectives.
- Appropriate strategy for training.
- Provision for assessing effectiveness of training.

TRAINING NEEDS IDENTIFCATION

Objectives of training needs identification

The objectives of training needs identification are:

• To identify a profile of the training needs and interests of the employees.
• To gather information on the climate, culture and communication links of the work place.
• To make recommendations for a training initiative that would be the basis for a strategic plan for employee development.

Process of Identification of Training Needs

The basic process of identifying training needs involves the following steps:

- Determine what is required or expected in the job.
- Determine the degree to which this requirement is being met.
- Determine whether training can bridge the gap between what is required in the job and the present knowledge, skills, attitudes or behaviour of the employees.

Collection of data

Data on the assessment of training needs can be collected in the following ways:

- Discussions with the officials and employees, supervisors and top management.
- Observing the employees, their work, work flow and relationships.
- Review of records and reports, particularly the reports if any which provide the reaction of the consumers to the services provided by the utility, organization structure, organization policies, records of past trainings etc.

Analysis of data

The analysis of the data is carried out with a view to make the assessment of training needs for various levels as below:

- Needs for the organization as a whole – corporate needs
- Needs for departments/teams within the organization – group needs
- Needs for individual employees – individual needs

There is a need for a i) Job analysis and ii) A person analysis for carrying out a training need analysis.

Job Analysis

The information is obtained on the following aspects :

- Problems faced by jobholders in learning basic skills and applying them successfully in work.
- Weakness in performance of existing jobholders due to gap in knowledge, lack of skills or motivation.
- Areas where competence levels are not up to standards required.
- Areas where future changes in work process or methods or job responsibilities indicate training needs.
- How training is carried out at present.

PART I: BOARD MEMBERS MANAGEMENT TRAINING

Section II: Introduction

Overview

As volunteer board members of your local water utility, you are fortunate that the State of Unity has had the foresight to require that you have some training. Although many of you may chafe at being required to do things, some will chafe even more at being required to do something that seems to be only "common sense." It is true that serving as a good board member is common sense. Because of the multiple responsibilities, you have, it can be difficult to recognize the most important ones. That is what this training will help you do. You will hear over and over the phrases, "It's the responsibility of the board" and "It's your responsibility as a board member." By the end of your 8 hours of training, you should be better prepared to succeed in this job.
That is right—it is a "job!" It is not an honorary position.

You do not just sit, listen, and make comments. You do not sit around and drink coffee and gossip. You may not have gotten a job description when you were appointed/elected, but you should have one. Your community has put its trust in you to make decisions that have a very significant effect on its health, welfare, and economics. And yes, you are responsible legally and morally for the decisions you make or don't make. It is your responsibility to make sure your customers have safe, dependable, and affordable drinking water. So begin by looking at your legal authority as a board member.

Legal Authority

You are directing a system authorized to operate by the state; therefore, the laws of the state regulate your actions.

State laws granting this authority vary, but most will include at least the following:
The legal process for forming and governing the entity

- General and specific powers granted to the entity by the state
- Powers or authority prohibited by the state
- A variety of other special provisions relating to the functioning of the entity such as legally prescribed methods of operation, record keeping, and reporting requirement

It is the responsibility of each board member to become familiar with and knowledgeable about state laws granting that system the authority to operate, the municipal or corporate charter, county or municipal ordinances establishing the system, articles of incorporation and bylaws, and any other documents relating to the organization of the system.
Without a full understanding of the authority and responsibility granted to the system, a decision maker cannot exercise prudent or proper judgement.
Aside from the authorizing statutes, there are numerous other state laws that may apply to the conduct and administration of the operating entity and the operation of the water system itself. It is the responsibility of board members to learn what other laws and regulations affect the system and to comply with those laws.

- ✓ The largest body of state law regulating your water system will be one that is designed to protect the public health. Others that may apply to you include the following:
- ✓ Procedures for purchasing and procuring goods and services
- ✓ Freedom of information and open meeting laws
- ✓ Procedures for accounting and auditing financial records

- ✓ Ethics standards applicable to boards and council members
- ✓ Insurance and bonding for public facilities and public officials
- ✓ Laws affecting the ability to incur debt by the entity
- ✓ Rights of eminent domain and property acquisition
- ✓ Laws regulating service areas or establishing service boundaries
- ✓ Laws dealing with sales taxes, use taxes, franchise taxes, and income taxes
- ✓ Labor relations statutes of all types
- ✓ Laws affecting the frequency, form, and general conduct of the meetings of boards of directors
- ✓ Contracts and contracting for services and/or construction activities
- ✓ Proper record keeping and reports relating to system operation and management

The types of documents relating to the origination of the legal entity responsible for supplying water to your community may include the following:
Articles of incorporation

- ✓ Petition to courts, court orders, resolutions, or judgments
- ✓ Corporation bylaws
- ✓ Certificates of operating authority
- ✓ Certificates of public convenience and necessity
- ✓ Public trust indentures or agreements
- ✓ Local ordinances or acts
- ✓ State or local enabling legislation
- ✓ Municipal charter
- ✓ Inter-local agreements with other entities or agencies

All documents that relate to the origination or incorporation of the legal entity authorized to operate your water system are extremely important and must be kept in the system records.

These documents form the legal basis for the system's existence and prescribe the conditions under which the system may legally operate. Similar to the organizational mission statement, these documents provide the framework for the operation and function of the water system. They should be kept in a safe place and should be reviewed periodically by all board members.

The Small System
Statement of Purpose

Customer complaints?
Too many long meetings where nothing gets decided?
Personality conflicts on the board?
Never enough money?

It is likely that serving on your water system's board hasn't turned out to be exactly what you had in mind when you were elected. Part of what makes serving on the board of a small water system so difficult is that different groups want different things from your system.

Customers want

- ✓ Low water bills
- ✓ Dependable service
- ✓ Good-tasting and safe water

State regulators want

- ✓ Compliance with regulations
- ✓ Properly designed systems
- ✓ Certified operators

Debt holders want

- ✓ Repayment of loans on time
- ✓ Financially sound operation
- ✓ Good system maintenance to protect their investment

Employees want

- ✓ Fair wages
- ✓ Good working conditions
- ✓ Job security

It is hard to satisfy anyone when everyone wants something different.
One of a board's biggest responsibilities is to balance the various demands on the system.
Is there a way to make balancing competing demands easier? There is no easy answer, but a clear sense of purpose shared by members of the board will help.
If your board spends time and effort developing a statement of purpose it will do the following:

- ✓ Provide a common basis for decision making
- ✓ Help the board understand all its responsibilities
- ✓ Help keep the proper perspective while focusing on day-to-day problems

The statement of purpose defines the results your water system is working to achieve.

Think about what you feel the purpose or "business of the system" should be. What is the reason for existing? Try answering the six questions below. (The words or phrases following each question suggest ideas to consider.)

1. Why does your water system exist? (Besides supplying water, what about protecting the public health and allowing the community to grow?)

2. What kind of water quality should your system provide? (Consider taste, odor, color, and safety.)

3. What is your general plan for pricing water? (Consider the following questions: Should it be a fair price to all?

4. Should it break even or generate profit? Should it operate at a loss? Should it encourage water conservation?)

5. What is your water supply plan? (Consider the following: uninterrupted service, dependability, minimum number of breakdowns, service expansion)

6. In what way will your system be operated? (Business plan)

7. Who should your system seek to serve? (Consider the service area and current and future customers.)

At your next meeting, ask the other members of the board to help develop a written statement of purpose for your system. As a board, talk about the questions raised on the previous page. When you develop a statement, the entire board can agree on, write it down. Have the board vote this statement of purpose into the official minutes.

Developing a written statement of purpose, the whole board supports takes time. Water is taken for granted. The importance of water involves a serious discussion.
Don't expect everyone to agree right away. Remember that everyone comes from a different background and has different experiences.
Don't bury differences of opinion about the purpose of the system. If differences are not settled, they will return later. While talking, members may realize how much they care about the ability of the water system to serve its purpose in the community.
The discussion process gives the board a chance to form closer ties, share expectations for the future of the system, and better understand the differences among board members. Once you have answered the six questions in ways everyone can agree on, you will have a stronger statement of purpose for your water system.

Below is a sample statement of purpose that would be suitable for a small community water system. You may use it as needed.

The purpose of XYZ Water System is to provide its customers with good-tasting water that consistently meets water-quality regulations.

The system will provide water to all its customers at a fair and reasonable price that reflects the full cost of producing, treating, storing, and distributing it.

Service will be dependable, uninterrupted, and operated in a businesslike way.

Because safe drinking water is so important in protecting the public health and the development of the community, the system will try to extend service to all customers in the service area that can reasonably be served.

A clear statement of purpose is like a compass. It helps keep all the day-to-day decisions pointed in the right direction.
The statement of purpose states the basic reasons for the system's existence. Use it as a yardstick for your board's decisions. Good decisions move the system toward achieving its broader purpose; poor decisions do not. Review your statement of purpose on a regular basis.

Managing vs. Operating: Who Does What?

Most small water systems do not have the money to hire a professional manager. So who takes on those responsibilities?

The board thinks the operator does, the operator thinks the board does, and actually, no one does.

Many small systems fail to clearly define board, operator, and bookkeeper responsibilities. They get into trouble because people are not sure who is supposed to be doing what and who is going to be held accountable.

The board is legally responsible for all aspects of the water system. This includes employee supervision, finances, operations and maintenance, planning, and compliance with safe drinking water regulations.

There is a difference between managing the system and operating it. “Managing” refers to the administrative functions such as planning, budgeting, policy setting, etc. “Operating” refers to the technical tasks such as taking water-quality tests, repairing lines, doing preventive maintenance on equipment, and treating water with the proper chemicals. Generally, operators are trained to operate a system, not manage one. With very small systems, the only employees may be an operator and a bookkeeper or clerk, and these are often part-time employees. Yet the same kinds of management activities needed for large systems with paid managers and staff must still be handled in a small system. Because the board is legally responsible, participate actively in the management of your system.

What Exactly Is Organizational Management?

Organizational management involves how the decision-making body exercises its delegated authority in governing the utility. The board of directors, board of commissioners, or city council is granted the authority and responsibility for governing the water system and for governing itself. What does this entail? The following general organizational management responsibilities are governed by state law, articles of incorporation, charter, organization bylaws, or certificate of incorporation. Refer to whichever documents specify what you are authorized or limited to do.

Self-Regulation by Boards. In general, the governing body has the responsibility of establishing rules and policies that dictate how the board will operate and conduct business. The governing board’s power to regulate its own actions and its own members is an extension of the legal documents mentioned previously. Policies regulating the board’s conduct of business deal mainly with procedural matters. When developing rules and procedures for doing business, it is important that the rules be fair and equitable to all members of the board and to all customers and that the rules are applied fairly and consistently in every case. If your policies aren’t consistent, people will question your decision making and your board will lose the trust and confidence of its customers.

Selection of Employees. The governing board has the responsibility to hire and supervise the employees who actually operate the system. This is one of the most important responsibilities the board exercises, especially in small systems in which a part-time operator and a part-time billing clerk/bookkeeper are often the only staff a system can afford. Many of the operating and financial tasks of the system may be carried out by as few as two people. It is important that the people hired by the board have the necessary experience and training to perform adequately and effectively all tasks necessary to run the system on a day-to-day basis. It is the board’s responsibility to decide how many people to employ, what those people will do, how they will do it, when it will be done, and who those people will be. After employment, it is up to the governing board to decide whether the job is being done properly. If not, the board must decide what actions to take to ensure it will be done right in the future. Remember that employees are an extension of your board. How well the system is operated is a direct reflection on the governing board. Ultimately, the board is legally responsible for the operation and financial health of the system. This responsibility also applies to any consultants your system may need—such as engineers, attorneys, or accountants. These consultants are "agents" of the governing body, and the board is responsible for the performance of their duties. For this reason, take the same care in selecting and hiring consultants as you take when hiring employees.

General Conduct of Affairs. The governing board is granted the responsibility for the "general conduct" of the utility. This means the board or council is granted the authority to take any actions it considers necessary to direct the operations of the system. Of course, to be valid, all actions must be legal under state laws, your charter, bylaws, etc.

Borrowing Money. Another major responsibility of the governing board is that of borrowing money. Usually, money is borrowed to finance construction of the system or to make improvements to an existing system. The board may pledge assets, issue certificates of indebtedness, pledge revenues, and issue mortgages or deeds in order to comply with the legal requirements of lenders.

Establishing and Changing Rates, Charges, and Assessments. The governing board of the system has the authority to set water rates, as well as to establish and collect other fees and charges. "Other fees and charges" are the tap fee or initial connection fee, a penalty for late payment of water bills, a reconnect charge if service is disconnected because of nonpayment of bills, and so on. The water rates of publicly owned systems are usually not regulated by state agencies or authorities. The rates of privately owned systems are regulated by state public service, public utility, or water commissions. Individual states do not have the authority to specify what costs of providing water must be recovered through a utility's rate structure. This restriction is to ensure that systems have the ability to charge adequate rates to remain financially strong.

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How Is All of This Done? It is recommended to use a "committee of one" system. Each member of the board has a specific area of management for which he or she is responsible. The "committee" will take the lead and head the full board toward developing efficient ways to manage its part of the system's activities. Each member of the board will become an expert for one area of the system.
Make sure that the following areas are covered:

- Employee and customer relations
- Financial operations and management
- Operations and maintenance
- Planning and development
- Regulatory compliance

A member of the board may have a talent or interest in one particular area, enabling him or her to work in that area. If the board cannot agree on who will oversee what, then rotate the responsibilities every few months. A special committee may be needed to deal with specific problems such as water loss or delinquent payment of bills.

Some boards have more than five members, so they may have "committees of two" or "committees of three." Each area needs at least one person who will assume primary oversight responsibility. The "areas of oversight" are the activities you will supervise and report on to the full board. In most cases, you won't take any direct action—you will only advise the board so that it can discuss and vote on needed actions. You will help define what needs to be done, suggest ways of doing it, and make sure the board's actions are carried out. Now, what do you do to properly oversee your area? It is easiest to approach your responsibility if you consider the following points for each area:

- Fact-finding
- Planning (setting objectives)
- Implementing
- Overseeing and reporting

Fact-finding. In order to advise the full board in each area of oversight, you have to learn what's being done in that area. In each area—customer relations, financial management, operations and maintenance, system planning and development, and regulatory compliance— you should ask the following questions:

- What is presently being done?
- What is not being done that should be done?
- What should be done better?

Fact-finding is the process of determining what exists now versus what should exist at some point in the future.

Planning. Planning is the process of setting goals and objectives to be achieved in the future. Based on what you determine in the fact-finding step, objectives are developed and recommended to the full board for each area of oversight. A separate session on planning will be presented later, but an overview is provided now on how you can start it. Use the area of oversight "operations and maintenance" as an example. In your fact-finding, you discover repair costs have gone up dramatically over the last few years, and now they are equal to 40 percent of the total budget. This may lead you to recommend to the board the objective of reducing repair costs at least 10 percent per year over the next 3 years.

An example of using the area "financial management" could be the following: You notice expenses are increasing faster than revenues are. You may recommend to the full board that it conduct a water rate analysis during the next 12 months to figure out how to meet expenses in the future or if a rate increase in necessary.

Implementation. Once the board has set objectives, make sure everyone is working toward those goals. In the implementation phase, answer the following questions:

- What exactly is going to be done?
- How is it going to be done?
- Who is going to do it?
- When is it going to be done?

Going back to the example, a number of things may have to be done to reach the objective of reducing repair costs. These include developing and using a preventative maintenance program, doing repairs "in house" instead of hiring someone to do them, or putting money from revenues in an equipment replacement reserve fund so you can replace equipment that is likely to break down. Whatever your area of oversight, it will be your job to see that the system or procedure exists to meet the board's objectives.

Overseeing and Reporting. The last phase of your committee work is overseeing and reporting. Each "committee" should report to the board at the monthly meetings. The agendas should include the bookkeeper's report among the reports. The first "committee" on the list was "employee supervision." The person with this responsibility must be available if there's an employee problem or need. This won't always be possible, but try to select the person who is most available. Remember the following important rules when working with employees:

- It is impossible for employees to answer to several bosses. Each employee should be responsible to only one person on the board. That one person, the “employee supervision committee,” must have the full board’s authority to act on its behalf with regard to employees.
- Whatever “committee” you are, you’ll have to get information from employees to do your job. You may get information, but remember that you cannot tell them what to do. If they are doing something wrong, report to the board and it will instruct the “employee supervisor” how to handle it.

It will take some time to do these things. You may have had the mistaken idea when you hired a certified operator that your job was done. Not so. Your small water system is a business. As a board member, you have to make it your business to know what is going on.

The “committee of one” method suggested here is a simple way for everyone on the board to share the responsibilities.

At your next monthly board meeting, get the process going. Set up committees and schedule reports on the next agenda.

You will find things won’t keep slipping through the cracks, and you won’t be as likely to say, “Well, I thought someone else was supposed to do it!”

Am I a Good Board Member?

Please grade yourself as a board member and as a decision maker. An honest self-assessment should give you an idea of your effectiveness as a board member. Circle the letter that best describes your grade for each statement. The grades should indicate your strengths and weaknesses as you participate in the business conducted by your water system board.

A B C D E F	1.	Unless I am sick or a real emergency occurs, I attend all board meetings and am on time.
A B C D E F	2.	I carry my share of the responsibility and will do any tasks that I can to see that business is conducted properly and efficiently.
A B C D E F	3.	I find out what business will be conducted and am well prepared for the meeting.
A B C D E F	4.	I have studied our organization’s bylaws.
A B C D E F	5.	I really want to serve our organization. I have no personal agenda and expect no hidden financial rewards for serving.
A B C D E F	6.	I am familiar with our water system; know most of its users; and know where our lines, wells, and tanks are located.

A B C D E F 7. I am a team player who does not allow my emotions or disagreements with other board members to interfere with my objectivity in making decisions. I try to make decisions that are best for the water system.

A B C D E F 8. I am familiar with the laws that affect our board such as water quality and health department requirements, policies for hiring and firing employees, and liability of boards/board members.

A B C D E F 9. I participate in long-range planning. I know the investment required and the cost of operating the system.

A B C D E F 10. I am for fair water rates. However, I am also for rates that cover operating costs and provide adequate funds for future plans.

A B C D E F 11. I know the major responsibilities of the employees hired by the board.

A B C D E F 12. I believe in periodic evaluation of employees. I also strongly believe in hiring the most qualified person for a job and allowing that person to do the job without interference from the board.

A B C D E F 13. I believe that I should be available to work on specific jobs and committees in order to spread around the work load and not put all of the load on the board president or chair.

A B C D E F 14. I do my best to present a good image of the board to the public. I do not make negative comments that produce friction and disharmony among board members.

A B C D E F 15. I know the policies of the board for bids and contracts and for hiring services for the water system.

A B C D E F 16. I know the rules of the organization concerning rates, late payments, disconnecting services, and reinstating services.

A B C D E F 17. I try to increase my knowledge of our system, our bylaws, the legal and environmental regulations, and other information that would benefit me as a board member.

A B C D E F 18. I know the rules we use for conducting business such as following an agenda, making motions, and finalizing business decisions.

A B C D E F 19. I try to have a good working relationship with the manager, operator, and other employees of the water system or water department.

A B C D E F 20. I urge the board to communicate with users through bill stuffers, newsletters, and/or public media.

Pre-Training Test

We all know there are varying degrees of problems and challenges facing water system boards, the purpose of this assessment is to gauge your thoughts about your system's current situation and your service as a board member.

1. How often does your water system (board) conduct city/town board meetings?
   A. Every Month
   B. Bi-monthly
   C. Weekly
   D. Other
2. How often do you attend your city government board meetings?
   A. Every meeting
   B. At least 75% of the meetings
   C. At least 50% of the meetings
   D. Very Seldom, do I attend water board meetings
3. How often do you hear a report from your waterworks operator or water system department head?
   A. Every month
   B. Not every month, but at least six times each year
   C. Once each year
   D. Only when necessary
   E. Never
4. How long has it been since your system has evaluated its water rates?
   A. Within 1 year
   B. Within 3 years
   C. Within 5 years
   D. Within 10 years
   E. Longer than 10 years
5. What financial information is made available to you and other members of your board when you have meetings? (Circle All that Apply)
   A. Current Expenses / Invoices / Claims Docket
   B. Financial Reports including Income Statement / Balance Sheet / Aged Accounts
   C. Check Register or Disbursement Journal
   D. Bank Statements
   E. Nothing
6. Are you active in planning your system's budget?
   A. Yes, all board members participate in budget planning process
   B. No, I only vote on the budget after it has been prepared by other board members serving on the budget committee
   C. No, I only vote on the budget after it has been prepared by our accountant
   D. No, I only vote on the budget after one board member or employee has prepared it.
   E. No, our system does not prepare an annual budget
7. Do you and other board members of your system each have a copy of your bylaws or other governance policies?
   A. Yes, I bring my copy to every meeting.
   B. Yes, I bring my copy to the annual meeting only.
   C. Yes, I never bring it to a meeting – but I have read the bylaws and fully understand the contents.
   D. No, I don't have a copy but I know that there is an available copy at every meeting.
   E. I don't know where a copy of our bylaws is located.

8. How much time can a customer of your water system go without paying his bill before his water service is disconnected?
   A. 30 Days
   B. 60 Days
   C. 90 Days or Longer
   D. It depends on who it is – we do lock a few customers but are not consistent as far as a set time or policy.
   E. We generally do not disconnect water service for non-payment of customer water bills.

9. When is the last time your system had a pumping test performed on its wells?
   A. Within 1 year
   B. Within 2 years
   C. Within 5 years
   D. Within 10 years
   E. I don't know if we have ever had a pumping test.

10. How involved is your board with capital improvements planning?
    A. We meet at least once each year with our engineer and update our plans for expansion and improvements.
    B. We rarely consult with an engineer but have a long-term plan for expansion and improvements.
    C. We don't have a strategic capital improvements plan but occasionally will hire an engineer for a necessary project.
    D. My board has not considered further capital improvements since our system was constructed.

11. My water system has clear written policies for customer service, financial internal controls, operating procedures, and emergency procedures.
    A. True
    B. False

12. My water system has clear written job descriptions for our employees as well as written contracts for nonemployees performing regular recurring services for the system.
    A. True
    B. False

13. My water system mails newsletters to our customers at least once each year.
    A. True
    B. False

14. My water system does not mail out newsletters but attempts to keep customers informed about plans for improvements, rate increases, annual meetings, and other important information.
    A. True
    B. False

15. How many years have you served on your water board?

Less than 1 year

   A. 1-5 years
   B. 6-10 years
   C. 10 - 15 years
   D. Longer than 15 years

16. How much new information do you think you will learn through a Certified Board Management Training?
    A. None
    B. Not very much
    C. Hopefully, I will learn some new information.

Post-Training Test

This assessment will further assist efforts to correct any problems, add new subjects, and otherwise improve our efforts in offering quality training and information to other water system board members.

1. If your system is not currently meeting every month, will you attempt to get this policy changed so that you and other members of your board can be kept informed on a regular basis?
    A. Yes, I understand the importance of meeting monthly and plan to discuss this with other board members as soon as possible.
    B. No, I do not see the need to meet on a regular basis.
    C. Does not apply – my system currently meets monthly.

2. I plan to be more active as a board member representing my neighbors and my community as a whole.
    A. Yes, I understand the important function of serving as a board member and know that I need to get more involved and active in my attendance.
    B. No, I have no interest in doing anymore than I currently do or fulfilling my duties as a board member.
    C. Does not apply – I attend every meeting and actively represent my community.

3. I understand the importance of meeting monthly with our waterworks operator and the need to periodically meet with other professionals including our engineer, attorney, and accountant.
    A. Yes, I want to establish better communication with all professionals that can help our water system provide the best quality drinking water and the best service possible.
    B. No, I don't see the need to communicate with our operator, engineer, attorney, or accountant.
    C. Does not apply – my water system actively communicates with our operator and other professionals.

4. I would like to have an analysis performed on my system's water rate structure.
    A. Yes, I understand the need to have fair and equitable rates that not only provide the necessary revenues for current budgetary expenses, but also to generate funds for emergencies and future capital improvements.
    B. No, we just raised our rates.
    C. No, I don't see the necessity of regularly reviewing our rate structure.

5. Do you understand the importance of reviewing your system's financial information monthly?
    A. Yes, I understand that as a board member, it is part of my fiduciary responsibilities to review financial information and to ensure that the system is operating efficiently.
    B. No, I do not see the need for board members to review financial information.

I plan to actively participate in preparing my system's annual budget.

A. Yes, I understand the importance to play an active role in preparing the budget as a decision-maker for my water system.
B. No, I will continue to review, make comments, and approve budgets prepared by our professional staff or accountant.
C. No, I do not see the need for my system to have an annual budget.

6. I plan to obtain a copy of my system's bylaws or governance ordinances, thoroughly study them, and have them available at all meetings I attend. I also understand the need to periodically have our attorney review our current operation and ensure that we are complying with our bylaws and if not, to either get into compliance or amend the bylaws.
   A. Yes, I understand the need not only to be very familiar with our bylaws but also to have a copy at every meeting should a situation arise that demands a review of the bylaws.
   B. I am already bringing a copy of our bylaws to every meeting
   C. No, I don't see the need for each board member to have a copy of the bylaws or the necessity of having a copy at all meetings.

7. I understand the necessity of having clear written policies covering all operations and facets of my water system. I plan to use the templates provided in the manual or to obtain professional assistance in developing policies for my water system.
   A. Yes, I plan to do this as soon as possible.
   B. No, my system currently has written policies but I do plan to review them to ensure that they are effective.
   C. No, I do not see the need for written policies for my water system.

8. I understand the necessity of the board being proactive in long-range planning my water system's budget and capital improvements, and the need to regularly review system finances and reports from our staff members and other professionals.
   A. Yes, this is one area that I would like to see our water system improve and I plan to get more active in our long-range planning.
   B. No, my water system is already engaged in long-range planning.
   C. No, I do not see the need for long-range planning for my system.

9. I understand the necessity of keeping our customers fully informed and would like to see my system mail out newsletters at least once each year or to periodically have an article published in the local newspaper.
   A. Yes, I think that this is a good idea and think that the minimal costs and time involved would be well worth the effort.
   B. Does not apply – my system currently mails newsletters or publishes information about our water system in the local newspaper.
   C. No, I do not see the need for our customers to be kept informed.

10. Please list below any comments that you have regarding the training and ways that it could be improved. Also list any new subjects that you think might be helpful to add to the curriculum or as non-mandatory follow-up board training.

Section III: Association Organization and Governance

The following test should be taken by each board member. The results are for the board member's use only, and its use is at the, board member's discretion. Opinions shared by board members will reflect the mindset of the board on certain topics. If board members are willing to share their results, then this assessment can help the board identify its strengths and its weaknesses.

Bylaws and Board Meetings: A Self-Assessment

Please respond to the following statements about your water system management. Select only one answer for each of the questions. Circle the letter next to the statement that best describes your opinion. This test is useful only if your answers are honestly given, without reservation.

Please respond to the following statements about your water system management. Select only one answer for each of the questions. Circle the letter next to the statement that best describes your opinion. This test is useful only if your answers are honestly given, without reservation.

1. Board members of our water system
   A. Have studied and are very familiar with our bylaws.
   B. Have read and are somewhat familiar with our bylaws.
   C. Have read our bylaws.
   D. Have generally not read our bylaws.
   E. Are not familiar with our bylaws.
2. Considering all our board members, what percent of our board is familiar with our bylaws?
   A. 80 percent or more
   B. 60 percent
   C. 40 percent
   D. 20 percent
   E. 0 percent

3. Our board relies on our bylaws to the following extent:
   A. Every member of the board has a copy, we always have at least one copy at board meetings, and we frequently refer to the bylaws if questions arise.
   B. At least one copy of our bylaws is available at board meetings, and we occasionally use them if questions arise.
   C. We have copies of our bylaws available, but we rarely use them even though they would be helpful.
   D. We seldom refer to our bylaws about any matter, and we often do not have a copy available.
   E. We never refer to our bylaws, and we often do not have a copy available at our meetings.

4. Regular meetings of our board are
   A. Scheduled well in advance, board members are always given notice, and dates and times are seldom changed unless emergencies occur.
   B. Scheduled in advance, board members are sometimes notified, and dates are sometimes changed.
   C. Scheduled in advance but sometimes are changed without all board members being notified.
   D. Scheduled by the president or chair before each meeting, and board members often forget about the meeting.
   E. Haphazardly scheduled, and some members are often uncertain about the time and the place of the meeting.

5. For our board meetings, attendance is
    A. Almost always 100 percent.
    B. 100 percent more than half the time.
    C. Averages about 80 percent.
    D. Averages about 60 percent.
    E. Often so low that meetings have to be rescheduled.

6. Generally, our board members
    A. Serve with enthusiasm and are very interested in the business of the water system.
    B. Sometimes are enthusiastic and are interested in the business at hand.
    C. Sometimes discuss issues that are not related to the business of the board.
    D. Often discuss issues not related to the business of the board.
    E. Always waste time and often make hasty decisions.

7. The agendas for our board meetings are
    A. Always prepared ahead of time and sent to each board member well in advance.
    B. Usually prepared ahead of time and sent to board members in advance.
    C. Prepared and handed out at the beginning of each board meeting.
    D. Usually prepared and handed out at the beginning of each board meeting.
    E. Seldom written and handed out at board meetings.

8. Most of the business finished by our board of directors is the result of
    A. Participation by all board members, with each member giving input into the decision process at the board meetings.
    B. Participation by two or three members who usually dominate the discussion and are persuasive in board decisions.
    C. Phone calls in which business is discussed between the president or chair and one or two board members, and decisions are made before board meetings or without board meetings.
    D. The president or chair making the decisions and getting other board members' approval after a brief discussion.
    E. The president or chair making the decisions and getting the approval of enough board members to approve the decision, without any effort to contact all board members.

9. Although our board members have different opinions, our board meetings run
    A. Very smoothly and efficiently.
    B. Fairly smoothly, with few unnecessary arguments.
    C. Too long because of too much attention to unnecessary details.
    D. Too long because of the discussion of personal topics unrelated to the business of the board.
    E. Very inefficiently because of personality clashes and members often taking sides.

10. The members or water users of our system

Always know what is going on with the water system because they are kept personally informed about board policies.

A. Usually know what is going on because the board keeps them informed of board decisions.
B. Know very little about the business of the organization and get most of their information at annual meetings, when detailed reports are given and written reports are distributed.

C. Know very little because they do not have access to any detailed information during the year or at the annual meeting.
D. Have a very poor knowledge of the system and are sometimes angry because of lack of information from the board.

Grades: number of A's___, B's___, C's___, D's___, and E's (F's)____

The Legal Formation and Operation of a Rural Water Association Organized as a Nonprofit Corporation

The discussion that follows highlights the major rules that rural water associations must follow as nonprofit corporations. These rules apply to membership, boards of directors, membership meetings and notices, special meetings and notices, voting procedures, developing and changing bylaws, and other laws required for a water association to be in compliance. This discussion is for educational purposes only and carries no legal authority. Boards must refer to the actual codes and consult their board attorneys for all legal matters.

Articles of Incorporation

The water association articles of incorporation must include the following:
A distinct corporate name that cannot imply that it is organized for a purpose other than that stated or permitted

- The period of duration, which may be perpetual
- The street address of the registered office and the name of the agent at that office. Each association must continuously maintain a registered office
- The name and address of each incorporator. One or more persons may act as incorporators by delivering the articles of incorporation to the Secretary of State for filing.

The articles may include the following:

- The names and addresses of the initial directors
- Provisions consistent with state laws
- The purpose of the organization
- A statement indicating that the board is responsible for managing the business and regulating the affairs of the corporation

Defining, limiting, and regulating the powers of the corporation, its board of directors, and its members.

Organizing After Incorporation. If the initial directors are named in the articles of incorporation, these directors are responsible for holding an organizational meeting to appoint officers, adopt bylaws, and carry on business. This meeting can be called when approved by the majority of the directors. If the initial directors are not named in the articles of incorporation, the organizational meeting will be called subject to the approval of the majority of the incorporators. The first order of business is to elect directors who will be responsible for completing the organization, appointing officers, developing bylaws, and carrying on business. If an organizational meeting is not held, action taken must be described in a written consent signed by each incorporator.

Amending the Articles of Incorporation. An association may amend its articles of incorporation when such amendments are needed if those amendments are lawful. The board of directors may pass amendments for extending the duration of the corporation and for deleting the names of the initial directors and registered agents unless otherwise specified. All other amendments are subject to a vote by members at a membership meeting. This vote may be held at either an annual meeting or at a specially called meeting. Written notices explaining the proposed amendment or a summary of the changes that will be voted on shall be sent to each voting member within the time and manner prescribed in the articles of incorporation or bylaws. A proposed amendment is adopted if two-thirds of the votes cast or a majority of the voting membership approves it, whichever is less. These articles must be filed with the Government and must include the name of the corporation, the text of the amendments, the date of adoption, and the vote relative to the number of members at the meeting and the number of total members.

Powers of the Association

Each rural water association or corporation is organized for the purpose of supplying water to its members located in the association's service area or have paid a deposit and utilize the service provided by the water association but do not live within the service area. Water associations are given legal power to fulfill their purpose. This power includes but is not limited to the following rights:

- Exist over a long and undetermined length of time unless limitations are placed in its articles of incorporation.
- Sue and be sued in its corporate name.
- purchase or receive real or personal property and
- Lease or dispose of all or part of its property and assets.
- Make contracts and guarantees, incur liability and borrow money.
- Elect officers and agents of the corporation who may be directors or members and define their duties.
- Make and alter bylaws, which cannot be inconsistent with its articles of incorporation.
- Pay pensions and establish pension plans for any or all of its directors and employees.
- Impose dues, assessments, admission, and transfer fees upon its members.
- Establish conditions of membership, admit members, and issue memberships.
- Carry on business.
- Do all legal things necessary to further the activities and the affairs of the corporation.
- Cease its corporate activities and surrender its franchise.

These powers are granted to the association, but the particulars of how the granted powers are implemented are described in the association's articles of incorporation and the association's bylaws.

Requirement of Bylaws

The incorporators or the association's board of directors must adopt bylaws for their nonprofit rural water association. The provisions of the bylaws must set forth how the corporation is to be managed and regulated, but the bylaws cannot be inconsistent with the articles of incorporation.
These articles included provisions that managed and regulated the powers of the association and its board of directors and members. Associations that have been organized in this manner have essentially used the articles of incorporation as the basis for their bylaws. Articles of incorporation and bylaws should be reviewed to ensure they are consistent and current.
Below are fundamental items that must be addressed in a public water system's bylaw:

1. A fixed time for the annual meeting
2. Terms of the directors (these cannot exceed 3 years but may be staggered to ensure management continuity for the system)
3. The association shall delegate one officer to prepare and authenticate minutes of the board meetings
4. Members have a right to inspect and copy the records of the association

Approving Amendments to Bylaws. Rural water associations that are organized as nonprofit corporations can amend their bylaws. For an amendment to be adopted, the board of directors must approve it unless the amendment relates to the number of directors, the composition of the board, the terms of office of the directors, or the method used to choose directors. Amendments must also be approved by two- thirds of the votes cast by its members or by the majority of the total membership, whichever number is less. Members may adopt rules that require a higher voting percentage or they may adopt any other basis for approval. If board approval is required, the board may also require a higher percentage of affirmative votes or votes on some other basis. If the board seeks to have an amendment approved by the members at a membership meeting, the corporation must give notice of this matter to the membership and a copy or summary of the amendment must accompany the notice. If the board or the members seek to have the amendment approved by written consent or written ballot, a copy or summary of the amendment must be sent with this material. Notices must be sent in accordance with the consent, mailing time, date, and place rules required by law.

Rural Water Association Bylaws and Board Responsibilities

The most important document that a water systems board possesses is its bylaws. For newly formed associations, developing bylaws and adopting them should be a top priority. Bylaws set forth the purpose and the rights of the organization: the type of service, the area of service, the responsibilities, and the procedures to follow. Boards and organizations must be cautious in establishing bylaws so that they do not conflict with local, state, or federal laws, making them ineffective. Familiarity with the organization's bylaws is essential for effective management of the water system. Because of extensive regulations and frequent lawsuits, boards must adhere to well-established rules and policies. Good bylaws set board procedures that cover the items in the following outline:

1. Membership in the water system organization
    - A. How to become a member
    - B. Legal ownership and renters
    - C. Membership rights and number of properties served
    - D. Transferring membership
    - E. Termination of membership
    - F. Right to dissolve organization's assets
    - G. Membership certificates

2. Meetings
    - A. Annual meetings
    - B. Elections
    - C. Voting
    - D. Regular meetings
    - E. Special meetings
    - F. Quorums
    - G. Proxies
    - H. Order of business

3. Boards of directors
    - A. Number of members
    - B. Terms
    - C. Election of officers
    - D. Filling unexpired terms
    - E. Quorums
    - F. Removal from office

    Duties of the board
    - A. Approve membership
        - a. Select employees and agents and set compensation
        - b. Borrow funds and provide related documents and security instruments

c. Prescribe rules in conducting business and penalties for breaking rules
d. Prescribe officer or manager duties and employee duties and penalties for nonperformance
e. Authorize and establish financial audits
f. Prepare necessary budgets
g. Set water rates, connection fees, reconnection fees, method of billing, due dates for payments, penalties for late payments, collections, and assessments; determine the class of users

B. Require bonding when necessary
C. Select depository bank
D. Prescribe the duties of the board officers: the president, the vice president, and the secretary-treasurer, or the secretary and the treasurer

4. Providing service to users
   G. Items provided by the organization
   H. Items provided by users
   I. Additional service lines
   J. Rules for water shortages
   K. Use of surplus funds

5. Amendments to bylaws

An affidavit or statement should be prepared and notarized as proof of the adoption of the bylaws or amended by laws that govern the decision-making process of the board.

Practical Exercises: Bylaws

1. If you do not have copies of your bylaws and think they are lost, begin a search of the historical files of your association. Former board presidents, board members, or secretaries may have records that include the bylaws. If they are found, go to exercise 2. If they are not found, contact the Secretary of State's office to see if an application was ever approved. If there are no bylaws, go to exercise 3.
2. If you have a copy of your bylaws, review it to see if the document is current. List any changes or additions you would like to make. Prioritize your list. If you think there are important changes to be made, ask your president to put "updating bylaws" on the agenda for a board meeting. If the board decides that changes are needed, the suggested changes should be brought before the membership at the annual meeting or at a special meeting.
3. If your organization operates as an association but has never filed for nonprofit corporation status and has never approved official bylaws, it is operating illegally.

The Board of Directors

All rural water associations that are organized as nonprofit corporations must have a board of directors that is responsible for the management of the corporation or the authorizing of other persons to be delegated some of those duties and responsibilities. All directors must be individuals who meet all qualifications prescribed in the bylaws or articles of incorporation. The number of directors may be increased or decreased from time to time by amending the articles or bylaws or by procedures prescribed in the bylaws.

Except for the initial directors, all directors shall be elected at annual meetings of the membership unless some other time or method has been specified in the articles of incorporation. The articles or bylaws must specify the terms of the directors. Except for designated or appointed directors, the terms of the directors may not exceed 3 years. If no terms are specified in the articles or bylaws, the term of each director shall be 1 year. Directors may be elected for successive terms.

If the association decreases the number of directors or their terms of office, this decision will not affect the terms of the directors that are serving at the time of the decision. The term of a director who is filling a vacancy of an elected person will expire at the time of the next election of directors. If a director is filling the vacancy of a director that is appointed, that director's term will expire at the end of the term scheduled for the director that is being replaced. Despite the expiration of terms, a director will continue to serve until a successor is selected or until there is a decrease in the number of directors as voted on by the membership in the prescribed manner.

The articles of incorporation or the bylaws may provide for staggered terms of directors by dividing the total number of directors into groups. The terms of office of the groups do not have to be uniform. For example, if there are six directors, two may serve 2- year terms, two may serve 3-year terms, and two may serve 4-year terms.

If directors have been added at different times, they could serve terms of equal lengths and elections could be held each year for only those positions with terms that expire that year. Staggered terms give the board some continuity and ensure continuing input from experienced directors. A director may give a resignation to the board's president or secretary. The resignation is effective when the notice is given unless a later date has been specified.

If a later date is specified, the board may fill the vacancy before that date, but the successor would not take office until the specified date.

Role of a Nonprofit Board Member

The primary goal of the board and therefore each individual board member is to protect the public's interest. Nonprofits are allowed to exist as such because they provide a public service that would otherwise have to be provided by the government. Because of this, they are given special consideration in taxation, so they are not taxed the same as a for-profit organization. In order to gain and retain nonprofit status, certain requirements must be met. The board is responsible for ensuring that the board meets the legal requirements established for nonprofits and operates within them. Each board member can safeguard the public's interest by keeping themselves informed of the activities of the association. This also means that board members should act in the well-being of the organization itself, its employees, and the customers it serves. The function of board members within an organization varies with each organization. This level of involvement changes depending on the needs of the organization. The main objective through all of these roles and responsibilities is for the board member to enable the organization to achieve its stated purpose while protecting the public's interests. Some specific duties of board members are:

- **Duty of Care:** A Duty of Care is the first and most important role of a good board member. A Duty of Care means that individual board members must be present at the organization's meetings and be prepared to make informed decisions on issues before the board.
- **Selection of Chief Executive:** It is the board's responsibility to hire or appoint someone to run the organization. The person that the board hires will be responsible for the organization's day to day operations as well as hiring the necessary staff to carry out these functions. This is the most important decision a board makes for the organization. If there is no chief executive, then the board assumes these responsibilities.

- **Organizational Direction:** The board's job is to set goals for the organization to carry out. An effective board member (and, by implication, an effective board) will consult the staff to determine the goals and objectives of the organization.
- **Strategic Planning:** The board has a role to look at the long-term goals and financial health of the organization. They are responsible for setting long-term objectives for the organization. This also includes long-term financial planning for the organization. It is the board's responsibility to plan for capital improvements as well as be financially prepared to handle emergency situations involving capital assets that may arise.
- **Stewardship:** The board member should always ensure that the organization's resources are being used in the best way possible and in the way that best benefits the public and its customers.
- **Aid to staff:** An effective board should assist in both large and small matters where the organization's staff needs it. This need varies widely depending on the individual organization.
- **Community Relations:** The individual board member is a representative of the organization in the community.
- The board should keep the community and its customers informed of the plans and activities of the organization.
- **Ethics:** It is each board member's responsibility to set an example and create an environment of ethical behavior for other board members and staff to follow. It is extremely important that board members conduct themselves with the highest ethical standards in all matters concerning the organization. It is also the board member's responsibility to ensure that fellow board members and the staff do the same.
- **Oversight:** Each board member is ultimately responsible for how the organization and its business is conducted. Board members should always be aware of how organizational resources are being used by the staff and other board members. It is each board member's responsibility to be watchful that the organization is in compliance with all laws and regulations governing it.

Removal of Directors. Members of rural water associations may remove one or more of the elected directors without cause. Elected directors can only be removed by the membership at a meeting called for that purpose. The meeting notice must state that at least one of the purposes of the meeting is to remove a director or directors. All directors may be removed by this process.
The number of votes cast to remove a director has to be equal to the number of votes required to elect a director at election meetings. The board of directors may remove a director without cause if that director has been elected by the directors. A two-thirds vote, or a greater number if set forth in the bylaws, is required by the directors in office before a director can be removed. If the articles or bylaws provide for the removal of a director for missing a certain number of board meetings, which were specified when the director became a board member, then that director may be removed from office for missing at least that specified number of meetings. Removal for missing meetings requires a majority of the directors to vote for removal.
Directors who have been designated as directors through the articles of incorporation or through the bylaws can be removed by amending the articles or bylaws and by removing the designation. Appointed directors may be removed without cause by the person appointing the director unless otherwise stated in the bylaws. The person removing a director must give written notice to the director being removed and a copy of this notice must be sent to the president or the secretary.

The court in the county where the water association's office is located may remove a director. The association or 50% plus 1 percent of its voting members may commence a proceeding (civil, criminal, administrative, or investigatory action) if the court finds that the director has engaged in fraudulent or dishonest conduct, has engaged in gross abuse of authority or discretion, has not acted in the best interest of the corporation, or has participated in an activity that is considered a conflict of interest. If members institute the proceedings, the association will be made a party defendant. A court may remove the director or bar the director from serving on the board for a stated time period.

Filling Vacancies in the Board of Directors. If a vacancy occurs on the board of directors, including vacancies created by increasing the number of directors on the board, members may elect a replacement if the vacant office was held by an elected director. This rule stands unless specified otherwise by the articles of incorporation or by the bylaws. If the selection is not made by the membership, the board of directors may fill the vacancies of officers selected by the board. If the directors remaining in office constitute less than a quorum, they may fill the vacancy by a majority vote of the directors remaining in office.

If the vacant office was held by appointment, then only the person who appointed the director may fill the vacancy. If the position is one designated by the articles of incorporation or by the bylaws, the vacancy cannot be filled by the board but shall be filled by procedures found in the articles or in the bylaws. Vacancies that will occur at a specified later date because of resignations or removal may be filled before that date, but the new director cannot take office until the vacancy occurs.

Compensation of Directors. Unless the articles of incorporation or the bylaws provide otherwise, a board has the authority to fix the compensation of its directors.
For most associations, the bylaws state that the directors receive no compensation for their services. Directors are usually reimbursed for mileage and travel expenses or are paid a per diem for attending to board business that is beyond ordinary services.

Emergency Powers of Boards of Directors. If a catastrophic event occurs and a quorum of the board of directors cannot be readily assembled, emergency rules allow the association to act. The directors that are available can modify the lines of succession to accommodate the incapacity of any director, officer, employee, or agent. They can relocate the principal office, designate

Designate alternative offices, or authorize officers to do so. Unless emergency bylaws provide otherwise, meeting notices may be given only to directors that it is practical to reach and notice may be given in a practical manner including publication or radio. One or more officers of the corporation who are present may be deemed to be directors in order of rank and seniority so that a quorum can be achieved. Corporate action taken in good faith during the emergency is binding but may not be used to impose liability on a director, officer, employee, or agent.

Meetings of Boards of Directors. Boards of directors are authorized to hold regular or special meetings. Unless stated otherwise in the articles of incorporation or in the bylaws, any or all directors are permitted to participate in these meetings, and meetings may be conducted through any means of communication by which all participating directors can simultaneously hear each other during the meeting. A director participating by this means is deemed to be present in person at the meetings.
Action by Board of Directors Without Meeting. If the articles or the bylaws do not address action taken without meetings, these nonprofit corporation rules apply. Action may be taken without a board meeting; however, it must be taken by all members of the board (All board members must give written consent). Decisions must be unanimous. The action must be evidenced by one or more written consents describing the action. These consents must be signed by the directors and included in the minutes. The action taken is effective at the time the last director signs the consent unless the consent specifies an effective date. This action has the same effect as a “meeting vote” and may be described as such in any document.

Liability of Directors. Directors must discharge their duties with good faith that they are acting in the best interests of the corporation. Unless there is knowledge that makes reliance unwarranted, a director is entitled to rely on information, opinions, reports, or statements including financial statements and financial data prepared or presented by one or more officers or employees of the association that are believed to be reliable and competent; legal counsel, public accountants, or other professions whose works are within their expertise or competence, or a committee of the board of directors of which he is not a member if he believes the committee merits confidence. Directors are not liable for actions taken or failure to take action if their duties are performed in compliance with these rules. Anyone alleging a violation has the burden of proving the violation.

A director who votes to distribute any part of the income of the association to its members, directors, or officers is liable to the association for the amount that the distribution exceeds the amount that is allowed in its articles of incorporation or in its bylaws. The liability occurs if it is established that the action was not in the best interests of the association. A director found liable is entitled to a contribution from every other director who could be held liable for the same offense. That director is also entitled to a contribution (some amount or value of the wrongful distribution) from each person who received the unlawful income or distribution up to the amount of the unlawful distribution whether or not that person knew that the rules had been violated. Normally, a rural water association does not allow any of its income to be given as a distribution.

Powers of Committees Created by the Board of Directors. Unless prohibited by the incorporation articles or by the bylaws, a board of directors may create one or more committees and appoint members of the board to serve on those committees. Each committee shall have two or more directors who serve at the pleasure of the board. The creation of a committee and the appointments to a committee must be approved by a majority of the directors in office when a committee is created or by the number required by the articles or by the bylaws under the association's quorum and voting rules. Rules that govern meetings, action without meetings, notices and waivers of notices, and quorum and voting requirements of the board of directors apply to the committees and to committee members. Committees of the board may exercise the authority specified by the board. Committees, however, do not have the power to authorize distributions, pledge the transfer of assets, recommend a merger or a sale, or recommend membership dissolution. Committees cannot elect, appoint, or remove directors; fill vacancies of the board; or fill vacancies of committees. They cannot adopt, amend, or appeal bylaws. The creation of a committee and the delegation of power to the committee do not alone constitute compliance by a director with the rules associated with acting in the best interests of the association.

Prohibition of Loans to Directors or Officers. Rural water associations may not lend money to a director or an officer of the association. The association is also forbidden to guarantee loans or obligations for a director or an officer. If a director or officer has borrowed money or has a guarantee from the association, that borrower has liability on the loan even though the loan, was made in violation of the law.

Code of Ethics and Board Policies

Ethics

A code of ethics is crucial to an organization. Having and adhering to a code of ethics is crucial to maintaining organizational integrity, public trust, and employee board relations. As an organization serving the public, public trust, public safety, and the public welfare should always be of the utmost concern. Individuals in an organization should treat with respect and consideration all persons, regardless of race, religion, gender, abilities, age, national origin, sexual orientation, political beliefs, military service, and creed. The organization's business should always be conducted in accordance with the highest ethical

standards and professional behavior possible. In order to carry on ethical business, the organization must abide by all applicable laws and regulations. In order to promote an atmosphere of ethical behavior written penalties for inappropriate behavior must exist. Strict adherence to these policies is critical.
If the conduct of a board member(s) comes into question, the board should determine whether the conduct followed reasonable ethical standards and adhered to approved policies. Above all individuals should demonstrate care for the well-being of each other, the community, and the organization.

Requirements also include policies regarding conflict of interests, whistle blowing, record retention, document destruction, and executive compensation. The nonprofits should have board policies covering at a minimum these topics and that have been written, approved by the board, and entered into the minutes.

Conflict of Interests

A conflict of interest occurs anytime that an individual's personal beliefs or associations might keep them from making an unbiased decision. A board member is expected to put the interests of the organization above any self-serving interests. Different types of conflicts of interests are financial, loyalty to multiple organizations, and conflicting roles and relationships. A strong conflict of interest policy is crucial to the integrity of an organization. This is essential to avoid legal problems, public scandals, and have a functioning organization. This policy should be presented to and signed by board members and others involved in the organization as they join and the policy should be reviewed regularly.

Potential conflicts of interests should be disclosed when a member joins the board and reviewed periodically thereafter. When a conflict does arise, it should be disclosed and reviewed by the other board members. Conflicts of interests are almost impossible for a board to avoid entirely. The best policy for this is to be forthcoming regarding the potential conflict and then decide how to best deal with it. If a member has an ongoing and serious conflict, then it might be best if they resign from the board. Most conflicts can be easily dealt with if board members are open about them.

The key to an effective conflict of interest policy is to have a clear manner for disclosing and dealing with these conflicts as they arise. Directors must not be involved in conflict-of-interest transactions. A conflict-of-interest transaction is a transaction in which a director has a direct or an indirect interest.

- The association cannot solely void a transaction because of a direct interest if any one of the following is true:
- The material facts were known or were disclosed to the board or to a committee of the board, and the board approved or authorized the transaction.
- The material facts were known or disclosed to the voting members, and they approved or authorized the transaction.

The transaction was fair to the association. A director is considered to have an indirect interest if the entity of concern is one in which a material financial interest is held or one in which a general partnership is held. Being a director, officer, or trustee of the entity would be an indirect interest as well

If the board knows the material facts, a conflict-of-interest transaction can be approved if the transaction receives an affirmative vote of the majority of the directors or committee members who have no direct or indirect interest in the transaction. However, a single director cannot authorize a transaction. For this purpose, a majority of the members who have no interest would constitute a quorum. A vote cast by a director with a conflict of interest does not affect the validity of the transaction if the transaction was approved under the aforementioned rules.
A transaction can also be approved if it receives the majority vote of its qualified members who have no interest in the transaction. Neither the vote of a member who is a director that has a conflict of interest

nor the vote of a member who is employed by or under the control of the entity in question can be counted. Their votes, however, can be counted in decisions related to the transactions that have nothing to do with conflict-of-interest decisions. A majority of the members whose votes are entitled to be counted will constitute a quorum or this purpose whether or not they are present.

Whistleblower Policy

A whistleblower is a person who reports dishonest or illegal activity occurring in an organization. These activities may be fraud or any other type of activity that should not be tolerated in an organization. This should cover any person breaking the code of conduct of the organization.

This policy should address what constitutes illegal or dishonest activity, how to report it, how to investigate it, and what protections are provided for the whistleblower. These whistleblowers are not only protected by organizational policy, but also by state and Government of South Sudan law. Clear definitions are key to a successful whistleblower policy so that all involved know what acts are covered, what constitutes retaliation, and how to report the activity. Reporting should always be confidential. For this policy to be effective, there must be a clear process in place for reporting, clear penalties when violations occur, and stick to each

Record Retention and Document Destruction

Record retention policy describes the files the need to be retained for the organization to exist and function. This should also account for the limited nature of record keeping such as limited space for records. These records must be retained for institutional history, strategic planning, and potential legal problems that may arise. Law may set the length of time these documents must be maintained. If so then the length of time set by the organization’s policy must meet or exceed the legal length of time.

A Document Destruction Policy must establish which documents can be destroyed, when they can be destroyed, and how to go about destroying them. This policy is crucial because documents cannot be destroyed if the organization is or may soon be under investigation for any reason. This also applies to electronic documents. Both record retention and document destruction policies are essential components of risk management for an organization.

WTO Compensation

An executive compensation policy is necessary to determine compensation for executives of an organization. This includes all persons in an organization who have substantial influence over an organization even if they do not have the title of Supervisor of WTO. The board making these decisions must be independent, have collected data to determine the compensation of other comparable positions, document the basis of their decision, clearly state the qualities the board seek for the position (description of position), and state the process to go about hiring and paying these WTO executives. The description of the position should include factors that are important to the board such as education, experience, and any other skills that might be important to the position.

This policy should also set out a process for adjusting the compensation for reasons such as cost of living, bonuses, etc. There should be no off-agreement benefits. For this policy in particular it is crucial to pay attention to the legal requirements governing compensation policy and process.

Membership in Water Associations

A nonprofit rural water association may admit any person as a member. The articles or the bylaws establish the criteria for membership. No person can be admitted as a member without that person’s consent. The members of rural water associations are the users of the association's water who have been admitted as members of the association.

Members of an association can be expelled. No member may be expelled or membership terminated or suspended if the procedure is not fair and reasonable and if it is not carried out in good faith. A procedure is considered fair and reasonable when the articles or the bylaws provide for a notice to be given not less than 15 days before the action and when the notice gives the reasons for the action. The member being expelled, terminated, or suspended must be given the opportunity to be heard orally or in writing by the persons authorized to take the action. This hearing, whether oral or written, must take place not less than 5 days before the effective date of the action being taken. It is fair and reasonable to consider all the facts and circumstances. Any written notice sent by mail must be sent by first-class or by certified mail to the last address shown on the association's records. Any proceeding that challenges the expulsion, termination, or suspension must be commenced within 1 year of the effective date of the action. A member who has been expelled, terminated, or suspended may be liable to the association for dues or fees owed.

Officers of the Association

The bylaws of a nonprofit water association must have the officers described in its bylaws or appointed by the board of directors in compliance with its bylaws. A duly appointed officer may appoint one or more assistant officers if authorized to do so by the bylaws or by the board of directors. The bylaws or the board of directors will delegate to one of the officers the title of secretary with the responsibility of preparing the minutes of the board of directors' and the members' meetings. This officer will be responsible for authenticating the records of the association, taking minutes, maintaining current membership records, and making all reports required by law.

Each officer has the authority and shall perform the duties set forth in the bylaws, and each officer shall perform the duties prescribed by the board or by an authorized officer to the extent that the duties are consistent with the bylaws. Officers of water associations normally include a president, a vice president, and a secretary-treasurer. Officers must act in the best interests of the association and must adhere to essentially the same standards required of directors. An officer must perform duties with the good-faith belief that the best interests of the association are being met. Unless an officer has knowledge to the contrary, information, reports, or statements, including financial records and financial data, can be relied on to make decisions. These must be prepared or presented by officers or employees of the association known to be reliable and competent in the matters presented or by legal counsel, public accountants, or other professionals or persons with expertise and competence for the matters presented. An officer is not liable for the action taken if duties are performed in this manner. Any person alleging a violation has the burden of proving the violation.

An officer may resign at any time by delivering notice to the association. The resignation is effective when the notice is given unless a later date is specified in the notice. If the association accepts the later date, the board can fill the pending vacancy before the effective date, but the successor would not take office until the effective date. A board of directors may remove any officer at any time, with or without cause.

Proceedings Brought by Members or by Directors

Members or directors can file legal complaints on behalf of the association with the chancery court in order to force the association into compliance with its articles or its bylaws. Proceedings may be brought by members having 5 percent or more of the voting power or by 50 members—whichever is less. For example, for small systems with only 100 members, only 5 members would be required. Any director may initiate proceedings. Only members or directors may bring proceedings.

A complaint must be verified and the explicit demand must be made in order to determine what action was needed by directors, why the complainants could not obtain the action, or why demands were not made. If the association is in the process of investigating the demand, the court may stay the suit until the investigation is completed. When the proceedings are terminated, the court may require complainants to pay any defendant's reasonable expenses including legal fees if the court finds the proceeding was commenced frivolously or in bad faith. If the proceedings result in the association taking some action requested by the complainants or if any compromise was reached, the court may award the complainants reasonable expenses, including legal fees.

Membership Meetings

Nonprofit rural water associations are required by law to hold annual membership meetings, and the date, time, and place of annual meetings must be prescribed in the association's bylaws. The president and chief financial officer shall report on the activities and financial condition of the association at the annual meeting. If no specific place designated, then annual meetings will be held at the site that was selected as the association's principal office. For many associations, this site would not be conducive to annual meetings, so the bylaws should include a site selection. Sometimes annual meetings cannot be held at the stated time fixed in the bylaws; failure to hold the meetings at the listed dates and times will not affect the validity of any association actions. Notices of meetings and meeting agendas are governed by an association's bylaws. Notices must be provided to members in a fair and reasonable manner that is consistent with the bylaws. A meeting notice is considered fair and reasonable if the members are notified of the place, date, and time at least 10 days before the meeting if the notice is mailed by first-class or by registered mail.

A 30-day notice is required if the notice is mailed other than by first-class or registered mail. Notices cannot be mailed more than 60 days before the meeting date. Exceptions to these rules may be made if circumstances indicate that other means would be fair and reasonable.

Notices of annual meetings must include descriptions of any matter that must be approved by the members. This business would include any matter of conflict of interest, indemnity, amendment to the articles or bylaws, merger plan, sale or lease of assets, or dissolution of the association. The agendas included in meeting notices must include matters that a member intends to raise at that meeting if a written request from that member is received by the secretary or president of the association at least 10 days before the association gives notice of the meeting. Unless specified otherwise in the bylaws, if an annual meeting is adjourned to a different date, time, and place, notice need not be given of the new date, time or place, if the new date, time or place is announced at the meeting before the original meeting's adjournment. If no notice is given, details of the adjourned to date, time, and place must be announced before the adjournment of the existing meeting. If a new record date for which members are notified must be set to be fair and reasonable or if the bylaws specify other procedures, then notices must be given of the new meeting date.

Members may waive notice of meetings by signing a written waiver and by delivering it to the association for inclusion in the association's records or minutes. The mere presence of a member at a meeting waives any objection to a lack of a notice or a defective notice unless that member objects at the beginning of the meeting. Attendance also waives notice of matters being considered that were not listed in the meeting notice unless that member objects when the matter is presented.

Any member that is entitled to participate in an annual meeting may apply for an annual meeting if one has not been held within 6 months after the end of the association's fiscal year or within 15 months after its last annual meeting— whichever date is the earliest. The court may order a meeting on application of a member who signed a demand for a special meeting or a person entitled to call a special meeting and a notice of the meeting was not given within 30 days after the proper delivery of the notice or if a notice was given and the meeting was not held in accordance with the notice. If annual meetings or special meetings are not held when required and the proper procedures listed above have not been carried out, then the court may fix the time and place of the meeting, specify a record date for determining the qualified voting members, prescribe the form and content of the meeting, fix the quorum required or direct that the votes represented at the meeting constitute a quorum for this action, and enter any other orders necessary to accomplish the purpose or purposes of the meeting. If the court orders a meeting, it may order the association to pay the member's costs including legal costs that were incurred to obtain this order.

Special meetings can be called in nonprofit associations with members. Special meetings can be called by the board or by the person or persons authorized to do so by the articles or bylaws. Members may call for a special meeting if at least five percent of the eligible voters sign, date, and deliver to any association officer one or more written demands for the meeting describing the purpose or purposes for which the meeting will be held. The close of business on the 30th day before the delivery of the demand for the special meeting is the record date for determining if the five percent (5%) requirement has been met. If the demand for the special meeting has met the requirements and a notice for a special meeting has not been issued within 30 days after the written demands were properly delivered, a person signing the demand or demands may set the time and place of the meeting and give notice subject to the fair and reasonable rules governing notices. Special meetings may be held at the place stated in the bylaws for meetings or if no place is stated, it shall be held at the association's principal office. Only the business described in a meeting notice can be conducted at a special meeting of members. No other matters or no other business may be considered.

Voting by Members. Unless the articles or bylaws provide otherwise, each member is entitled to one vote on each matter voted on by the members. Unless provided otherwise, if a membership includes two or more persons on record and one votes, the vote binds all persons included in the single membership. If more than one person votes and the membership includes more than one person, then the votes will be divided on a pro-rata basis so that the total equals one vote.

Preparation of a List of Members. Nonprofit rural water associations are required to prepare an alphabetical list of the names of all its members who are entitled to receive a notice of meetings. The list must show the names, addresses, and the number of votes each member is entitled to vote at meetings. This list must be available for inspection by any member for the purpose of communicating with other members. The list must be available within 2 business days after a notice is given about the meeting for which the list was prepared, and it must continue to be available through the meeting date at the principal office or at a reasonable place identified in the location where the meeting will be held.

A member, a member's agent, or a member's attorney may inspect the list at a reasonable time and at the member's expense (this expense may not exceed the estimated cost of reproduction) during the period when it is available for inspection. The list also must be available at the meeting. If the association refuses access to the list, it is subject to court-ordered inspection at the association's expense, to postponement of the meeting, and to paying costs, including legal costs of obtaining the court order. Unless a written demand for inspection or copying a membership list has been made before the meeting and the association has refused to comply, the validity of action taken at the meeting is not affected.

Quorum. Unless the articles of incorporation or bylaws require a higher or lower quorum, 10 percent of the votes entitled to be cast on a matter must be represented at a meeting of members for a quorum to exist. A bylaw amendment to decrease the quorum for any member action may be approved by the members, or approved by the board unless prohibited by the bylaws. Amendments to increase the quorum must be approved by the members. Unless one-third or more of the voting power is present in person or by proxy, the only matters that may be voiced at an annual meeting of members are those matters that are described or have been described in the meeting notice.

Notice of Regular or Special Meetings of Boards of Directors. Unless the articles or bylaws provide otherwise, regular meetings of the board of directors may be held without notice (written or oral communication) of the date, time, place, or purpose of the meeting. Unless the articles or bylaws list longer or shorter periods, special meetings of a board must be preceded by at least 2 days' notice of the date, time, and place of the meeting to the board members. The purpose of the meeting need not be included in the notice unless required by the articles or bylaws.

Waiver of Notice of Meeting of Board of Directors.

A director may waive any notice required by the articles or the bylaws before or after the date and time stated in the notice. Except when attending the meeting, the waiver must be in writing, signed by the director, and filed with the minutes or association records. A director's attendance or participation in a meeting waives any required notice unless that director at the beginning of the meeting or promptly upon his arrival objects to holding the meeting or transacting business at the meeting and does not vote for or give assent to action taken at the meeting.

Record-Keeping Requirements

Rural water associations are required to keep as permanent records:

- Minutes of all meetings of its members and board of directors
- A record of all actions taken by members or director's costs cannot exceed the estimated costs of production or reproduction of these records. The membership list provided must be one that was compiled no earlier than the date of the member's demand.

If the association does not allow a member who follows the proper legal procedures to inspect or copy records, the appropriate chancery court may order the inspection and copying and charge the expenses to the association if the member makes application to the court. The association has to prove that it refused inspection in good faith because it had a basis for doubting the right of the member to inspect the records demanded. If the court so orders the inspection and copying of the records demanded, it may impose reasonable restrictions on the use of the records by the demanding member.

Video transcript of legal issues, featuring Judge James H. Herring, Court of Appeals of Rubkona County, and Sherrie M. Edwards, formerly with the Rubkona County State University Extension Service/Community Resource Development

EDWARDS: Judge Herring, please tell us how rural water associations are legally organized.
HERRING: There are three types of rural water associations: 1) nonprofit corporations, 2) utility districts, and 3) privately owned corporations or enterprises.

EDWARDS: How are water rates set for these organizations?

HERRING: Water rates for privately owned organizations are regulated by the Rubkona County Public Service Commission. Nonprofit corporations and utility districts created by the county boards of supervisors regulate their own rates.

EDWARDS: Please explain how a nonprofit corporation is operated.

HERRING: Nonprofit corporations are governed by a board of directors, which is typically elected at the annual meeting of the corporation.

EDWARDS: Are annual meetings required by law?

HERRING: Yes. They must be held annually, and official minutes must be kept of the meeting. At this meeting, the minutes of the previous meeting are read and new directors are elected. Usually, the directors serve staggered terms so that all directors will not be up for election at the same time.

EDWARDS: When does the board of directors meet?

HERRING: On a regular basis, preferably at least monthly. At these meetings, the board authorizes the payment of all indebtedness's of the corporation and transacts any other necessary business. Minutes are kept of these meetings. It is important to note that a corporation legally speaks through its minutes, and minutes must be kept of every meeting.

EDWARDS: Are these minutes and other records of the corporation open to public inspection by the members of the corporation?

HERRING: Yes, absolutely. However, our laws set out a procedure for making a formal request for an inspection of the records. The corporation, through its representatives, has a duty to inform the members how to request access to the records.

EDWARDS: How are the officers of the corporation typically selected?

HERRING: The officers are selected by the board of directors of the corporation and include a president, a vice president, a secretary, and a treasurer. These officers may or may not be members of the board of directors, which is the final governing body of the organization and sets the policy until the next annual meeting.

EDWARDS: Do the members of the board of directors or the officers have any potential liabilities as a result of their positions with the corporation?

HERRING: Yes. If a director or an officer takes any action that is not authorized by official action of the corporation through its minutes, there is the potential that the individual could be held liable for his unauthorized actions. Also, a director or officer can be held liable for unlawful acts. Therefore, it is important that the corporation receive sound legal advice at all times, as well as sound advice from an engineer at all times.

EDWARDS: What about conflicts of interest?

HERRING: That is a very important question. The answer is that a director can be held financially responsible for voting to approve any transaction in which he has a financial interest, directly or indirectly.

EDWARDS: Can members of a nonprofit water association cast their votes at an annual meeting by proxy?

HERRING: Unless the articles of incorporation or bylaws of a corporation prohibit voting by proxy, members of a water association may do so at an annual meeting. However, there is a detailed legal procedure that must be followed in order for such votes to be legally cast. Therefore, an attorney should be consulted as to how proxy votes should be cast.

By Laws of Bentiu Water Utility

Bylaws

Of

____

ARTICLE I

General Purposes

The purposes for which this board is formed and the powers which it may exercise are set forth in the articles of in Water Utility of the board.

ARTICLE II

Name and Location

Section 1. The name of this board is the____.

Section 2. The principal office of this board shall be located in the City (Village) of ______________________________________, County of ____________________________State of ______________________________________.

ARTICLE III

Seal

Section 1. The seal of the board shall have inscribed thereon the name of the board the year of its organization and, ____.

Section 2. The secretary of the board shall have custody of the seal.

Section 3. The seal may be used for causing it or a facsimile thereof to be impressed or affixed or reproduced or otherwise.

ARTICLE IV

Fiscal Year

The fiscal year of the board shall begin the ______________ day of ________in each year.

ARTICLE V

Membership

Section 1. Membership will be limited to those who obtain the organization's services and is nominated by the Sate Ministry of Infrastructure and shall have a voice in its management.

Section 2. Every person (which word as used herein includes any legal entity) who is lives in ------------------- locality, or served by the water system may become a customer upon signing such applications and agreements for the purchase of water as may be provided and required by the -----------------------water utility and upon the payment of such connection fee as may be imposed by the board provided that only one membership at a time may be held for each property served.. Only one membership may be held with respect to property at one time. The board of directors shall cause to be issued appropriate certificates of membership, provided that membership shall not be denied because of the applicant's race, color, creed, sex, age, marital status, or national origin. Membership may be denied if capacity of the water system is exhausted by the need of its existing members, or if the proposed use of the applicant is such that it would interfere with existing uses previously authorized by the board.

Section 3. Each member/customer shall have only one membership for each property served, regardless of the number of service connections the member may obtain to serve the property.

For the board members, each person shall have only one vote. In no event shall more than one vote be cast with respect to any board resolution.

Section 4. Membership shall be transferable but the transfer will be effective only when noted on the books of the board. Such transfer will be made only to a person who obtains a qualifying interest in the property. A member will transfer membership in the Water Utility to a successor in in a board meeting and with a notice to the appointing authority, the Ministry of Infrastructure. The secretary, upon request, will make note of such transfer upon the records of the Water Utility but need not issue a new certificate to the successor in interest of the previous existing member.

Section 5. The membership in the Utility may terminate upon the resolution by the board. Membership also may be terminated by action of the board of directors where the use of the property is changed so as to materially increase the amount of water consumed to the prejudice of other existing members or to the prejudice of the orderly operation of the system.

Section 7. The termination of the membership of any customer shall not disqualify for membership any other person who has or obtains who otherwise meets the requirements of these bylaws.

Section 9. Upon ceasing to be customer, the board will not look to the successor in interest for the payment of any past due amounts. The board will seek collection only from the individual who incurred such charges or assessments.

ARTICLE VI
Membership Certificates

Section 1. This Water Utility shall not have capital stock. Membership in the Water Utility shall be represented by membership certificates. Such certificates shall represent the right to use and enjoy the benefits of the board's water supply system upon the payment of necessary assessments, if any, and of reasonable charges based upon such use, provided such use and enjoyment are consistent with the rules, regulations, and contracts affecting the same as may from time to time be prescribed by the board.

Section 2. A membership certificate shall be issued to each customer of fully paid membership, numbered consecutively in accordance with the order of issue, and bear on its face the following statement:
This membership certificate is issued and accepted in accordance with and subject to the conditions and restrictions stipulated in the articles of in Water Utility and bylaws and amendments to the same of the ____ Water Utility.

ARTICLE VII
Meetings of Members

Section 1. The annual meeting of the members of this Water Utility shall be held at the City (Village) of _________________, County of ____________________, State of ______________________, at ___________ o'clock ____.m., on the _________________ in ____________________________ of each year, if not a Sunday or legal holiday, or if a Sunday or legal holiday on the next business day following. The place, day, and time of the annual meeting may be changed to any other convenient place, day, and time in the county by the board members giving notice thereof to each member not less than ten (10) days in advance thereof.

Section 2. Special meetings of the members/customers may be called at any time by the action of the board members and such meetings must be called whenever a petition requesting such meetings is signed by at least ten percent of the members/customers and presented to the secretary or to the board. The purpose of every special meeting shall be stated in the notice thereof, and no business shall be transacted thereat except such as is specified in the notice.

Section 3. Notice of meetings of members of the Water Utility, both regular and special, shall be given by notice written to each board member and a copy to the Ministry of Infrastructure for record, not less than ten (10) nor more than forty (40) days prior to such meeting. Such a notice shall state the nature, time, place, and purpose of the meeting, but no failure or irregularity of notice of any annual meeting, regularly held, shall affect any proceedings taken thereat.

Section 4. The presence at a meeting of members entitled to cast in their own right ________ percent of the total number of votes shall constitute a quorum. Such proxies may be general or restrictive.

Section 5. Directors of this Water Utility shall be elected at the annual meeting of the members as provided in Article VIII, Section 1. No cumulative voting shall be allowed.

Section 6. The order of business at the regular meetings and so far as possible at all other meetings shall be:

1) Calling to order and proof of quorum
2) Proof of notice of meeting
3) Reading and action on any unapproved minutes
4) Reports of officers and committees
5) Election of directors
6) Unfinished business
7) New business
8) Adjournment

<u>ARTICLE VIII</u>

Directors and Officers

Section 1. The board members of this Water Utility shall consist of 10 members, all of whom shall be customers of the Water Utility. The directors named in the articles of in Water Utility shall serve until the first annual meeting of the members and until their successors are elected and have qualified. At each annual meeting thereafter, the members shall elect for a term of three years the number of directors whose terms of office have expired. Each director shall hold office for the term for which elected and until a successor shall have been elected and qualified.

Section 3. If the office of any director becomes vacant by reason of death, resignation, retirement, disqualification, or otherwise, except by removal from office, a majority of the remaining directors, shall by a majority vote, choose a successor who shall hold office until the next regular meeting of the members of the Water Utility, at which time the members shall elect a director for the unexpired term or terms. The new member, will, however, have to be approved by the Director General, Ministry of Infrastructure.

Section 4. A majority of the board members shall constitute a quorum at any meeting of the board. The affirmative vote of the majority of the directors at a meeting at which a quorum is present shall be the act of the board.

Section 5. Compensation of officers may be fixed only at any regular or special meeting of the members of the Water Utilities. Directors shall receive no compensation for their services as such, except for a modest seating allowance, approved by the State Ministry of Infrastructure.

Section 6. Directors may be removed from office in the following manner: Any member/customer, City Council officer, or director may present charges against a director by filing them in writing with the secretary of the Water Utility. If presented by a member, the charges must be accompanied by a petition signed by ten per cent of the members of the Water Utilities customers. Such removal shall be voted on at the next regular or special meeting of the members and shall be effective if approved by a vote of a majority of those voting if a quorum is present. The director against whom such charges have been presented shall be informed, in writing, of such charges at least twenty days prior to the meeting, and shall have the opportunity at such meeting to be heard in person or by the counsellor to present witnesses; and the person or persons presenting such charges shall have the same opportunity. If the removal of a director is approved, such action shall also vacate any other office held by the removed director in the Water Utility. A vacancy in the board thus created shall immediately be filled by a vote of a majority of the members present and voting at such meeting. A vacancy in any office thus created shall be filled by the board of directors from among their number so constituted after the vacancy in the board has been filled. In all these processes, the City Council and the State Ministry of Infrastructure will be notified.

ARTICLE IX

Duties of Directors

Section 1. The board of directors, subject to restrictions of law, the articles of in Water Utility, and these bylaws, shall exercise all of the powers of the Water Utility, and, without prejudice to or limitation upon their general powers, it is hereby expressly provided that the board members shall have, and are hereby given full power and authority in respect to the matters as hereinafter set forth to be exercised by resolution duly adopted by the board:

A. To approve customer applications and to cause to be issued appropriate certificates and to permit the connection of properties to the system in the future in cases involving proposed construction or may issue such certificates prior to the commencement of the proposed construction.

B. To select and appoint all agents or employees of the Water Utility, remove such agents or employees of the Water Utility, prescribe such duties and designate such powers as may not be inconsistent with these bylaws, fix their compensation and pay for faithful services.

C. To borrow from any source, money, goods, or services and to make and issue notes and other negotiable or non-negotiable instruments evidencing indebtedness of the Water Utility to make and issue mortgages, deeds of trust, pledges of revenue, trust agreements, security agreements and financing statements and other instruments evidencing a security interest in the assets of the Water Utility; and to do every act and thing necessary to effectuate the same.

D. To prescribe, adopt, and amend, from time to time, such equitable uniform rules and regulations as, in its discretion, may be deemed essential or convenient for the conduct of the business and affairs of the Water Utility and the guidance and control of its officers and employees, and to prescribe adequate penalties for the breach thereof.

E. To order, at least once each year, an audit of the books and accounts of the Water Utility by a competent public auditor or accountant. The report prepared by such auditor or accountant shall be submitted to the members of the Water Utility at their annual meeting, together with a proposed budget for the ensuing year. Copies of such audits and budgets shall be submitted to such parties as may be required by other agreements.

F. To fix and alter the charges to be paid by each member for services rendered by the Water Utility to the customers, including connection or reconnection fees where such are deemed to be necessary by the directors, and to fix and alter the method of billing, time of payment, manner of connection, and penalties for late or non-payment of the same. The board may establish one or more classes of users. All charges shall be uniform and non-discriminating within each class of users.

G. To require all officers, agents, and employees charged with responsibility for the custody of any of the funds of the Water Utility to give adequate bonds, the cost thereof to be paid by the Water Utility, and it shall be mandatory upon the directors to so require.

H. To levy assessments against the customers of the Water Utility in such manner and upon such proportionate basis as the directors deem equitable, and to enforce collection of such assessments by the suspension of water service or other legal methods. The board members shall have the option to suspend the service of any customer who has not paid such assessment within 30 days from the date the assessment was due, provided the Water Utility must give the member at least 15 days' written notice at the address of the member on the books of the Water Utility of its intention to suspend such service if the assessment is not paid. Upon payment of such assessments, any penalties applicable thereto, and a reconnection charge, if one is in effect, service will be promptly restored to such a member.

I. Section 3. Duties of the Secretary. The Secretary shall keep a complete record of all meetings of the Water Utility and of the board of directors and shall have general charge and supervision of the books and records of the Water Utility. The Secretary shall attest the Chairman's signature on all membership certificates and other papers pertaining to the Water Utility unless otherwise directed by the board of directors. The Secretary shall serve, mail, or deliver all notices required by law and by these bylaws and shall make a full report of all matters and business pertaining to the office to the members at the annual meeting or at such other time or times as the board of directors may require. The Secretary shall keep the corporate seal and membership certificates issued and affix said corporate seal to all papers requiring a seal. The Secretary shall keep a proper membership certificate record, showing the name of each member of the Water Utility and date of issuance, surrender, transfer, termination, cancellation, or forfeiture. The Secretary shall make all reports required by law and shall perform such other duties as may be required by the Water Utility or the board of directors. Upon the election of a successor, the Secretary shall turn over to the successor all books and other property belonging to the Water Utility that the Secretary may possess. The Secretary shall also perform such duties with respect to the finances of the Water Utility as may be prescribed by the board of directors.

ARTICLE X

Duties of Officers

Section 1. Duties of Water Utility Supervisor. The Water Utility Supervisor shall preside over all meetings of the Water Utility and the board, call special meetings of the board of directors, perform all acts and duties usually performed by an executive and presiding officer, and sign all membership/customer certificates and such other papers of the Water Utility as may be authorized or directed to sign by the board of directors, provided the board of directors may authorize any person to sign any or all checks, contracts, and other instruments in writing on behalf of the Water Utility. The Water Utility Supervisor shall perform such other duties as may be prescribed by the board of directors.

Section 2. Duties of the Assistant Water Utility Supervisor. In the absence or disability of the Water Utility Supervisor, the Vice President shall perform the duties of the Water Utility Supervisor; provided, however, that in case of death, resignation, or disability of the Water Utility Supervisor, the board of directors may declare the office vacant and elect a successor.

ARTICLE XI

Benefits and Duties of Customers

Section 1. The Water Utility will install, maintain, and operate a main distribution pipeline or lines from the source of the water supply and service lines from the main distribution pipeline or lines to the property line of each customer of the Water Utility at which points, designated as delivery points, meters to be purchased, installed, owned, and maintained by the Water Utility shall be placed. The cost of the service line or lines from the main distribution pipeline or lines of the Water Utility to the property line of each customer shall be paid by the Water Utility. The Water Utility also may purchase and install a cut-off valve in each service line from its main distribution line or lines, such cut-off valve to be owned and maintained by the Water Utility and to be installed on some portion of the service line owned by the Water Utility. The Water Utility shall have the sole and exclusive right to use such cut-off valve. However, the provisions of this section shall not be construed to require the acquisition or installation of meters or cut-off valves where the directors determine under the circumstances of the system and the nature of the membership that the use of either or both devices is impractical, unnecessary to protect the system and the rights of the customer membership, and/or economically not feasible.

Section 2. Each customer will be required, at the customer's expense, to have dug a ditch for the connection of the service line or lines from the property line of the customer to customer's dwelling or other portion of the member's premises, and to purchase and have installed the portion of the service line or lines from the customer's property line to the place of use on the customer's premises. The member will maintain such portion of such service line or lines which shall be owned by the customer, at the customer's own expense. The Water Utility may, if the board of directors so determines, purchase the pipe for and install such portion of such service line or lines, the cost of which will, however, be paid by the individual customers. In addition, each customer shall pay such connection charge, if any, as may have been imposed by the board of directors before such member will be entitled to receive water from the system.

Section 3. Each customer may be permitted to have additional service lines from the Water Utility system in the discretion of the board of directors upon proper application therefore and the tender or payment not to exceed the then existing connection charge. The approval by the board of directors of additional service lines to an existing customer may be made conditional upon such provisions as the board of directors determines necessary to protect the interests of other customers and to allow for the orderly expansion and extension of the system. Each service line shall connect with the Water Utility system at the nearest available place to the place of desired use by the customer if the Water Utility System has sufficient capacity to permit the delivery of water through a service line at that point without interfering with the delivery of water through a prior service line. If the Water Utility System is inadequate to permit the delivery of water through a service line installed at such place without interfering with the delivery of water through a prior service line, then such service line shall be installed at such place designated by the Water Utility.

Section 4. Each Customer may be permitted to purchase from the Water Utility, pursuant to such agreement as may from time to time be provided and required by the Water Utility, such water as is needed for domestic, commercial, institutional, industrial (cottage industry), or other purposes as a customer may desire, subject, however, to the provisions of these bylaws and to such rules and regulations as may be prescribed by the board of directors. Each customer shall be entitled to have delivered, through the customer's service lines, only such water as may be necessary to supply the needs of each customer, including the customer's family, business, institutional, or industrial (cottage industry) requirements. The water delivered through each service line may be metered separately, irrespective of the number of service lines owned by a member.

Section 5. In the event the total water supply shall be insufficient to meet all of the needs of the customers or in the event there is a shortage of water, the Water Utility may prorate/ration the water available among the various customers on such basis as is deemed equitable by the board of directors and may also prescribe a schedule of hours covering use of water for commercial, Institutional, or industrial (cottage industry) purposes by particular members and require adherence thereto or prohibit the use of water for commercial, agricultural, or industrial purposes; provided, that if at any time the total water supply shall be insufficient to meet all of the needs of all of the customers for domestic, livestock, commercial, institutional, or industrial(cottage industry) purposes, the Water Utility must first satisfy all of the reasonable needs of the members for domestic purposes before supplying any water for livestock purposes and must satisfy all of the needs of all of the customers for domestic purposes before supplying any water for commercial or industrial(cottage industry) purposes; and provided further, that where a customer has more than one service line, the Water Utility may cut off the flow of water to the nondomestic service lines until such time as the supply of water from the system is sufficient to meet the needs of all of the members for domestic purposes. During such periods of shutoff of additional service lines there shall be no minimum fee charged to the customers having such additional service lines and the cost, if any, of resuming the flow of water to such additional service lines shall be borne by the Water Utility.

Section 6. The board of directors shall, with the consent of the City Council, so long as it shall either hold any obligations or insure any financing of the system, prior to the beginning of each calendar year, determine the flat minimum monthly rate to be charged each customer during the following calendar year for a specified quantity of water, such flat minimum monthly rate to be payable irrespective of whether any water is used by a customer during any month, the amount of additional charges, if any, for additional water which may be supplied the customers, and the amount of penalty for late payments, and shall fix the date for the payment of such charges. A Customer to be entitled to the delivery of water shall pay such charges at the office designated by the Water Utility at or prior to the dates fixed by the board of directors. The failure to pay water charges duly imposed shall result in the automatic imposition of the following penalties.

A. Non-payment within ten days from the due date will be subject to a penalty of ten (10) percent of the delinquent account, which percent may be changed at the discretion of the board of directors.
B. Non-payment within thirty days from the due date will result in the water being shut off from the customer's property without any notice thereof to such delinquent customer. Upon the payment by the delinquent customer of past due water charges, penalties thereon and any reconnection charge, such member shall be entitled to resumption of the water supply. During the time of such suspension of water to a customer, such customer shall have no right to vote in the affairs of the Water Utility.

Section 7. The board of directors shall be authorized to require each customer to enter into water users agreements, which shall embody the principles set forth in the foregoing provisions of these bylaws.

ARTICLE XII

Distribution of Surplus Funds

Section 2. The organization will provide services substantially at cost. Dividends shall not be paid on the basis of membership or shares of stock in the organization. All funds from whatever sources remaining at the end of the year in excess of those needed to meet current losses and expenses will be transmitted to the City Council which shall retain for such purposes as retiring indebtedness incurred in acquiring assets, expanding the organization's services, maintaining reserves for necessary purposes, or reducing subsequent year's water rates. However, the Water Utility will maintain records the funds transferred to City Council every month. Required records for this purpose include financial records that show the organization's revenues from all sources for each year and records, such as bills or receipts, showing the amount of each customer's business annually with the organization.

Amendments

ARTICLE XIII

These bylaws may be repealed or amended by a vote of the majority of the members present at any regular meeting of the Water Utility, or at any special meeting of the Water Utility called for that purpose, except that so long as any indebtedness is held by or guaranteed by the City Council and the State Ministry of Infrastructure, the customers shall not have the power to change the purposes of the Water Utility so as to decrease its rights and powers under the laws of the State, or to waive any requirement of bond or other provision for the safety and security of the property and funds of the Water Utility or its members, or so to amend the bylaws as to effect a fundamental change in the policies of the Water Utility without the prior approval of the City Council and the State Ministry of Infrastructure in writing.

____

We certify that the foregoing bylaws were duly adopted by the members on ___________________, ______ that the same are in full force and have not been amended.

Given under our hands and the seal of the Water Utility, this _______________________ day of _____________________, ______.

____

Secretary

____

President

Knowing Your Bylaws: A Learning Exercise for Board Members ■

Circle "yes" or "no" as an answer for statements 1-4.

1. I have studied or carefully read the bylaws of our water system organization.

   yes   no

2. Each member of the board has a copy of the bylaws.

   yes   no

3. At least one copy of the bylaws is available at each board meeting for use in verifying actions or procedures taken by the board.

   yes   no

4. Our water users are issued certificates of membership.

   yes   no

For items 5-21, circle all answers that are correct. Some of the statements may have more than one correct answer.

1. My water system is organized and legally operates as a
   A. municipality
   B. nonprofit corporation
   C. utility district
   D. private corporation

2. Membership in the water system organization is
   A. limited to those who buy water.
   B. not a concern because there are no members and the city provides the service for a fee, with fees going into the overall city budget.

3. According to our bylaws, user priority is best described as
   A. domestic first, farm second, then industry.
   B. domestic first, industry second, then farm.
   C. only domestic users.
   D. all users are treated equally and no priorities are set.

4. Potential users or those applying for use of our water system may
   A. be denied use because of age or nationality.
   B. cannot be denied use or membership for any reason.
   C. may be denied use if the water supply is already exhausted by the needs of existing users.
   D. may be denied use, as prescribed by the bylaws, if plans include using the water for an unauthorized use.
   E. may be denied use if previously disconnected for failure to pay water bill.

5. Every separate water user in our system

   A. may add an additional house for a child to his line and meter as long as the original user assumes responsibility for payment of the water bill.
   B. must be separately metered and separately billed.

6. A new user of our water system
   A. must make application for membership, be approved by the board, and be issued a certificate.
   B. must pay a connection fee regardless of the presence of an existing meter.
   C. must own the property if water is to be supplied.
   D. may be a renter only if the property owner posts bond.
   E. may become a member by a transfer from another member if the transfer is recorded by the secretary.
   F. must own capital stock in the assets of the organization.

7. A user of our water may
   A. have the water cut off and penalties imposed if the bill is not paid in a specified period of time.
   B. have the water cut off and penalties imposed if users are added to the member's meter in violation of the bylaws.

8. The date and time of our annual meeting
   A. is set by our bylaws and is the same each year unless that date falls on a Sunday or on a legal holiday.
   B. may be changed by the board of directors if the membership is given advance notice.
   C. is determined each year by a vote of the members at the previous annual meeting.
   D. is determined each year by the board of directors, who places advance notices in public places to inform the users.

9. Special membership meetings
   A. may be called at any time of the year by the board of directors.
   B. must be called only if a majority of the members demand that a meeting be held.
   C. may be held, but the only business that can be discussed is that specified in the notice sent to the users or members.
   D. are held each time major purchases are made for the water system.

10. For regular meetings of the board of directors,
   A. times and dates are set for the entire year at the beginning of each year but may be changed by the board if prior notices are mailed or posted.
   B. meetings must be scheduled each month of the year.
   C. are not always necessary if business can be conducted over the phone by the president or chair.
   D. each meeting is usually scheduled by the board at the previous meeting.

11. A motion voted on at our annual meetings passes and is valid
   A. only if a majority of the water system users votes for it.
   B. if there is a quorum and a majority of those present votes for the motion.
   C. if a majority of the board members present concurs with the results.
   D. if a majority of those present at the meeting votes for it regardless of the number of members present at the meeting.

12. Voting decisions on business matters undertaken at regular board meetings are valid

A. if a majority of the board members present votes for the decision.
B. only if a majority of the elected board members votes for the decision.
C. only if the membership approves the decision by vote in a special session.
D. if a quorum is present and a majority votes for the decision.

13. A member of our water system organization can vote by proxy
    A. if the proxy is submitted in writing and is filed with the secretary.
    B. if the member gives the proxy written permission to vote.
    C. if the proxy only serves as a proxy for one member.
    D. if our bylaws are changed. Presently, proxies are not allowed.

14. The general order of business at our annual meetings
    A. is set by the president or chair before each meeting and is presented in written form to the members at the meeting.
    B. is outlined in the bylaws of our organization.
    C. is decided on at the beginning of the meeting by the board members present.
    D. varies from meeting to meeting, depending on the importance of the matters at hand.

15. The president or chair of the board has the following duties:
    A. mails all notices required by the laws and the bylaws
    B. presides over all meetings of the board and meetings of the membership or users of the water system
    C. signs all checks, papers, and contracts
    D. decides the date, time, and place of all board meetings

16. The vice president or vice chair
    A. performs the duties of the president if the president is absent or sick.
    B. becomes president automatically if the president resigns.
    C. is responsible for setting the agenda at all meetings.
    D. may not succeed the president if the president resigns or dies and the board declares the office vacant and elects another board member.

17. The secretary-treasurer has the following duties:
    A. maintains minutes of all board meetings
    B. mails or delivers all notices required by law or by the bylaws
    C. supervises all financial records, other records, and reports of the organization
    D. collects fees paid by users and keeps all records of payment
    E. maintains a seal and stamps all papers requiring the official seal

18. The water system is responsible for
    A. getting water to the houses of the water users.
    B. installing and maintaining water lines up to and including the meter of each user.
    C. installing lines up to the property line of the user, but each user is responsible for the expenses from the meter to the house.
    D. supplying pipes and materials for the user to connect the house, but the user has to bear these expenses.

For items 23-34, fill in the blanks for those that apply to you.

19. Our fiscal year runs from _________________ to _______________.
20. Our annual meetings are held on (month) _________ (day) ______ each year unless this day falls on a Sunday or is a holiday.
21. If the time of the annual meeting is changed, members must be given notice at least _____ days in advance.
22. A special meeting must be called if ____ percent of the members request a meeting through a petition to the board.
23. Regular and special meetings require that notices be mailed not less than ____days nor more than _____days before such meetings are held.
24. The presence of _____ percent of the total voting members or users in person or through proxy constitutes a quorum for conducting legal business at member meetings.
25. 29. Our board has ____ members. At least _____ board members must be present to conduct business legally at board meetings.
26. Water bills are mailed on the _____ of each month.
27. Interest penalties are added to the bill if payment is not mailed by the _____ of each month.
28. Service may be suspended to users who have not paid their bills within _____ days or _____ months.
29. A suspension notice __is/__is not sent before disconnection.
30. A suspension notice is sent ____days before disconnection.

Section IV: Conducting Meetings

The Way Business Is Conducted at Board Meetings: A Self-Assessment

Please respond to the following statements related to your water system management. Select only one answer. The answers reflect only the opinion of the board member making the assessment, but the joint opinions of the board members would help point out the strengths and the weaknesses of the board and identify areas where improvement is needed.

1. Our regular board meetings are
A. scheduled well in advance for the same week of the month, the same day of the week, and the same time.
B. If changes have to be made, members are contacted several days before the meeting.
C. scheduled in advance but not the same week or same day of the week depending on board members' activities and workloads. Members are contacted in advance.
D. scheduled from meeting to meeting, as needed, depending on the other activities of board members.

2. Members are usually contacted in advance.
D not scheduled in advance, but all members are contacted when a meeting is held.
E haphazardly scheduled, and usually some board members do not know about the meeting.

3. Agendas for our meetings are
   A. almost always prepared in advance and sent to all board members before the meeting.
   B. almost always prepared in advance but not always sent to all members before the meeting.
   C. prepared before the meeting and handed out to board members at the beginning of a meeting.
   D. prepared at the beginning of the meeting.
   E. almost never prepared before business is conducted.

4. Agendas for our meetings
   A. have enough detail to let members know the exact nature of the business to be conducted.
   B. have too much detail but are understandable.
   C. have enough detail but are often too vague to convey the exact nature of the business to be conducted.
   D. are too sketchy or generic to give evidence of the nature of the business to be conducted.
   E. are nonexistent.

5. At our meetings, we
   A. follow the agenda and finish our scheduled business.
   B. follow the agenda but often get bogged down in details that make our meetings too long.
   C. follow the agenda, but discussion often strays from the business at hand and we seldom complete our scheduled business.
   D. often change the agenda as the meeting progresses.
   E. never follow an agenda.

6. Minutes of our meetings are
   A. very accurate and reflect exactly what goes on at our meetings, including the approved actions with the precise motions, the vote, and how individual members voted.
   B. accurate, but often they do not have details related to motions and votes.
   C. fairly accurate but sometimes vague about exact actions taken by the board.
   D. often inaccurate, and board members spend too much time correcting minutes.
   E. sometimes inaccurate, but the board often does not get around to making all the needed changes.

7. Our minutes
   A. are kept on file, are easily accessible, and provide a precise record of our actions.
   B. are kept on file and provide a reasonable record of our actions.
   C. are kept on file, but minutes for some meetings are often missing.
   D. are filed but often are hard to find and copies are missing.
   E. are haphazardly filed, often are not filed, and provide a poor record of our activities.

8. Our minutes are
   A. promptly sent to board members for approval after each meeting.
   B. usually sent to board members for approval before the next meeting.
   C. sent to board members for approval, but often board members do not respond before the next meeting.
   D. not distributed but are read and adopted at the next meeting.
   E. adopted at the next meeting, but often some things are not clarified.

9. For our board,
   A. all members know our rules for conducting business, know how to make motions and amendments, and are good at conducting business quickly and effectively.
   B. most members know our rules for conducting business, but some members often try to ignore the rules in business discussions.
   C. a few members know our rules for conducting business, but we often do not follow our own rules.
   D. the president or chair knows the rules, but others are not familiar with the rules and depend solely on the president or chair for keeping things in order.
   E. we do not follow any specific rules in conducting business.
10. Our board president or chair
    A. does an excellent job of organizing and conducting meetings.
    B. does a good job of organizing and conducting meetings.
    C. does a fair job of organizing and conducting meetings.
    D. is organized sometimes but often comes to meetings unprepared.
    E. is poorly organized.

11. Our board president and board members
    A. make an effort to keep each other informed and help each other in conducting business.
    B. keep each other informed, but most of the work is usually performed by one or two members.
    C. have some communication, but work is often done reluctantly by board members.
    D. have poor communications, and most of the work is done by the president or by one person.
    E. are sometimes openly hostile to each other, and work is often incomplete.

12. Our manager has been
    A. carefully selected by the board according to ability, has a specific job description, works without interference from board members, and is subject to an objective performance evaluation by the board.
    B. carefully selected by the board, manages the system without a job description, often reports to the board, but is not subject to a performance evaluation.
    C. selected by the board, operates under very close board supervision without a job description, and seldom has to report to the board.
    D. selected by the board because of influential pressure, does only a fair job of running the system, answers to those that influenced the hiring, and does not systematically report to the board.
    E. changed several times over the years because it is difficult for managers to work without board interference.

13. Our board
    A. keeps the water users very well informed of meetings, current board actions, and future plans for the water system.
    B. complies with all the rules regarding meetings and informs the members by direct personal contact about board actions and plans.
    C. informs the users indirectly by newspapers or by other mass media about board meetings and board actions.
    D. does only the minimum required by placing a notice of the annual meeting in a newspaper and only informs users attending the annual meeting about water system business.
    E. makes no effort to communicate to users and avoids giving out information unless required to do so.

    Number of answers: ____A's ____B's ____C's ____D's ____E's (F's)

A Guide for Conducting Business at Board Meetings

The keys to effective business meetings are knowledge of the bylaws, a properly prepared agenda, and knowledge of established written rules for conducting business. Some of the major frustrations that board members feel are often related to simple and basic problems of conducting business. Complaints about wasting time, not being informed, meetings taking too long, not knowing exactly what decisions have been made, important issues not being discussed, and an uneasiness about the way the board operates are all to prevalent among water system organizations. Some water system association boards have had members complain publicly that their organizations are not following the rules in conducting legal business. The bylaws contain the major purpose of the system and rules for making operational decisions but usually offer no help in formalizing procedures for conducting meetings.
The president or board chair has the major responsibility for conducting meetings, but this person should not have to establish the rules of conduct.

These rules should be established and written by the board as part of water system board or policy so that any board member conducting a meeting will follow the same rules.

Scheduling Meetings and Notifying Members

Schedules and agendas for annual meetings and special meetings are prescribed in the bylaws, but regular board meeting procedures are usually not included. Annual meetings of nonprofit associations are legally required. A schedule of regular board meetings should be prepared a year in advance or for an extended period of time. If possible, meetings should be scheduled for the same week of the month and the same day of the week. This pattern makes the meetings easier to remember and helps board members fit the meetings into their schedules, allowing them to plan personal business around board schedules. Changes in the schedules may be made as they become necessary. Meeting once a month is usually not overly burdensome and gives board members the opportunity to become better acquainted in the working environment. For regularly scheduled meetings, the board should establish a policy to notify board members of the date, time and place of the meeting by first class mail a week before (or a specified number of days before) the meeting and to follow up with a phone call one to two days before the meeting.

Many water system boards have so few members that notification is essential to ensure that a quorum will attend. Usually, the impetus for notification comes from the president or chair, who often asks the secretary to mail the notices and make the calls. For some organizations or associations, the president calls directly to help ensure that board members will attend the meeting.

Agendas

A properly prepared agenda, sent to board members before a meeting, outlines the nature of the business to be conducted. This agenda allows time for better preparation and assures board members that business will be conducted in an orderly and efficient manner. Agendas for the annual meetings of associations are often topically outlined and set in the bylaws. A typical agenda for a board meeting will have the following elements:

1. Call to order and proof of quorum
2. Evidence of notices of meeting
3. Reading and approval of minutes
4. Officer and committee reports
5. Election of directors
6. Unfinished business
7. New business
8. Adjournment

A proof of quorum and evidence of meeting notices are necessary to verify that legal meetings are held and that the association or organization is following the rules of its own bylaws. The board should take the approval of the minutes seriously because the minutes provide the only legitimate record and proof of the board's business decisions. At most annual meetings, at least one or two board members are elected, depending on the rotation defined in the bylaws. There may not be any unfinished business from the previous meeting, but if there is unfinished business, it must be considered before new business is conducted. A business meeting officially ends when a motion is passed to adjourn the business meeting.

Agendas for the regular meetings of the board should not be overly detailed, but they should include enough detail for board members to know the exact business to be discussed at the meeting.

An example of too little detail follows:

1. Needed repairs
2. Replacing a pump

This could be clarified by changing the agenda items to the following:

1. Spending $2,000 for repairs on the line from Flynn Road to Knarl Hill
2. Spending $8,000 to replace the pump at well 1 on Knarl Hill

The president, the manager, or a designated board member should develop the agenda and send it to board members in time for them to think about the topics, gather information if necessary, and prepare for the meeting. Before the agenda is defined, the manager, the operator, and all board members should be consulted to decide which items should be reviewed. The manager usually has the responsibility of contacting the operator and presenting to the board any items from the operator. Priorities should be set only after this is done.

Boards need an approved policy that sets a deadline for adding agenda items. The agenda should be changed only if emergencies occur after it has been distributed. The president or chair should check with committees before the agenda is set to determine which committees will report.

Using a Consent Agenda

A consent agenda can be used to improve the effectiveness of a business meeting and to reduce the time required to conduct a meeting. A consent agenda is an agenda pulled from the regular agenda based on items that require action but are not thought to need further discussion. If a board member wants to discuss an item that has been included on the consent agenda, then that member can request that the item be moved from the consent agenda to the regular agenda for discussion. Before removing the item from the consent agenda, the president or chair may ask if the question can be quickly answered or the problem quickly resolved. If this can be done, the board member may then allow the item to remain on the consent agenda. A consent agenda prevents wasting time on matters that have already been reported, that have already been evaluated, that have already been discussed, or that have been fully explained in attached written documents. Decision making is a mere formality on a consent agenda. All consent items are blocked together and voted on in one motion.

For example, the consent agenda on the right was developed from the regular agenda on the left.

Agenda	Consent Agenda
1. Call to order	12. Approval of minutes
2. Declaration of quorum	13. Acceptance of publicity committee report
3. Approval of minutes	
4. Finance committee report: income, expenses, balance	
5. Operations and maintenance report: compliance update, location and severity of leak repairs, recommended improvements or scheduled maintenance	
6. Publicity committee report on news release	
7. Payment of bills, contracts, and bids	
8. Purchasing new pump for Knarl Hill well	
9. Replacing lines from Flynn Road to Knarl Hill	
10. Complaint by Mr. Jones about service to his area	
11. Adjournment	

Approving the consent agenda first would eliminate time spent individually on the items in the regular agenda.

Minutes

Minutes are the legal record for water associations and for board actions. Taking minutes and reviewing minutes are serious responsibilities. Recording accurate minutes is necessary for the proper functioning of the water system board. Minutes confirm precisely what business was conducted by the board and may provide critical evidence of board decisions. Approved minutes offer board members the assurance of verified activities. They also offer the opportunity to examine records to ensure that required and needed activities of the water system have been conducted. A poor set of minutes often leaves board members more vulnerable to criticism and legal actions. Several precautions can be taken to reduce the possibility of errors in the minutes. During a meeting, the secretary should sit in a position where proceedings can be heard and understood. If questions arise, the secretary should immediately ask for clarification. Some secretaries prefer to take notes, tape the proceedings, and then use the notes and the recording to develop the first draft of the minutes. Minutes should be detailed enough to give the important aspects of the meeting but not so detailed as to record every comment made during the meeting.

Actions taken from telephone conferences or other decision forums must be recorded in the minutes. Copies of the minutes should be distributed to board members for review as soon as possible after the meeting. Delaying distribution can lead to members' forgetting details of the meeting or losing notes from the meeting. The meeting time can be reduced by sending copies to board members for their approval before the next meeting. The minutes usually can then be quickly approved, and the reading and correcting of the minutes can be avoided.

Minutes should

- give the nature of the meeting: regular meeting, special meeting, or emergency meeting. If the meeting is a special meeting, the reason and purpose of the meeting should be specified.
- give the time, date, and location of the meeting.
- list the names of the board members who are present and who are absent.
- list in order of occurrence the matters discussed,
- the actions taken, and the votes on the actions.
- include the precise wording of the motions made, who made the motions, who seconded the motions, and the votes on the motions by each board member present.
- list the time, date, and place of the next scheduled meeting.
- state the time the meeting was adjourned.

Rules for Making Motions

Any organization that has frequent meetings and heavy business loads should adopt policies about the way business is conducted. Most organizations follow
"Robert's Rules of Order," which is specified in the bylaws. These rules are comprehensive. Being knowledgeable about all procedural rules requires extensive study. Therefore Rubkona County rural water associations should outline their own short set of rules of conduct.
This set of rules must not conflict with the bylaws. The short set can generally be developed from the more extensive rules without conflicting with them. These rules should be written and adopted by the board as a policy of the organization.

Other Rules

Other basic rules may be incorporated if they do not conflict with nonprofit corporation laws or the bylaws. An example of other basic rules that might improve meeting efficiency follows:

1. The time, date, and location of a regular meeting must be posted in a public location known by water system users.
2. The president must contact all board members to seek their input before developing a final agenda for a regular meeting.
3. The agenda for a regular meeting must be distributed to the board at least 2 days before each meeting.
4. Any member user who wants to discuss a problem or an issue before the board must contact the president of the board at least 3 days before the meeting or before the agenda has been distributed to get permission to address the board. The president has the option of approving or not approving the request. If approved, the item is added to the agenda.
5. The president or chair must follow the agenda in conducting a regular meeting.
6. All board members must follow the bylaws, the rules established for making motions, and all other policies approved for the water system board.
7. The minutes of a meeting must be sent out for correction no later than 1 week following a meeting; board members must make comments and corrections no later than 1 week before the next meeting so the secretary can make the changes before submitting final copies for approval at the next board meeting. These ideas are submitted to help the water system organizations conduct business more efficiently. Each organization has its own strengths and weaknesses in this area and will need to establish a plan that fits its particular needs in making effective decisions.

Table 1: Parliamentary procedures at a glance

[1]To do this	You say this	May you Interrupt the speaker	May you be seconded	Is the motion debatable	Is the motion amendable	What vote is required
Adjourn the meeting	"I move that we adjourn"	May not interrupt the speaker	Must be seconded	Not debatable	Not amendable	Majority vote required
Recess the meeting	"I move that we recess until…."	May not interrupt the speaker	Must be seconded	Not debatable	Not amendable	Majority vote required
Complain about noise, room etc.	"Point of leverage"	May not interrupt the speaker	No need seconded	Not debatable[2]	Not amendable	No vote required[3]
Suspend further consideration of something	"I move we table it"	May not interrupt the speaker	No need seconded	Debatable	Not amendable	Majority vote required
End debate	"I move the previous question"	May not interrupt the speaker	No need seconded	Debatable	Not amendable	Two thirds vote required
Postpone consideration of something	"I move we postpone until….."	May not interrupt the speaker	No need seconded	Debatable	Not amendable	Two thirds vote required
Have something studied further	"I move we refer this matter to a committee"	May not interrupt the speaker	No need seconded	Debatable	Not amendable	Majority vote required
Amend a motion	I move that this motion be amended by….."	May not interrupt the speaker	No need seconded	Debatable	Not amendable	Majority vote required
Introduce business (a primary motion)	I move that	May not interrupt the speaker	No need seconded	Debatable	Not amendable	Majority vote required

[1] The motions or points above are listed in established order or precedence.
When any one of them is pending, you may not introduce another that's listed below it, but you may introduce another that's listed above it.
[2] In this case, any resulting motion is debatable.
[3] Chair decides.

Table 2: Parliamentary procedures at a glance

To do this[4]	You say this	May you Interrupt the speaker	May you be seconded	Is the motion debatable	Is the motion amendable	What vote is required
Object to procedure or personal affront	"Point of order"	May interrupt speaker	No second needed	Not debatable	Not amendable	No vote required; chair decides
Request information	"Point of Information"	If urgent may interrupt speaker	No second needed	Not debatable	Not amendable	No vote required
Ask for vote by actual count to verify voice vote	"I call the division of house"	May not interrupt speaker[5]	No second needed	Not debatable	Not amendable	No vote required unless someone objects[6]
Object to considering some diplomatic or Improper matter	"I object to consideration of this question"	May interrupt speaker	No second needed	Not debatable	Not amendable	Two-thirds vote
Take a matter previously tabled	"I move we take from the table.."	May not interrupt speaker	Must be seconded	Not debatable	Not amendable	Two-thirds vote
Reconsider something already disposed of	"I move we now (or later) reconsider our action"…relative to…"	May interrupt speaker	Must be seconded	Debatable if original motion is debatable	Not amendable	Majority vote
Consider something out of order	"I move we suspend the rules and consider…"	May not interrupt speaker	Must be seconded	Debatable	Not amendable	Two-thirds vote
Vote on a ruling by the chair	"I appeal the chair's decision"		Must be seconded	Debatable	Not amendable	Majority in negative required to reverse chairs decision

[4] The motions, points and proposals listed above have not established order or precedence. Any of them may be introduced at any time when the time except when the meeting is considering one of the top three listed in above chart (motion to adjourn, motion to recess, point of privilege).

[5] But division must be called for before another motion is started.

[6] Then majority vote is required.

Knowing How To Conduct Business: A Learning Exercise for Board Members

Circle "yes" or "no" for statements 1-3.

We have specific rules or written policies stating how our agendas are developed for our regular board meetings.

yes	no

We have used a consent agenda at a business meeting of our water association.

yes	no

Our bylaws specify the rules that we use (such as "Robert's Rules of Order") in conducting our business meetings.

yes	no

Some of the statements below may have more than one answer. Circle all answers that are correct.

1. Agendas for our annual meetings are
   A. basically set by our bylaws.
   B. exclusively determined by the board of directors or selected board members without regard to our bylaws.
   C. established when members arrive for the meeting.
   D. none of the above.

2. The agenda for a board meeting
   A. must be followed by the president in conducting the meeting.
   B. can be changed anytime the president or chair wants to introduce new business.
   C. is set before the meeting and is changed only if a current emergency arises.
   D. is not often used in conducting the meeting.

3. A consent agenda is an agenda that
   A. all board members have agreed upon.
   B. an agenda that is separate from the regular agenda and is used for items that have been added after the regular agenda has been completed.
   C. puts all the business items together.
   D. is pulled from the regular agenda based on items that do not require further discussion. These items are blocked together and voted on together to save time in conducting meetings.

4. Minutes of our board meeting are
   A. kept by our secretary who was elected by the board and has this responsibility according to our bylaws.
   B. kept by our office manager who was appointed by the board.
   C. kept by different board members according to attendance and availability at meetings.
   D. written from notes that the president keeps.

5. Minutes
   A. provide a legal record of board activities during business meetings and are for internal use only.
   B. need to be accurate because they provide the official record of business conducted by the board.

C. are informally used to keep a record of business decisions but do not need to be maintained after business action has been completed.
D. need to be maintained in a chronological file for a long period of time as a historical and legal record of business activities.

6. To help ensure that accurate minutes are maintained,
   A. copies of the minutes should be distributed to board members soon after a meeting, and the board members should make any corrections promptly and return them so that corrected copies can be prepared.
   B. tape recorders may be used so that exact proceedings can be reviewed.
   C. the secretary should be willing to ask questions immediately if clarification of the proceedings is needed.
   D. each board member should keep notes, especially for items that the individual board member was an active participant in discussing.

7. Minutes should include
   A. every statement made during the meeting.
   B. the time, date, and place of the meeting.
   C. a list of the board members present at and absent from the meeting.
   D. a precise wording of the motions made, who made the motions, who seconded the motions, and the voting results.

8. The rules of conduct that we follow for business meetings
   A. are not part of our bylaws.
   B. cannot conflict with our bylaws.
   C. are set in our bylaws to follow "Robert's Rules of Order."
   D. are not part of any bylaws or written policy that we have.

9. For rules that follow "Robert's Rules of Order," the order of occurrence for a motion to be accepted or rejected is
   A. motion, discussion, second, vote.
   B. motion, second, vote, discussion.
   C. discussion, motion, second, vote.
   D. motion, second, discussion, vote.

10. Common rules that are often added to improve the efficiency of meetings and save time are done to
    A. limit the number of motions that can be made during a meeting.
    B. limit the time of discussion by each discussant and limit the number of times each participant can discuss a motion.
    C. set a time to end the meeting regardless of the business left to do or the progress made.
    D. not allow amendments to motions.

11. Amendments to motions are normally made
    A. before a motion is seconded.
    B. after the original motion has passed.
    C. after the original motion has failed.
    D. after a motion is seconded and the chair has asked for discussion.

12. Problems with the preciseness of motions can be practically eliminated by
    A. requiring that motions be written.
    B. requiring the presiding officer to repeat or read the exact motion before a vote.
    C. requiring the secretary to write the motion and read it to the group before recording it in the minutes.
    D. none of the above.

13. When making a motion, a board member can often reduce the need for an amendment if
    A. the motion is general enough to give some leeway in carrying out the business.
    B. the motion includes the provision for referring the matter to a specific committee.
    C. it includes what work is to be done, who is to do the work, when it is to be done, and how much is to be spent.
    D. none of the above.

14. Business is more easily conducted when it is grounded by
    A. rules that are adopted before a meeting and are applied for that meeting only.
    B. a set of bylaws, a written agenda, a written policy on making motions and conducting business, and an accurate recording of the minutes.
    C. a set of bylaws only, because others rules may conflict with the bylaws.
    D. no rules but depends on an effective presiding officer.

15. Employee problems can be reduced and employee morale can be increased by
    A. hiring a strict manager who supervises employees and helps them with every decision.
    B. using detailed job descriptions when hiring and by using objective performance evaluations for all employees.
    C. informally handling the hiring and promotion of employees.
    D. by hiring employees for short periods of time only and by letting them go when workloads decrease.

16. The people that the board is most responsible to are
    A. the manager and the employees of the board.
    B. other board members.
    C. the president or chair of the board.
    D. the members or users of the water system.

17. The best way to reduce board problems with the members or users of the rural water system is to
    A. do the minimum required in informing users about board meetings and board business. People normally do not want to be bothered with board business and trust the board to make the right decisions.
    B. put only a public ad in the newspaper about the time and place of the annual meeting and discuss only business at annual meetings.
    C. keep the users personally informed about proposed budgets, costs, income, future investments, and other business to keep surprises to a minimum and create a more open atmosphere.
    D. have as little contact as possible with the users and respond to problems through the manager, operator, or other employees.

Policies and Ordinances

Comprehensive Customer Service Policy
______________________ Water Utility

I. General Authority:

The ______________________ Water Utility Board has unanimously passed a resolution addressing the herein-stated Customer Service Policy. The ______________________ Water Utility Board has the ultimate authority and responsibility to ensure the financial health and stability of the Water Utility. It is inherent that every Customer of the Water Utility is treated in a fair and equitable manner and that each Customer pays for the services provided by the Water Utility.

II. Definitions:

A. Water Utility: The Water Utility refers to the member-owned public water system formally known as ____ Water Utility

B. Board: The Board refers to the Directors of the Water Utility that have been duly elected in accordance with the bylaws of the Water Utility.

C. Customer: Customer refers to any household or business that is receiving water supplied by ______________________ Water Utility

D. Service Connection: Service Connection refers to the physical tap, line, curb stop, meter, and meter box supplied by and owned by the Water Utility. Where the Customer is required to pay for the installation of the abovementioned equipment and to pay a security deposit to use the Service Connection, the Water Utility retains full ownership and control of the Service Connection. The Customer benefits by being the sole customer who has access to the Service Connection.

E. Late Charge: The Late Charge is a _____% assessment of the current balance that has not been received by the _____ day of each month.

F. Service Charge: The Service Charge consists of one of two fees assessed if full balance of customer's account is not paid within _____ days. The first type of Service Charge is a Collection Fee. The Collection Fee is assessed if the Board, its employees or contractors has to physically go to a customer's residence to collect entire balance. The Reconnection Fee is assessed if the Service Connection is terminated for delinquency.

G. Delinquent: A customer's account is considered delinquent if any portion of the account is over ______days late.

H. Hardship Agreement: The Hardship Agreement is an informal written agreement between a customer of the Water Utility and the Board. The Hardship Agreement is granted when a customer has incurred a large water charge that he is unable to pay current bill in full. The Hardship Agreement is also granted when a customer has incurred a hardship such as an illness, family death, loss of employment, etc. and is unable to pay current bill in full. The Water Utility will not terminate a Service Connection if a valid Hardship Agreement is in force.

I. Payment Extension Agreement: The Payment Extension Agreement is an informal written agreement between a customer of the Water Utility and the Board. The Payment Extension Agreement is granted to a customer before the _____ day of each month where the customer agrees to pay all past due and current balances before the end of the current month. The Water Utility will not terminate a Service Connection if a valid Payment Extension Agreement is in force.

J. Terminate: To Terminate a Service Connection is to actually lock or cup the Water Utility's curb stop or to remove the Water Utility's meter for the purpose of discontinuing water service to the customer.

K. Bad Debt: A Bad Debt is a balance that is still owed on a customer's bill _____ days after the Service Connection has been terminated. Bad Debts will be collected through prompt lawsuit filings for the purpose of being awarded a judgement and garnishment of wages to reimburse the Water Utility all legal expenses, court costs, and Bad Debt from the customer.

L. Theft of Water: Theft of Water refers to tampering with, including the adjustment or removal of locking devices on a utility meter
The customer who is benefiting from Theft of Water will be held accountable, not necessarily the person that has removed or tampered with the meter lock. The Board will seek to prosecute any customer that is engaged in the Theft of Water.

M. Customer Grievance: A Customer Grievance is an informal complaint generated by a Water Utility Customer and directed to the Water Utility's Billing Clerk. The Customer must inform the Billing Clerk of any suspected error or discrepancy in the billing of the Customer's water usage. The Billing Clerk then investigates the Customer Grievance. The Customer and Billing Clerk must present evidence before the Board at the regular monthly Board Meeting.

N. Board Meeting: The ____________________ Water Utility Board conducts its regular monthly Board Meeting on the 3rd Thursday of each month. All meetings are open to the public, but anyone wishing to address the Board must notify a Board Customer or employee or contractor of the Water Utility at least one day prior to the Board Meeting.

O. Billing Clerk: The Billing Clerk is contracted to provide Accounts Receivable Services including, billing, collecting, posting, and depositing all Customer payments.

P. Maintenance Superintendent: The Maintenance Superintendent is responsible for all aspects of O&M for the Water Utility and complying with regulations under the supervision of the certified operator of record.

Q. Service Extension: Any extension of the ______________________ Water Utility existing facilities including the installation of meters / service connections or main line extensions.

R. Applicant for Service: Any person or entity applying to ______________________ Water Utility for new water service.

S. Notice of Intent: Is issued by the _________________ County Department of Health Environmentalist which is basically an affidavit of an individual promising to install the on-site waste water (sewerage) disposal system recommended by the Environmentalist.

T. Engineer: A professional certified civil engineer with extensive experience in the hydraulic design and construction of potable water systems.

U. Certificated Area: The delineated franchise boundary established by the Rubkona (or Bentiu) establishing _____________________ Water Utility as the sole water utility provider within the service area.

V. Users Agreement: A contractual agreement between applicants for water service and _____________________ Water Utility

II. Service Extension Policy:

A. Meter Installations / Connections for Individual Applicants whose property intersects an existing water main:

Applicants requesting water service to property where existing water mains are present either on the property or across a public road from the property and where a new meter installation is needed are required to complete the following procedures prior to the installation of a water meter:

a. Applicant shall first request that the Maintenance Superintendent confirm that an adequate sized water main exists either on the property where the service connection is to be located or across a public road from the property.

b. Upon confirmation of the location of the _____________________ Water Utility water main on or near the property of the applicant's proposed service connection, the Applicant shall obtain a Notice of Intent from the Water Board.

c. The Applicant shall then make arrangements to meet the Billing Clerk in order to execute the Users Agreement at which time the Notice of Intent shall become the property of _____________________ Water Utility and the Applicant pays the applicable following fees:

Membership Fee: (Non-Refundable Contributed Capital)	SSP
Residential Security Deposit: (Refundable upon Termination of Services)	SSP
Rental Security Deposit: (Refundable upon Termination of Services)	SSP
Commercial Security Deposit: (Refundable upon Termination of Services)	SSP
Industrial Security Deposit: (Refundable upon Termination of Services)	SSP
Water Tap Fee: (Non-Refundable Materials and Labour Costs of Installing Service)	SSP
Road Cut Fee: (Non-Refundable Extra Charge if Main is opposite property on dirt or gravel road)	SSP
Road Bore Fee: (Non-Refundable Extra Charge if Main is opposite property on paved County Road)	SSP
Highway Road Bore Fee: (Non-Refundable Extra Charge if Main is opposite property on State or Federal Highway)	SSP

Applicants requesting water service to property where existing water meters are present are required to complete the following procedures prior to completing a User's Agreement:

a. Applicant shall request the Maintenance Superintendent to inspect the existing service connection to ensure that all necessary equipment including the curb stop, meter, meter coupling, meter box and top are in place prior to executing the Users Agreement. The Maintenance Superintendent shall also inspect property as well as system maps to ensure that property is within sewer service area and that an existing sewer main is on or near the property.

b. If Applicant has moved a Mobile Home onto the property of an existing water service connection, the Applicant shall first obtain the Notice of Intent from the Rubkona County Environmentalist as outlined above in Paragraph 1, Line B.

c. The Applicant shall then make arrangements to meet the Billing Clerk order to execute the Users Agreement at which time the Notice of Intent shall become the property of ______________________ Water Utility and the Applicant pays the applicable following fees:

-Membership Fee: (Non-Refundable Contributed Capital)	SSP
-Residential Security Deposit: (Refundable upon Termination of Services)	SSP
-Rental Security Deposit: (Refundable upon Termination of Services)	SSP
-Commercial Security Deposit: (Refundable upon Termination of Services	SSP
-Industrial Security Deposit: (Refundable upon Termination of Services)	SSP
-Connection Fee: (Non-Refundable Labour Costs of Connecting Service)	SSP

B. Meter Connections requiring the extension of Water or Sewer Mains:

Applicants requesting water and service to areas where existing ______________________ Water Utility water mains are not present are required to complete the following steps:

1. Obtain a Petition for Service from the Maintenance Superintendent and gather signatures of all individuals and entities who have property within the proposed service extension area who would also like to be connected to ______________________ Water Utility

2. Upon the completion of the Petition for Service, the Applicant shall present said petition to the Board. If the Board determines that not all potential customers have been included in the Petition for Service, the Board may require a written explanation as to why these individuals or entities are not included.

III. Collection Policy:

A. Collection of Customer Water Payments:

1. ____________________________ has been contracted by ______________________ Water Utility to receive, post and deposit customer water and sewer payments at the following address:

_____________________________ is hereinafter designated the Billing Clerk.

2. Customers of ______________________ Water Utility should receive a current monthly statement detailing current and past due water charges on or shortly after the ____ day of each month. If a customer does not receive a monthly statement, it is the customer's responsibility to contact the Billing Clerk so that another bill can be mailed. Failure to receive a monthly statement does not relieve the customer of any payment obligation nor prevents the Termination of a Service Connection.

B. Grievances, Payment Extension Agreements, and Hardship Agreements:

1. Customer Grievance:
If a Customer has a dispute regarding the current bill, the Customer is required to contact the Billing Clerk to inform him of the discrepancy. The Billing Clerk, after investigating the merits of the complaint will in turn notify the Customer of any findings. The Billing Clerk cannot under any circumstances adjust a water bill. However, the Billing Clerk must report his findings to the Board before the _______ day of each Month. The Board will act on testimony from both the Billing Clerk and the Customer at the Board Meeting and will make any adjustments accordingly. No Late Charges or Service Charges will be assessed after a Grievance has been filed. Upon a ruling of the Grievance by the Board, the Customer has 5 days to pay the balance in full. If the balance is not received by the Billing Clerk within 5 days of the ruling, applicable Late Charges and/or Service Charges will be assessed.

2. Payment Extension Agreement:
If a Customer has a past due amount reflected on the bill that he receives, the Customer may appear in person before the Billing Clerk to file a formal Payment Extension Agreement provided that the Payment Extension Agreement is filed before the _____of the month. The Payment Extension Agreement must stipulate full payment of both current and past due charges and applicable late charges before the end of the month. If the Customer does not pay full balance on or before the last day of the month, the Payment Extension Agreement becomes null and void. If the Customer has not fulfilled his promise to pay by the end of the month, the Customer will not be allowed to file another Payment Extension Agreement for six months. Furthermore, if a Customer has defaulted on his agreement to pay, the Service Connection supplying water to the Customer will be terminated within 5 days without any other notice or warning.

3. Hardship Payment Agreement:
If a Customer incurs any type of hardship including a high water bill, loss of employment, loss or damage of property caused by fire or natural disaster, death or illness of family Customer, or any other catastrophe that hinders the Customer's ability to pay his full monthly bill, the Board may grant a Hardship Payment Agreement. The Hardship Payment Agreement will only be granted if the entire Customer's past due balance has been previously paid. The Hardship Payment Agreement stipulates that at least one half of the current monthly minimum be paid before the ______ day of each month. The remaining balance of the Customer's bill is not forgiven or adjusted but carried over each month with no accumulation of Late Charges provided that the Customer pays at least the minimum stipulated in the Hardship Payment Agreement before the _____ day of each month. The Hardship Payment Agreement is granted for a maximum term of three months. At the end of the term, the Customer may appear before the Board to request an extension not to exceed two more months. The Customer agrees to pay all remaining charges within 15 days of the term expiration of the Hardship Payment Agreement. The Customer may be entitled to filing a Payment Extension Agreement to extend the full repayment of the balance by the end of the month that the Hardship Payment Agreement expires. Failure of making the minimum payment stipulated in the Hardship Payment Agreement by the end of each month will result in the automatic termination of the Hardship Payment Agreement. Twelve calendar months have to elapse before a Customer may petition the Board for another Hardship Payment Agreement, regardless of whether or not the Agreement's promises have been fulfilled by the Customer.

C. Proof of Payment:
1. If a Customer has a dispute regarding the proper credit and posting of a water payment, it is the Customer's responsibility to provide acceptable Proof of Payment. Proof of Payment may consist of one of the following:

a. ______________________ Water Utility Payment Receipt
b. Statement & Photocopy of Cancelled Money Order from company issuing money order. (A Money Order Receipt is not proof that the payment was made. This receipt is only proof that you purchased a money order. It should always be retained in the event that a Customer needs to request a trace from the company issuing the money order.)

2. It is the responsibility of the Customer to notify the Billing Clerk of any discrepancy including an improperly credited or missing payment. The Billing Clerk will notify the Customer if he cannot find or solve the problem. The Customer must appear before the Board and either provides Proof of Payment or request additional time to obtain proof. The undisputed portion of the water statement should be paid before the _____ day of the month.

V. Cut-off Policy:
A. Billing, Late Assessments, Cut-Off Notices:
1. ______________________ Water Utility usually reads meters between the ____and ____ of each month after which time the Billing Clerk calculates the water / sewer statements and mails them. The full balance shown on the statements are due and payable immediately after they are mailed. Failure for a customer to receive a water statement does not waive the customer's responsibility to pay all charges included in the statement nor does is this grounds for not charging late charges, service charges, or terminating service.

2. A ____% late charge of the current balance will be assessed if payment is not received by the ____ day of each month.

3. A cut-off notice will be mailed to each customer with any past due amount still owed after the ____ day of each month.
4. Failure of a customer to remit full payment of all current and past due charges within five days of the cut-off notice being mailed will result in the customer's service being terminated. Refer to Paragraph "C" below for further explanation.

4. Failure of a customer to remit full payment of all current and past due charges within five days of the cut-off notice being mailed will result in the customer's service being terminated. Refer to Paragraph "C" below for further explanation.

B. Delinquent Collections:
1. If a Delinquent Customer has failed to pay his entire bill by the date shown on the Cut-Off Notice, the said Customer may offer full payment including a SSP_______ Collection Fee. It is the responsibility of the Customer to offer payment to the employee or contractor that has arrived on site for the sole purpose to terminate the Service Connection. Furthermore, the Customer must present full payment including the Collection Fee to the employee or contractor within 5 minutes of requesting the Service Connection not be Terminated. If the Customer is unable to gather the full payment within 5 minutes, the employee or contractor must terminate the Service Connection without further delay.

C. Termination of Service:
1. If a Delinquent Customer has had his Service Connection Terminated, he must appear before the Billing Clerk or an Authorized Board Customer to pay full payment of current charges, past due charges late charges and service charges to include a SSP_______ Reconnection Fee. After full payment has been received, the Delinquent Customer can expect his Service Connection to be restored within 8 hours.

2. If a Delinquent Customer who has had his Service Connection Terminated but is receiving water through a meter that has had its locking device tampered with or removed, then the Board will file criminal Theft of Water charges against the customer. The Board will also immediately file a civil lawsuit against the Customer to seek a judgement to recover all current and past due water charges, late charges, service charges, charges for damage to the lock and / or meter, and any applicable court costs.

D. Bad Debts:

1. If a Delinquent Customer has not paid his full balance within _______days after Termination of Service, the Billing Clerk shall write a letter to the Customer requesting full payment within _______days. The letter shall also state the Water Utility's Customer Service Policy and the intent to file a lawsuit against the Customer if payment is not received by the specified deadline.

2. If after ______days of mailing notice concerning Bad Debt balance, and the account still has not been settled, the Billing Clerk shall apply the customer's security deposit to the balance, print a detailed transaction report for the customer's account over the last six months, and supply this report along with all copies of all correspondence to the customer since the meter has been terminated, the customer's address, social security number, place of employment and any other recorded information to the Board. The Board shall then have its attorney prepare a lawsuit to recover the unpaid balance as well as any other fees that the board or court deems necessary including but not limited to legal fees and court filing fees.

3. If a customer owing a Bad Debt balance has had his / her deposit applied against the outstanding balance, the customer will be required to complete another water user's agreement and post a security deposit equal to twice the amount of the applicable user class deposit for residential, commercial, or industrial customers.

VI. Implementation, Enforcement, and Amendments of the Customer Service Policy:

A. Implementation:

The Board for ___________________ Water Utility has resolved to fully implement the Customer Service Policy by the ________ of __________, ________. All employees, contractors, and designees of ______________________ Water Utility will be charged with the responsibility of strictly adhering to the Customer Service Policy.

The Board shall also publicly post or distribute copies of this policy to the customers immediately.

B. Enforcement:

The employees, contractors, and designees of ______________________ Water Utility shall enforce the Customer Service Policy. Every Customer of the Water Utility will be required to be subject to the same Customer Service Policy. No preferential treatment of any Customer including members of the Board will be tolerated.

Approval:

Be it resolved, that the ______________________ Water Utility Board conducted a monthly business meeting on the ______ day of ___________, ______.

Furthermore, that the Board, acting upon a motion made and duly seconded, unanimously approved the Customer Service Policy contained herein the nine preceding pages.

Be it further resolved, that the said policy will remain in force until such time that the Board of ______________________ Water Utility resolves to amend said policy.

____ ________________

Secretary of the Board Date

- Appendix A -

__________________W.A.

No. 0057

Water Users Agreement

Account Number __________________
Previous User _____________________
Application Date __________________

I, (Signature of Applicant), hereby make application to __________________W.A, (hereinafter called the Utility) for water service.

Witnesseth

In consideration of the Utility providing water service to me, I agree:

1. To pay all necessary installation and/or connection charges as required by the Company for water service and or sewer service, which includes a refundable security deposit.
2. To install and maintain at my expense all necessary service lines, plumbing and fixtures to enable the property owned by me to be connected to the
3. Company's water meter as well as sewer service line to be connected to the sewer tap installed by the Utility.
4. To pay all monthly charges beginning with the first complete billing cycle after water service has been established at the Company's water meter on my property. I understand that regardless of whether or not I have installed the necessary service line or have consumed any water; I will still be required to pay the necessary monthly minimum established by the Water Utility. I further understand that if I do not receive a statement of current monthly charges it is my responsibility to contact the Utility during normal business hours to arrange payment and the fact that I have not received a water statement does not waive my responsibility to pay those charges or any late assessments or service charges that result for my failure to remit the proper payment when it is due.
5. To use the water in accordance with the rules and regulations established in the Company's Bylaws and Amendments which includes prohibiting me from connecting or allowing the connection of other residential dwellings or businesses to my water service.
6. To properly notify the Company when I change mailing addresses, if I relinquish control of my property or for any other reason to request that water service to my property be terminated.
7. To grant the Company, its successors and assigns, a perpetual easement in, over, under and around my property with the right to erect, construct, install, and lay, and thereafter use, operate, inspect, repair, maintain, replace, and remove water pipelines and appurtenant facilities together with the right to utilize adjoining lands belonging to the me for the purpose to ingress to and egress from the Company's easement.

In consideration of my payment of all charges necessary for the installation and/or connection of water service, the Utility agrees:

1. To make every effort to provide a continuous supply of safe potable water to me. I understand that at times due to equipment or power failures, water main breaks, weather related damage, and other unpreventable circumstances that the supply of water to my property may be interrupted. I understand that a guarantee of an uninterrupted supply of water cannot be granted by any water utility including __________________W.A. and that if my residence or business requires a continuous supply, then it is my responsibility to install at my expense the necessary equipment to provide an alternate water supply. I further understand that I am required by law to notify the Company of my intention to connect

an alternate supply and that the Company is required by law to inspect the supply to ensure that I have included the required backflow devices to prevent possible contamination to the Company's water distribution system.

2. To charge me each month the established minimum charge plus applicable rates according to the actual flow usage registered on the Company's water meter and recorded monthly by the Company. I understand that at times inclement weather may prevent the reading of the water meter on my property and that the
3. Company may use an estimated charge based upon my historical consumption and that such estimations are provided by law but restricted by the fact that actual readings must be recorded the month preceding and the month following the estimation and that I must be notified that the charges are based upon usage estimates. I also understand that it is my responsibility to provide proof of reading error or payment error to the Company in order for an adjustment to be considered.
4. To notify me of any changes in rates, policies, or amendments to the bylaws of the Company

----

(PRINT OR TYPE) and Affix Unity State Notice of Intent (Pink Copy) to Company Copy of Users Agreement

Office Use Only		Property Owner:..
Amount Received:	SSP	Renter:..
Retainable Charges:	SSP	Mailing Address:..
Membership:	SSP	Village:..
Refundable Deposit:	SSP	Telephone (Home):.......................Telephone (Work):...............................
Date Funds Deposited:		Identification Number:..
Received By:		
Taxable or Tax Exempt		
Applicable Rate Table		

- Appendix B -

__________________W.A.

Petition For New Service (Multiple Users)

We, the undersigned persons hereby formally request water service from __________________W.A. to the locations listed below. We (circle one) will pay all applicable fees including engineering services, legal fees, and construction/ installation fees prior to __________________W.A. extending service – **OR** – We request that __________________W.A. make application for state funds for the full costs of extending service. We understand that the decision to extend service not only is contingent upon the approval of the Water Utility Board of __________________W.A. but also upon the approval of the Utility's Plumber, the town council and the Ministry of Roads Housing and Infrastructure. We also understand that we will be required to execute Water Users Agreements with the Company after funding is approved and begin paying a monthly minimum water bill in addition to any flow charges resulting from usage and /or treatment immediately after water service has been extended. Furthermore, we understand that all costs to __________________W.A. for extending service including principle and interest debt service expenses will be calculated in our minimum monthly water bill.

(Please Print all Information other than Signatures)

Name	Service Address	Telephone	Signature

- Appendix C -

__________________W.A.

Service Extension Agreement

and

Conditional Notice of Intent to Purchase Approved Line Extension

The __________________W.A. Board of Commissioners at a meeting on ____________, 20___ entered into the following agreement with ______________________________.

__________________W.A. agrees to grant approval for a tie-in to its existing system with the line extension proposed by ___________________________ for the installation of water mains, valves, service lines, and water meters and necessary appurtenances for approximately ______ connections in accordance with approval of engineering plans and specifications granted by the Town Council and the Minsitry of Housing, Roads and State Infrastructure Supply on ____________, 20_____, reference number __________.

__________________W.A. also agrees to its intent to purchase the proposed line extension, warranty, and right-of way easement for not more than 200 SSP (South Sudanese Pounds) from ____________________________ subsequent to the receipt of documentation consisting of engineered as-built drawings, on-site inspection reports, certification from the project engineer that the project has been constructed in accordance with the approved plans and specifications, and proof of satisfactory bacteriological test results.

____________________________ agrees that if the conditions specified in the intent agreement stated above are not met within thirty days after __________________W.A. begins supplying water to the proposed line extension, ____________________________ will install meters at each tie-in to __________________W.A.'s existing line, pay the applicable commercial security deposit, and begin paying monthly the applicable water rate specified in the water purchase agreement to be executed by and between __________________W.A. and ___________________________________. Furthermore, __________________________________ also acknowledges that failure to submit the documentation required for transfer of ownership, that it may be required to submit necessary applications to the Town Council and the Minsitry of Housing, Roads and State Infrastructure, and other applicable entities to create a separate public water supply system.

____________________________ also agrees that if the conditions specified in the intent agreement are met, it will be responsible for payment of all attorney costs and necessary filing fees that may be incurred in the transfer of ownership and granting of easement to _________________W.A..

Witnesseth

_______________________________ __________

Date

- Appendix D -
HARDSHIP PAYMENT AGREEMENT
__________________W.A.

________________________________, who has water service at ______________________________, has incurred a hardship relating to the payment of his / her current water bill owed to __________________W.A. The reason for the hardship is: (circle one) illness/injury, death in family, loss of employment, excessive water bill as the result of a leak, other ______________________.

Witness

_______________________________, herein identified as the Customer agrees to pay at least SSP________________ in addition to subsequent monthly water bills by the _______day of each month to _________________W.A..,herein identified as the Company. The remaining balance will accumulate without any penalties or interest for a maximum of three months from the date of this agreement. On / / , the remaining balance must be paid in full or the customer must petition the Board of Commissioners of _________________W.A. for an extension of not more than two additional months.

Customer

__________________________________ __________ ____________________________________
(Signature of Customer) (Date) (Identification Number or Driver's License)

____
(Customer's Place of Employment)

_________________ ________________
Home Phone Num. Work Phone Num.

Company

__________________________________ __________
(Signature of Customer) (Date)
The end of the term of this agreement is: / /.

Future Hardship Payment Agreement Limitations

The Company will not grant future Hardship Payment Agreements to the Customer unless at least 12 calendar months have elapsed from the end of the term of this agreement or at the end of the two-month extension of the Hardship Payment Agreement (Whichever is later.) This does not prevent the customer from entering into a Payment Extension Agreement at any time after the end of the term of this agreement unless the Customer has not complied with the conditions of this agreement.

Default

If the Customer does not pay the stipulated balance on the dates as stated above, this agreement will be considered null and void, and the Company will terminate water service to the Customer. If Customer's service is terminated due to failure to comply with the conditions of this agreement, the service can only be restored after the Customer has paid all water charges (including unpaid balance), late charges and service charges. Furthermore, the Company reserves the right to not enter into future Hardship Payment Agreements or Payment Extension Agreements with the Customer if the Customer fails to comply with the conditions of this current agreement. Furthermore, if the Customer has his / her water service terminated due to default of this agreement and fails to remit the entire balance including all water charges, late charges, and services charges within 60 days after termination, the Company will file a lawsuit with the _________________ County Justice Court. All court costs and attorney's fees will be included in the lawsuit.

FILE COPY IN PAYMENT SUSPENSE FILE FOR REVIEW AT END OF MONTH. After terms and conditions are met by customer, file in permanent customer historical file.

- Appendix E -

PAYMENT EXTENSION AGREEMENT

__________________W.A.

___________________________________, who has water service at

___________________________________, is

unable to pay his/her current and past due water charges by the cut-off date.

Witnesseth

___________________________________, herein identified as The Customer agrees to pay his / her entire balance including past due and current water charges and late charges of SSP___________ by the last day of this month to __________________W.A., herein identified as The Company. This agreement must be signed before the ___day of the month and becomes null and void on the last day of this month. The Company agrees not to terminate the water service of the Customer within this month but will access a ____ percent late charge if payment is not received by the ____ day of the month.

Customer

___________________________________ ___________ _____________________________________

(Signature of Customer) (Date) (Identification Number or Driver's License)

____

(Customer's Place of Employment)

__________________ _________________

Home Phone Num. Work Phone Num.

Company

___________________________________ ___________

(Signature of Customer) (Date)

The end of the term of this agreement is: ………../………… /…………….. .

Default

If the Customer does not pay his / her entire balance by the last day of this month, this agreement will be considered null and void, and the Company will terminate water service to the Customer. If Customer's service is terminated due to failure to comply with the conditions of this agreement, the service can only be restored after the Customer has paid all water charges (including unpaid balance), late charges and service charges. Furthermore, the Company reserves the right to not enter into future Payment Extension Agreements or Hardship Payment Agreements with the Customer if the Customer fails to comply with the conditions of this current agreement. Furthermore, if the Customer has his / her water service terminated due to default of this agreement and fails to remit the entire balance including all water charges, late charges, and services charges within 60 days after termination, the Company will file a lawsuit with the __________________ County Justice Court. All court costs and attorneys fees will be included in the lawsuit.

FILE COPY IN PAYMENT SUSPENSE FILE FOR REVIEW AT END OF MONTH. After terms and conditions are met by customer, file in permanent customer historical file.

Policies and Ordinances

Customer's Request for Correcting

Date Incident Occurred Nature of Grievance - Complaint the Problem

Date Incident Occurred Employee / Contractor accused of

Improper Conduct Witness to Alleged Incident

Previous Meter Reading Current Meter Reading Recorded by Date of Customer's on Water Bill on Water Bill Customer Reading

- Appendix F Customer
Grievance – Complaint Form
__________________W.A.

I, ___________________________________, have water service at ___________________________________, and do hereby make an official complaint against __________________W.A. The reason for my complaint stems from: (Circle One) improper payment credit, meter reading error, no response to a reported problem, improper employee conduct, other________________________.

Supporting Information
(Complete the Appropriate Fields that Apply to the Type of Complaint)

Meter Reading Error reading Error			
Previous Meter Reading on Water Bill	Reading Current Meter	Reading Recorded by	Date of Customer's
No Response to a Reported Problem			
Date Problem Reported	Employee to whom Problem Reported	Report of Same Date of Follow-Up of Same Problem	Date of 2nd Follow-Up Problem Report
State Problem That Has not Been Corrected Below:			
Improper Employee/Contractor Conduct			
Date Incident Occurred	Employee / Contractor accused of Improper Conduct		Witness to Alleged Incident
State the Details of the Alleged Incident Below: (Use another page if necessary)			
Other Customer Grievance - Complaint			
Date Incident Occurred	Nature of Grievance - Complaint		Customer's Request for Correcting the Problem
State the Details of the Other Customer Grievance - Complaint Below: (Use another page if necessary)			

Witnesseth

I, ___________________________________, do hereby attest that the information that I have provided above is true and factual. I understand that it is my responsibility to provide the burden of proof to further document my claims so that appropriate action can be taken by the Board of Commissioners of __________________W.A. I have been advised to: (Circle One) **1.** Provide substantiating proof at the monthly board meeting scheduled for / / at ______ o'clock. Or **2**. The employee has agreed to present this grievance – complaint to the board for action, which will not require me being present. I have requested that either one of the board members or one of the employees of _________________W.A. to contact me as to the board's decision at - (telephone number).

____ ______________

____

Name of Employee Assisting Customer with Grievance-Complaint Date Signature of Employee

- Appendix F –

Employee's / Contractor's Response to Board Concerning the Aforementioned Customer Complaint – Grievance

1. Do you agree with the customer's complaint? _____________
2. Provide the findings of your investigation that support your answer to Question 1 (Use another page if necessary): (Please note that if the Customer Complaint- Grievance pertains to either a "No Response to a Reported Problem" or "Improper Employee Conduct" you must provide a signed statement from all employees that have either witnessed or participated in the alleged incident).

If you answered "Yes" to Question 1, what corrective action would you recommend that the Board take to rectify this problem and satisfy the customer:

Signature of Employee / Contractor Date

-Appendix G -

__________________________W.A.

COLLECTION & CUT-OFF POLICY

SUMMARY

1. Water / Sewer bills reflecting usage fees for the previous month as well as any past-due balance amount should be received by mail around the first of each month. Full balances are due and payable between the first and tenth days of each month. Failure to receive a billing statement does not relieve a customer's payment responsibility nor waives any LATE CHARGES or other fees that may be assessed. Customers should contact the office @ ________________ if billing statements are not received by the _______day of each month.

2. Balances may be remitted in the form of checks (no two-party checks) or money orders through the mail to the following address: ______________________ W.A.
   All payments including cash remittances can be paid at:

   ____
   ____
   ____
   ____

   SSP_______ BAD CHECK FEE will be assessed upon the bank's return of any check for Non-Sufficient Funds or any other reason.

   If full payment of balance is not received by the _____th day of each month, the unpaid current balance will be assessed a ____% LATE CHARGE and the entire balance will be considered PAST DUE. Customers unable to pay their full balance by this date may enter into a PAYMENT EXTENSION AGREEMENT with the District to be executed only at the Bear Creek office provided that the terms and conditions of previous PAYMENT EXTENSION AGREEMENTS by and between the District and the customer have been honored by the customer. The execution of this agreement must be made on or before the ____th day of the month BEFORE the balance is considered DELINQUENT.

3. If any past due amount owed from the previous month is not paid by the ____th day of the following month, the entire balance will be considered DELINQUENT.

4. Cut-Off notices will be mailed following the _____th day of each month to all DELINQUENT customers. If full payment of entire balance has not been received within 5 days after date notices are mailed the service will be scheduled for termination. Failure to receive a Cut-Off notice does not relieve a delinquent customer's payment responsibility nor waives the assessment of RECONNECTION FEES. Customers must pay entire balance to prevent water / sewer service from being terminated.

5. After service is terminated, a SSP_______ RECONNECTION FEE will be assessed to the delinquent customer's balance. In order for water / sewer service to be restored, full payment of entire balance including LATE CHARGES and RECONNECTION FEES must be made in person at ________________________.

6. The return of any checks that were remitted for a DELINQUENT balance due to Non-Sufficient Funds or any other reason, shall result in having a SSP_________ BAD CHECK FEE assessed and warrant

immediate termination of service without any further notice. After delinquent service is terminated, another SSP________RECONNECTION FEE will be assessed and full payment of entire balance will be required to be made only with cash.

7. Customers who have not paid their full balance by the end of the month in which service is terminated will be mailed a final billing statement. After ______ days of final bill mailing, the unpaid balance will be considered BAD DEBT and the customer's security deposit will be applied to the balance and a letter requesting full payment of remaining balance will be mailed to the customer. If the customer has still not paid the BAD DEBT within thirty additional days, ______________________W.A. will seek a legal judgement through the ________________County Justice Court system which could result in additional legal fees and court costs being assessed by the court. This information may also be submitted to credit rating bureaus.

8. Any customer with a BAD DEBT balance that wants to have his / her water / sewer service restored will be required to pay full balance including any additional fees that have been assessed through collection efforts and execute a new Water / Sewer Users Agreement with the District and post a security deposit of twice the applicable amount of the standard residential, commercial, or industrial deposit.

*This Notice should be mailed to all customers to ensure compliance with the Customer Service Policy. *

Municipal Water Utility Policies
Rubkona/Bentiu Water Utility

Section I.

General

1.01 The Rubkona/Bentiu may adopt ordinances or policies that it deems necessary for the management and operation of the town's water utility. The purpose of the Rubkona/Bentiu Water Utility Municipal Water System Policies is to serve as a mechanism for the uniform disposition of policy and rules in the administration and operation of the municipal water utility and to comply with capacity development guidelines of the State Ministry of Housing, Roads and Infrastructures as well as the National Government in Juba.

Section II.

Non-Discriminatory Policy

2.01 Rubkona/Bentiu Water Utility does not discriminate against any eligible person or group of persons on the basis of race, color, religion, sex, age, national origin, political affiliation, familial preference, handicap, belief, or veteran status, or in any manner excluded from employment, promotion, or participation in any program administered or operated by Rubkona/Bentiu Water Utility or deny benefits of any service or activity sponsored or provided by Rubkona/Bentiu Water Utility This Non-Discriminatory Policy as adopted by the Rubkona/Bentiu Board prohibits such discrimination either in its employment, its service to its water system customers, its purchasing activities, and all other related activities. The responsibility for the implementation of this Policy rests with Rubkona/Bentiu Water Utility Board of Aldermen. Rubkona/Bentiu Water Utility shall seek to ensure that all customers and applicants for service be treated equitably and given equal access to service, water quality, and water quantity without preference nor discrimination.

Section III.

Drug-Free Workplace Policy

3.01 Pursuant to the federal Drug-Free Workplace Act of 1988, Rubkona/Bentiu Water Utility has established this Drug-Free

Workplace Policy. This Policy serves to protect Rubkona/Bentiu Water Utility, its employees, and others in addition to limiting liability and maintaining eligibility for receipt of future federal / state financial assistance. Rubkona/Bentiu Water Utility is a drug-free workplace. No employee shall engage in the use, sale, manufacture, distribution, possession, or dispensing of prohibited drugs at any time. Rubkona/Bentiu Water Utility will adhere to zero tolerance. A verified positive drug test will result in evidence of illegal drug use and the employee will be immediately removed from their safety-sensitive position and terminated. A breath alcohol test resulting in breath alcohol concentration of 0.02 or greater will result in the employee being immediately removed from their position and terminated. As a condition of employment, all employees shall abide by this prohibition and notify the Board of of any criminal drug or alcohol statute conviction or a violation of this policy.

Section IV.

Sexual Harassment Policy

4.01 Pursuant to Title VII of the federal Civil Rights Act of 1964, Rubkona/Bentiu Water Utility is committed to providing a workplace free of any manner of harassment which includes, but is not limited to, sexual harassment. Sexual harassment is unwell come sexual advances, requests for sexual favors, and other verbal or physical conduct of a sexual nature.

Section V.
New Customer Service Policy
5.01 General Policy Statement
This policy is intended for those applicants for new water service to serve individual single-family dwellings, small businesses, and other purposes with estimated water usage not to exceed 1,000 Liters per month. Applicants with excessive needs or those applicants proposing a new development of a subdivision, business or industrial development are excluded from this policy and are covered in the Subdivision-Development Policy and / or Applicants with Excessive Needs Policy.

5.02 Water Users Agreement
All applicants for water service must first execute a Utility Users Agreement and pay all applicable fees and a deposit before using water provided by Rubkona/Bentiu Water Utility. Applicants requiring the installation of new meters / service taps are required to also pay all applicable fees to connect to the sanitary wastewater system or obtain a Unity State Notice of Intent from the Blue Ridge County Health Environmentalist and submit this form to the Rubkona/Bentiu Water Utility.
Security Deposit: (Refundable upon Termination of Services) Permanent Structure SSP 500
Water Tap Fee: (Non-Refundable Materials and Labor Costs of Installing Service) SSP 750

5.03 Applicants with Excessive Needs
Applicants with excessive needs may require the upgrade of existing Rubkona/Bentiu Water Utility facilities including its existing water mains, wells, pumps, or other related facilities. The costs for these upgrades shall be paid by the applicant unless Rubkona/Bentiu Water Utility receives federal / state funding for the necessary upgrades.

5.04 Subdivisions/Developments
Applicants proposing to develop property (commercial, industrial, or residential) to serve more than one user shall adhere to the following procedures. All project related costs including but not limited to right-of-way procurement, engineering fees, attorney fees, construction costs, and inspection costs shall be paid by the applicant developing the property.

5.04.1 The Applicant shall be responsible for procuring the services of a licensed professional engineer to provide cost estimates, design, and construction supervision of proposed extension. Rubkona/Bentiu Water Utility reserves the right to have its engineer review the proposed design and make recommendations on necessary changes to the Applicant's extension design. If the Rubkona/Bentiu Water Utility Board of Aldermen deem that this review by their engineer is required, all costs associated with the review shall be reimbursed by the Applicant. Rubkona/Bentiu Board reserves the right to deny approval of the design of the Applicant's proposed extension.

5.04.2 After the conditional approval by Rubkona/Bentiu Water Utility, the Applicant (or his engineer) shall submit design plans to Unity State, Ministry Housing, Roads and Public Infrastructure. Upon the Rubkona/Bentiu Water Utility's receipt of approval by Unity State, the Board shall grant a Service Extension Agreement and Notice of Intent to Purchase Water Line Extension to the Applicant.

5.04.3 The Applicant shall pay Rubkona/Bentiu Water Utility a negotiated inspection fee not to exceed 2% of the estimated total project cost for the purpose of the Town providing a Resident Inspector. The said Resident Inspector shall be allowed to inspect all construction activities. The Resident Inspector shall notify the construction contractor and the Applicant's engineer of any problem related to the construction of the proposed extension. Town of Rubkona/Bentiu reserves the right to revoke the Notice of Intent to Purchase

Water Extension if it is determined that inferior workmanship or non-adherence to the approved design plans occurs during the construction of the extension and that the Applicant, his engineer, contractor or other agents do not comply with the recommendations of the Resident Inspector for corrective actions.

5.04.4 Upon the completion of construction, the Rubkona/Bentiu Water Utility Board shall authorize the pressurization of the extension contingent to approval of the Resident Inspector's Final Report. The Applicant shall be responsible for obtaining all necessary bacteriological samples and for the costs associated with testing those samples by an approved laboratory in Unity State.

Section V

Policies and Ordinances

5.04.5 After successful bacteriological testing and approval by Unity State and after other terms and conditions of the Service Extension Agreement and Notice of Intent to Purchase are completed, the Applicant shall sell the extension, final engineering plans, right-of-way easements and other required documentation to Rubkona/Bentiu for a sum not to exceed SSP 20.

5.05 Exceptions, Administrative Orders:

Rubkona/Bentiu Water Utility cannot extend service, connect existing meters for new service, or install new customer meters if the water system is near or over the physical capacity and / or if the WATER UTILITY has issued an Administrative Order prohibiting the extension, connection, or installation of new customer service. Only after Rubkona/Bentiu Water Utility has complied with the conditions of such an Administrative Order, can the Board of Aldermen authorize the extension, connection, or installation of new customers.

Section VI.

Cut-Off Policy

6.01 Past Due, Late, and Delinquent Defined

The amount shown on the Rubkona/Bentiu Water Utility's monthly customer water statements are due when mailed. Any portion of the current amount that is not paid by the 10th of the month is considered Late and is Past Due. A 10% Late Fee will be assessed to the previously current portion of the customer balance once it becomes Past Due. Any customer owing a Past Due balance on the after the 20th of the month shall be considered Delinquent. Customers with Delinquent balances over SSP 300 will have their service cut-off.

6.02 Restoring Terminated Water Service

Customers who have had their water service terminated due to having a Delinquent balance shall pay a Reconnection Fee of SSP200.00 in addition to the entire current and delinquent balances plus any other applicable fees. Customers who have had their water service terminated but are receiving water through a meter that has had its locking device tampered with or removed without authorization from Rubkona/Bentiu Water Utility may be prosecuted pursuant to state utility theft codes of law.

Section VII.

Water Rate Review Policy

7.01 Preparing the Annual Budget/Annual Water Rate Review

The Rubkona/Bentiu Water Utility shall prepare an Annual Budget prior to the beginning of each fiscal year. If the water (and other applicable utility revenue accounts) is not projected to adequately cash flow the utility operations, the Board of Aldermen shall either make reductions in the expense budget and increase utility rates or make necessary transfers to cash flow the utility operations. This action including the review of the utility rates shall be recorded in the minutes of the Rubkona/Bentiu Water Utility.

7.02 Five-Year Water Rate Review

At a minimum, Rubkona/Bentiu Water Utility shall review its water rate structure within five years of the implementation of the last water rate increase. Based on the most recent financial compilation report, if the total water utility revenues do not exceed water utility expenses by at least 10% and it has been at least four years since the last water rate increase, the Board of Aldermen should take steps to increase the water rates to adequately cover not only the current operational costs but also allow for future increases in expenses as a result of inflation and the cost of replacing capital components of the system.

Distribution System Flushing and Hydrant Policy

8.01 Distribution System Flushing

It is the policy of Rubkona/Bentiu Water Utility that all dead-end water mains on its distribution system be routinely flushed. Other lines or segments of lines should be flushed if the water is shut-off for any extended period of time or if necessary, to correct customer complaints related to the aesthetic properties of water including odor, color, and/or taste. The logistics of the flushing program shall be determined by the Public Works Director who should be cognizant of system hydraulics and the effects of flushing on pressure. All flushing activities shall be documented in the Flushing Log contained in the appendix of this policy and the total estimated amount of water shall be recorded in the Monthly Operating Report that is also contained in the appendix.

Section IX.
Appendix to Rubkona/Bentiu Water Utility General Policies
9.01 Office Staff Job Description
9.02 Public Works Director Job Description
9.03 Flushing Log
9.04 Monthly Operating Report
9.05 Water Users Agreement

Town of Blue Creek
Utility Clerk

Job Summary:
Under the supervision of the Public Works Superintendent, the Utility Clerk performs a wide variety of tasks necessary for proper financial management and operation of the utility. This is a non-exempt (hourly) part-time position that works under limited supervision. The position is hired by the full Water Board. There is a six-month probationary period. Evaluations are conducted at the end of the probationary period and annual thereafter during the month of September.

Education and Experience:
Requires at minimum a high school diploma or equivalent and at least two years cash accounting experience working at a public or private organization, preferably with a high level of customer contact.

Other Requirements:
Because this position is charged with the responsibility of handling the cash assets of the Town, the person filling this position must be bonded as a requirement by state law and by bond holders and as a result no person with a felony criminal record can be considered for this position. This position also requires a basic knowledge of computer operations, preferably with experience with accounting or billing software. There will be no waivers granted to the above requirements.

Operational Duties:
- Accounts Receivable Operations –
  - Receives, receipts, posts, and deposit all customer water payments.
  - Ages Accounts Receivable, post late charges to unpaid accounts, and generates monthly cut-off reports.
  - Executes Utility Agreements with new customers, deposits hook-up fees, and enters new customer data in computer.
  - Calculates utility bills by posting meter readings, printing and mailing bills by the end of each month.
  - Closes billing cycle and generates month-ending billing register and summary report by the end of each month.

- Customer Service Operations –
  - Responds to customer billing inquiries and reports of leaks or other problems from 8:30 – 12:30 on Monday, Tuesday, Thursday, and Friday (8:30 – 5:30 on Wednesday) if not a posted holiday.
  - Generates work orders for maintenance staff and records work orders on the Monthly Maintenance Work Log.
  - Returns all customer voice mail messages within 24 hours.
  - Follows up on customer complaints/inquiries to ensure with a Customer Satisfaction Survey post card within 2 weeks of call
  - Maintains alphabetized filing system of all utility customers and routinely files all customer correspondence (with the exception of utility bills), copies of returned checks, utility agreements, and other specific customer records.

- Record-Keeping Operations –
  - Generates required computer reports (billing register, cut-off listing, aged-accounts report, monthly summary report) and files these reports each month.

  - Receives, copies, distributes (for board and PW Director) all agency correspondence and files copies of this correspondence.
  - Assist the Public Works Director in maintaining the required the Water System Capacity Development Filing System.

- Accounts Payable Operations –
  - Obtains Purchase Orders pursuant to the Blue Creek Purchasing and Procurement Policy.
  - Maintains copies of all approved Water & Sewer Department Purchase Orders.
  - Forwards any received claims to the Town Clerk by the end of each month.

- Other Operational Duties –
  - Responds to emergency conditions pursuant the to Town of Blue Creek's Emergency Response Plan.
  - Performs other duties delegated or assigned by the Public Works Director.

Duties Related to the Management and Administration of the System:

- Advises and assists the Town Clerk and the Board in developing the Annual Budget for the Water Department.
- Assist external auditor in preparing the annual audit.
- Works closely with the Public Works Superintendent in procuring equipment, supplies, and outside services.

Required Knowledge and Skills:

- Extensive knowledge of cash accounting procedures, internal financial controls, basic math principles, and basic office procedures
- Working knowledge of computers, software applications, and office equipment.
- Ability to learn new software programs.
- Skills in customer service relations and proper telephone etiquette.
- Ability to understand and follow oral and written instructions.
- Ability to communicate effectively orally and in writing.
- Ability to establish and maintain effective working relationships with the Board, staff, outside service providers, and the customers.

Rubkona Water Utility
Public Works Director

Job Summary:

Under the limited supervision of the Commissioner of the Rubkona, the Public Works Director performs a wide variety of tasks necessary for the efficient production and distribution of water for sufficient quantity and quality to meet customer demand. In addition, the Public Works Director is responsible for the collection and treatment of waste and for maintaining all public infrastructure including buildings, plants, sidewalks, and parks. This position will be on 24 hours call everyday including weekends and holidays. The position is hired by the full Board. There is a six-month probationary period. Evaluations are conducted at the end of the probationary period and annual thereafter during September.

Education and Experience:

Requires at minimum a high school diploma or equivalent and at least two years' experience working at a public water supply system. This position also requires a valid Water Operators Certificate (with a Pass qualification and above) . The Board of Aldermen may waive the education and experience requirements if there are no applicants meeting the requirements for this position. However, if such a waiver is granted, the probationary period is automatically extended to one year in which time the person filling this position may be dismissed by a majority vote of the Board of Aldermen if there is reasonable evidence that the lack of education and experience is hindering the execution of the required duties stated below.

Operational Duties:

- Adheres to Water Utility Minimum Water Operator Guidelines.
- Ensures compliance with the state and National water quality standards.
- Provides regular oral and written Operations and Maintenance Reports to the Board of Aldermen summarizing system operations.
- Maintains and supervises control over the inventory of materials, supplies, chemicals, and equipment.
- Performs routine preventative maintenance inspections of equipment; performs repairs, adjustments, and maintenance of pumps, electric motors, valves, meters, chemical feeders, fire hydrants, lubricates and oils machinery, maintains gas engines and compressors, and maintains proper records of preventative maintenance work.
- Calculates water loss figures and supervises leak detection surveys when water dosage exceeds 15% of water produced.
- Responds to emergency conditions according to Rubkona's Standard Operating Procedures

Duties Related to the Management and Administration of the System:

- Provides supervision to other Public Works staff members and assigns, tracks, and evaluates the performance of these employees.
- Advises and assists the Board of Aldermen regarding repair / replacement of needed equipment.
- Develops estimates for recommended purchases of goods and services.
- Documents all maintenance activities on approved O & M Record Keeping System and presents copies of all work orders along with a statement to the Board of Aldermen each month for review and approval.
- Works closely with the engineers, contractors, and state regulatory officials.

- Participates with the Board of Aldermen and consulting engineers in planning system improvements or expansions.
- Handles customer inquiries and complaints related to water service or billing questions.

Required Knowledge and Skills:

- Extensive knowledge of the methods, practices, tools, and materials used in the operation, maintenance, and repair of water storage, treatment, and distribution equipment and machinery, including but not limited to:
- Extensive knowledge of chlorination disinfection and corrosion control equipment and required discharge rates.
- Working knowledge of the mechanics of pumps and other electrical equipment and machinery.
- Ability to learn plant electrical systems, power circuit changes, and circuit breaker resets.
- Ability to perform basic chemical tests.
- Ability to detect and diagnose faulty operation of equipment and make corrections.
- Thorough knowledge of the equipment, tools, and procedures used in installing and repairing water mains, services, fire hydrants, and meters.
- Knowledge of applicable laws and safety regulations for crew and public safety and the proper use of chlorine and other hazardous chemicals.
- Ability to plan, organize, and supervise the operation, maintenance, and repair of the utility's storage, treatment and distribution systems, and the organizational skills necessary for scheduling daily activities.
- Ability to establish and maintain effective working relationships with the Board, staff, contractors, engineers, government and regulatory officials, and the customers.

Rubkona County Monthly Flushing Log Month of _______________ 20___

Date of Flushing	Length of Time flushed	Location of flushing	Pressure	Orifice Size	Estimated Barrels flushed	Comments on Follow Up actions required

Quick Flow Rate Conversion Chart			
Orifice Diameter	Typical Application	Dynamic Pressure	Gallons Per Minute
¾"	Meter Base	60 psi	79 GPM
¾"	Meter Base	40 psi	64 GPM
1½"	Blow Off Valve	60 psi	316 GPM
1½"	Blow Off Valve	40 psi	260 GPM
2½"	Flush Plug/Hydrant	60 psi	880 GPM
2½"	Flush Plug/Hydrant	40 psi	720 GPM

Rubkona/Bentiu
Monthly Operating Report
Month of ____________ 20__

1. Water Accountability			
	Total Water Produced	A ____________________ Total Gallons Produced	
Total Water Sold		B ____________________ Total Gallons Sold	
	Gross Water Lossage	C ____________________ Gallons Lost (A-B)	
Estimated Water Flushed or (Used for Fire Protection)		D ____________________ Gallons Flushed	
	Adjusted Water Lossage (Unaccountable Water)	E ____________________ Gallons Unaccounted	
	Total Percent Water Lossage	F ____________________ (E / {A/100})	
2. General Customer Information			
A. Water Connections			
	1. Total Active Water Connections Last Month	2A1 _____________________ Current Water Actives	
	2. Total Active Water Connections This Month	2A2 _____________________ Last Month's Water Actives	
	3. Total Inactive Water Connections This Month	2A3 _____________________ Current Water Inactives	
	Net Increase (Decrease) in Active Connections	G _____________________ Active Increase (Decrease)	
3. General Maintenance Information & Supplemental Data			
	A. Number of New Meter Installations	__________________	
	B. Number of Reconnections	__________________	
	C. Number of Terminations	__________________	
	D. Number of Main Line Leak Repairs	__________________	
	E. Number of Service Line Leak Repairs	__________________	
	F. Number of Meter Leak Repair	__________________	
	G. Number of Meter Replacements	__________________	
	H. Number of Line Flushings	__________________	
	I. Average Free Chlorine Residual	__________________	
	J. BUREA OF STANDARDS Required Sample Results (Pass/Fail)	__________________	

4. General Comments:

Name of Person Completing Report ____________________________ Signature ____ Date ____

P.O. Box 320, Rubkona, MS 35755

UTILITY USERS' AGREEMENT

I, (Signature of Applicant) , hereby make application to Rubkona County, (hereinafter called the Utility) for water service.

Witnessed

In consideration of the Utility providing water service to me, I agree:

1. To pay all necessary installation and / or connection charges as required by the Utility for water, sewer, and sanitation service, which includes a refundable security deposit.
2. To install and maintain at my expense all necessary service lines, plumbing and fixtures to enable the property owned by me to be connected to the Utility's water meter.
3. To pay all monthly charges beginning with the first complete billing cycle after water service has been established at the Utility's water meter on my property. I understand that regardless of whether or not I have installed the necessary service line or have consumed any water; I will still be required to pay the necessary monthly minimum established by the Utility. I further understand that if I do not receive a statement of current monthly charges it is my responsibility to contact the Utility during normal business hours to arrange payment and the fact that I have not received a water statement does not waive my responsibility to pay those charges or any late assessments or service charges that result for my failure to remit the proper payment when it is due.
4. To properly notify the Utility when I change mailing addresses, if I relinquish control of my property or for any other reason to request that water service to my property be terminated.
5. To grant the Utility, its successors and assigns, a perpetual easement in, over, under and around my property with the right to erect, construct, install, and lay, and thereafter use, operate, inspect, repair, maintain, replace, and remove water pipelines and appurtenant facilities together with the right to utilize adjoining lands belonging to the me for the purpose to ingress to and egress from the Utility's easement.

In consideration of my payment of all charges necessary for the installation and / or connection of water, the Utility agrees:

1. To make every effort to provide a continuous supply of safe potable water to me. I understand that at times due to equipment or power failures, water main breaks, weather related damage, and other unpreventable circumstances that the supply of water to my property may be interrupted. I understand that a guarantee of an uninterrupted supply of water cannot be granted by any water utility including Rubkona County and that if my residence or business requires a continuous supply, then it is my responsibility to install at my expense the necessary equipment to provide an alternate water supply. I further understand that I am required by law to notify the Utility of my intention to connect an alternate supply and that the Utility is required by law to inspect the supply to ensure that I have included the required backflow devices to prevent possible contamination to the Utility's water distribution system.

2. To charge me each month the established minimum charge plus applicable rates according to the actual flow usage registered on the Utility's water meter and recorded monthly by the Utility. I understand that at times inclement weather may prevent the reading of the water meter on my property and that the Utility may use an estimated charge based upon my historical consumption

and that such estimations are provided by law but restricted by the fact that actual readings must be recorded the month preceding and the month following the estimation and that I must be notified that the charges are based upon usage estimates. I also understand that it is my responsibility to provide proof of reading error or payment error to the Utility in order for an adjustment to be considered.

3. To notify me of any changes in rates, policies, or ordinances of the Rubkona County

Office Use Only		Property Owner:………………………………………………………………………………
Amount Received:	SSP	Renter:………………………………………………………………………………………………
Retainable Charges:	SSP	Mailing Address:………………………………………………………………………………
Membership:	SSP	Village:………………………………………………………………………………………………
Refundable Deposit:	SSP	Telephone (Home):………………….Telephone (Work):…………………………
Date Funds Deposited:		Identification Number:……………………………………………………………………
Received By:		
Taxable or Tax Exempt		
Applicable Rate Table		

Required Fees
Security Deposit: (Refundable upon Termination of Services) Permanent Structure SSP 350
Water Tap Fee: (Non-Refundable Materials and Labor Costs of Installing Service) SSP 600
Sewer Tap Fee: (Non-Refundable Materials and Labor Costs of Installing Service) SSP 800

CERTIFICATION OF ADOPTION

I hereby certify that the above Rubkona Water Utility Policies were adopted by a motion properly made, seconded, and approved by the Town of Blue Creek Board of Aldermen on the ________ day of ________________, __________A.D. with the effective date being __________ day of _____________, _____________A.D. I further certify that the policy remains in force, has not been amended, or rescinded. Certified Record of Vote: ________voting “Yes”, __________voting “No”, __________Abstaining or Absent.

Directors voting “Yes” Directors voting “No” Directors Absent or Abstaining

____ ____

Jane Doe, Town Clerk
Rubkona County

Date

Sample Business Plan
Water Utility Long Range Plan
Bentiu/Rubkona Water Utility Board

Town of Bentiu/Rubkona Water Utility Mission Statement:

To preserve and enhance our water system so that we may provide safe drinking water at an affordable cost that will further improve the quality of life of our customers and promote economic growth…

Incorporated 2021

1.0 Introduction

1.1 Purpose of the Business Plan

The purpose of the Business Plan is to serve as a policy guide in the decision-making process of the Bentiu/Rubkona Water Utility Board in planning future improvements and enhancements to the Bentiu/Rubkona Water Utility. The Bentiu/Rubkona Water Utility Board recognizes the importance of planning in making effective decisions concerning the future of the Association. This plan is a result of an extensive study of the Town's existing technical, managerial, and financial capabilities and anticipates the future goals of the Association as determined by the Bentiu/Rubkona Water Utility Board. This plan should be periodically reviewed and amended as necessary to ensure its continued effectiveness as a guideline for anticipating future goals of the Association. At a minimum, the Current Year Capital Improvements Checklist should be completed each year using the 10-year CIP Checklist and scheduled CIP improvements as a guide. The Annual Budget should be updated each year as well. The text of this document should be updated every ten years with current information. Previously completed Business Plans should be a part of the permanent records of the Bentiu/Rubkona Water Utility.

1.2 Term and Amendments to the Business Plan

This Business Plan anticipates goals and objectives not to exceed ten years from the date of implementation of the plan. Once this term expires, the Long-Term Goals, Financial Plan, Capital Improvements Plan, and Annual Budget must again be revaluated and assessed in order for new goals and objectives to be defined. Each year, the Business Plan needs to be updated with the current year's capital improvements checklist and annual budget.

2.0 Background Information

2.1 Customer Profile

Bentiu/Rubkona Water Utility currently serves 380 utility customers. These customers are broken down by the following classifications: 334 Residential Water Customers; 8 Commercial Water Customers; 305 Residential Sewer Customers; 8 Commercial Sewer Customers. Average monthly customer water usage is currently 8,600 gallons (3,268,000 usage per month total). The current percentage of usage per customer class is as follows: 68.5% Residential Usage; 19.2% Industrial Usage; and, 15.3% Commercial/Agricultural Usage. Current demographic data reveals that the median age of Bentiu/Rubkona Water Utility's customers is 36 years old.

The current Annual Median Household Income is SSP 8, 000 and the current Unemployment Rate is X %. Nor many Employers are in the area.

2.2 Water System Profile

2.2.1 Water Source

Town of Bentiu/Rubkona currently has two water wells (190005-01 and 190005-02). The current rated design capacity of the Bentiu/Rubkona Water Utility is **108.5%** as determined on May 10, 2003 by the Rubkona County State Department of Health in its Sanitary Survey. Note that this is NOT acceptable and does not provide a reserve capacity for future growth or economic development. Well #1 (190005-01) is located behind the Town's Office and was drilled in 1967 at a depth of 1380 feet. This well has a 12" casing and a 6" screen and is rated to produce 108 gallons per minute at normal operating pressure (65psi). The second well (19005-02) is located nearby on Hwy 587 and was drilled in 1983 at a depth of 942 feet. This well has a 10" casing and a 6" screen and is rated to produce 195 gallons per minute at normal operating pressure 65psi). Well #1 draws groundwater from the Westchester Aquifer which is classified by the recently completed South Sudan Water Regulator Source Water Assessment Plan as having a HIGH PROBABILITY for source water contamination. Well #2 draws groundwater from the Miocene Series Aquifer and is classified by the Source Water Assessment Plan as having a low probability for source water contamination. Bentiu/Rubkona Water Utility has no emergency connections to other public water systems but is in close proximity to the Town of Green. The Town of Green has the capacity to serve Bentiu/Rubkona Water Utility if a connection were installed. The current analysis (2002 data) of contaminants in Bentiu/Rubkona Water Utility's Source Water and Distribution System are listed below. Note that no contaminants exceed National Primary Drinking Water Standards and represent only trace detects.

Table 3: Current analysis of contaminants in Bentiu/Rubkons water utility source & distribution system

Contaminants (units)	MCLG	MCL/AL	Bentiu/Rubkona Water Utility Water	Low Range	High Range
Barium (ppm)	2	2	0.007	0.007	0.007
Cadmium (ppb)	5	5	0.2	0.2	0.2
Chromium [Total] (ppb)	100	100	2	2	2
Copper (ppm)	1.3	1.3	0.032	0.032	0.032

2.2.2 Water Treatment

Bentiu/Rubkona Water Utility's Water System is classified as Class "C" Treatment pursuant to Rubkona County State Board of Health Environmental Regulations Part 302.4. Treatment processes include filtration, aeration, corrosion control and disinfection. The Water Treatment Plant is located behind the Bentiu/Rubkona Water Utility

Association Hall. Water Treatment Equipment includes the following:

1. Aeration – 1 Refinite Induced Draft Aerators. This aerator has a capacity of 250 gallons per minute.
2. Corrosion Control – Lime is injected into the system through a W&T Penwalt Lime Hopper set at a 20% stroke. Finished water targets an optimal pH level of 8.0 or greater.
3. Disinfection – Gaseous Chlorination consisting of one Hydro – Type 25 PPD Chlorinator, one Stay Rite Booster Pump, and one Hydro-Type Chlorine Ejector. Optimal Free Chlorine Residual at the treatment plant is 1.0 mg/l or greater.

2.2.3 Water Storage and Pressurization

Bentiu/Rubkona Water Utility has one (1) Hydropneumatic Water Storage Tank located at the water well. This is a 10,000 gallon tank that normally operates between 50 psi to 70 psi.

2.2.4 Water Distribution System

Bentiu/Rubkona Water Utility's Water Distribution System consists of mainly PVC schedule 126 water mains and service tubing, cast iron MJ water valves, and 4" fire hydrants. Most consumer water meters on the Bentiu/Rubkona Water Utility's water distribution system are PDM-type meters. A hydraulic analysis has not been completed on the Morgantown water system.

2.3 Personnel and Management

Bentiu/Rubkona Water Utility is governed by the Mayor / Bentiu/Rubkona Water Utility Board. The Board operates under the provisions of State Law. The Bentiu/Rubkona Water Utility Board meets on the first Tuesday of each month (unless a holiday in which the Bentiu/Rubkona Water Utility Board meets the following week) at 7:00 p.m. at the Bentiu/Rubkona Water Utility City Hall. All meetings are open to the public. The Board President serves as the ad hoc manager of the Bentiu/Rubkona Water Utility and the point of contact for the Town's employees. The Association employees one (1) part-time certified water operator under contract. The requirements for this position are outlined in the contract and stipulate a minimum operator license of South Sudan Water Regulator Class C. Pursuant to the contract, the certified operator provides guidance to the Bentiu/Rubkona Water Utility staff, is available 24 hours a day for water emergencies, and reports to the Bentiu/Rubkona Utility Water Board each month. The Association also employees a part-time bookkeeper who's principle duties include the collection, posting, and depositing of customer payments, the disbursement of approved claims, and recordkeeping. Additional financial operations are contracted through a professional engagement with a local accountant who provides monthly financial reports to the Bentiu/Rubkona Water Utility Board. The Association also employs a part-time maintenance technician/meter reader who performs normal preventative and corrective maintenance to the system daily as well as reads customer meters each month. The Bentiu/Rubkona Water Utility Board enjoys the benefit of legal consul through a retainer with a local attorney who attends the first meeting of each month. Current written Policies and Procedures include the aforementioned Bentiu/Rubkona Water Utility Bylaws as well as a Customer Service Policy, Operation & Maintenance Procedures, Emergency Response Plan, and a Cross Connection Control Policy.

3.0 Long-Term Goals

The Bentiu/Rubkona Water Utility sought the input from various stakeholder groups before the development of the following long-term goals. These groups included the following stakeholders: Bentiu/Rubkona Water Utility Customers, Bentiu/Rubkona Water Utility Employees, the State Ministry of Infrastructure, Roads and Housing as well as advice from our Attorney and Accountant and guidance from the South Sudan water regulator. It should be noted that while some identified needs were common with other groups, some of these same needs conflicted with the needs, advice, or guidance of other stakeholder groups. It was imperative that the Bentiu/Rubkona Water Utility Bentiu/Rubkona Water Utility Board weigh not only the needs, advice, and guidance communicated the Bentiu/Rubkona Water Utility Board but also that the Bentiu/Rubkona Water Utility Board take into account current and future regulatory requirements, infrastructure needs, and the Town's finances in developing these goals.

1) Develop and adhere to a 10-Year Capital Improvements Plan;
2) Secure Grants and Low-Interest Loans to assist in the financing of the replacement / rehabilitation of system components;
3) Reduce unnecessary expenses including the cost of unaccountable water;

4) Routinely implement small rate increases rather than waiting several years which will result in large increases;
5) Enhance Communication with our customers through quarterly newsletters;
6) Provide necessary equipment and training to the Bentiu/Rubkona Water Utility staff;
7) Work closely with the Rubkona County and other entities through partnerships and possible regionalization opportunities;
8) Meet all federal and state regulatory requirements and provide the best quality of drinking water possible;
9) Further develop financial reserves which may be necessary for future unexpected needs;

4.0 Financial Plan

The information listed below and on the following pages outlines the current (most recent audited figures) financial condition of the Bentiu/Rubkona Water Utility as well as other information regarding major creditors, debt service requirements, reserve fund requirements, procedures for adopting the annual budget, adequacy of current rates and projected rate changes, audit procedures, insurance coverages, growth potential, and future financial challenges.

4.1 Debt Service

Bentiu/Rubkona Water Utility has one major creditor, USDA-Rural Development which services two existing loans for the Association. The Association currently pays SSP XXXX each month toward the retirement of this debt (SSP XXXX annually). Funds are withdrawn from the Town's operating account by ACH electronic drafts on the 5th day of each month.

4.2 Budget and Audit Procedures

Bentiu/Rubkona Water Utility is required to prepare and an annual budget prior to the beginning of each fiscal year (June 1). A public hearing must be conducted at least 10 days prior to the adoption of the final budget. State law and loan service agreements also stipulate that a governmental audit be conducted at the conclusion of each year. It is the policy of Bentiu/Rubkona Water Utility that the audit be presented to the Bentiu/Rubkona Water Utility Board within six months (by November 30) of the end of each fiscal year.

4.3 Insurance Coverage

It is the policy of the Bentiu/Rubkona Water Utility Bentiu/Rubkona Water Utility Board that appraisals of system components be updated at least once every two years to be used in the specifications for soliciting bids for insurance coverage. Current insurance coverages include the following:

4.3.1 Property & Casualty SSP XXXX (Special Form / Freeze & Vandalism Coverage Included)
4.3.2 General Liability SSP XXX Aggregate / SSP XXXXX Occurrence (Non-Owned Auto Included)
4.3.3 Public Officials Liability XXXX Aggregate / SSP XXXX Occurrence
4.3.4 Fidelity SSP XXXX (Blanket Employee Crime)
4.3.5 Inland Marine SSP XXXX (Backhoe, Trailer, and Computer)
4.3.6 Workers Compensation – NONE (Not Required with present staffing levels)
4.3.7 Commercial Auto Liability – NONE (No Owned Vehicles)
4.3.8 Commercial Auto Comprehensive – NONE (No Owned Vehicles)
4.3.9 Umbrella Liability Coverage – NONE

4.7 Rate Structure / Changes

Existing Rate Structure: As reflected in the Bentiu/Rubkona Water Utility FY2021 audit, the existing water rate structure provided only SSP 128 in cash flow (which calculates into a 1.0 Operating Ratio). Note that South Sudan water Regulator requires an operating ratio of 1.10. This fact contributed to a lower Annual

Capacity Rating this past year. The current monthly cost per hundred gallons is A which is only U % of the state EDU average of 0.49 per hundred. The existing average monthly water bill is SSP WWWW.

Proposed Rate Increase: By increasing the minimum rate by SSP XXX to SSP YYYY and by adopting a uniform flow rate of SSP CCCC, this new rate would represent an overall increase of K % in the average monthly charge per customer from SSP OOOO to SSP TTTTT . Reflected over the five-year term of this rate, this would represent an annual increase of G%.

Table 4: 5-Year Operating Forecast (with proposed new rates)

	Year Ending 2004	Year Ending 2005	Year Ending 2006	Year Ending 2007	Year Ending 2008
Projected Revenues					
Water Sales	SSP203,677	SSP211,564	SSP212,886	SSP214,217	SSP215,556
Other Income	SSP 22,929	SSP 23,817	SSP 23,966	SSP 24,116	SSP 24,267
Total Projected Revenues	SSP226,606	SSP235,381	SSP236,852	SSP238,333	SSP239,822
Projected Expenses					
Fixed Expenses	SSP 95,621	SSP 95,621	SSP 95,621	SSP 95,621	SSP 95,621
Variable Expenses	SSP 98,028	SSP101,459	SSP105,010	SSP108,685	SSP112,489
Total Projected Expenses	SSP193,649	SSP197,080	SSP200,631	SSP204,306	SSP208,110
Projected Income (Loss)	SSP 32,957	SSP 38,301	SSP 36,221	SSP 34,026	SSP 31,712
Projected Fund Balance	SSP266,419	SSP304,720	SSP340,942	SSP374,968	SSP406,680
Operating Ratio	1.17	1.19	1.18	1.17	1.15

5.0 Capital Improvements Plan

The following plan projects Bentiu/Rubkona Water Utility's Water System Infrastructure Needs. A matrix listing the projected mitigation completion dates is listed in Appendix C. The following needs that are used in this plan and their corresponding definitions are listed below (in order of priority with the highest prioritized need listed first):

Urgent Needs – Those needs that should be addressed as soon as possible and that have a high probability of impacting public health, critical components of the water system, or other processes or procedures which if neglected could negatively impact the financial capacity of the water system.

Critical Needs – Those needs that should be addressed after Urgent Needs are mitigated and that may impact public health, critical components of the water system or compliance with federal and state drinking water regulations.

Other Needs – Those needs that should be addressed after Urgent and Critical Needs are mitigated and that have a low probability of impacting public health, critical components of the water system, or compliance with federal and state drinking water regulations.

Recurring Needs – Those needs that may be prioritized as Urgent, Critical, or Other and that should be anticipated to occur or recur at least twice during the term of the plan.

Note: It is important to remember that the initial prioritization of these needs is subject to change. An "Other Need" may evolve into a Critical or Urgent Need just as a Critical Need may become an Urgent Need.

5.1 Source Water & Auxiliary Source Needs

Wells - [RECURRING CRITICAL NEED] It has been recommended that pumping test be performed by a reputable well contractor on each of the Town's two water wells each year. Information obtained from these tests will be reviewed by the Bentiu/Rubkona Water Utility Board with the Public Works Superintendent and additional preventive or corrective maintenance will be determined if needed. It is anticipated that at least one of the pumps may need extensive work within the next ten years. It is estimated that the cost of this maintenance can range up to SSP35,000. This is considered a Recurring Need and can be expected at least once every 15 years.

Existing financial reserves or financial assistance through the Rubkona County Rural Development, and / or the Rubkona County Local Governments and Rural Water Systems Improvements Board will be used to pay for this anticipated maintenance. Routine annual well pumping tests will be budgeted as a normal operational expense each year.

Auxiliary Source - [URGENT NEED] While it is anticipated that the Franklin County Water Association will procure its own water supply to serve its satellite West Bentiu/Rubkona Water Utility System (PWS ID# 190002), it is not known at this time whether this well will have the capacity to serve Bentiu/Rubkona Water Utility through the existing purchase-water connection during emergency conditions or power outages. Because Water Utility requires that public water systems maintain at least a 20psi minimal pressurization, t has been recommended that the Association acquire an emergency generator(s) capable of running at least one of the water wells, the treatment plant, and the service pumps during such an emergency. The costs associated with the procurement and installation of a generator and automatic transfer switch can exceed SSP XXXX . Existing financial reserves or financial assistance through the Rubkona County Development Authority, Rural Development, and / or the Rubkona County Local Governments and Rural Water Systems Improvements Board will be used to pay for this anticipated maintenance.

5.2 Water Treatment Needs

Filtration – [RECURRING CRITICAL NEED] It is anticipated that at least one of the filters will need to have its filter media changed-out within the ten-year term of this plan. The cost of this routine maintenance can range up to SSP XXXXX or more. This is considered a Recurring Need and can be expected at least once every 15 years. Existing financial reserves or financial assistance through the Rubkona County, and / or the Rubkona County Local Governments and Rural Water Systems Improvements Board will be used to pay for this anticipated maintenance.

Aeration – [RECURRING CRITICAL NEED] The motors on the Induced Draft Aerators will eventually require some maintenance (or replacement). Additionally, the Aerator trays periodically need to be pressure washed and cleaned. The costs of this preventative maintenance is minimal and should be budgeted for at least once during the ten-year term of this plan.

Corrosion Control – [OTHER NEED] It has been recommended that the Association consider switching to lime (instead of soda ash) due to the fact that the optimal pH would be reduced to around 7.0 and that the operational costs would be significantly reduced. Note that capital cost associated with the installation of a lime treatment plant are considerable and that this should only be considered after consultation with a professional engineer and if financial assistance is available to include this in a capital improvements project. If the optimal pH parameters increase or if the raw water pH significantly drops, the ability to comply with corrosion control optimization standards may be negatively impacted. In this event, the Public Works Superintendent should seek technical assistance from the Water Utility Regional Engineering Services Branch for guidance and advice which may include the recommendation to procure phosphate injection equipment. The costs of this would be less than SSP XXX and may be paid for by the existing reserves, budget, or financing by the Rubkona County Local Governments and Rural Water Systems Improvements Board or by the Community Loan Fund.

Disinfection – [CRITICAL NEED] It has been recommended that the Association consider the installation of an automatic switch-over chlorination system which will further insure disinfection of the Town's finished water supply. South Sudan Water Regulator requires a minimal 0.5 mg/l free chlorine residual. Treatment system does not have a problem achieving this benchmark requirement normally, if the chlorine cylinder runs out before a manual change-over, the Association risks microbial and viral contamination and waterborne disease outbreaks not to mention non-compliance with Water Utility regulations and the TCR Rule. The Association should consider this only after consultation with a professional engineer and with the South Sudan Water Regulator Regional Engineering Services staff. The costs associated with this capital improvement can range up to SSP XXXX or more and may be paid for by the existing reserves, budget, or financing by the Rubkona County Local Governments and Rural Water Systems Improvements Board or by the Community Loan Fund.

5.3 Water Storage & Pressurization Needs

Elevated Water Storage Tank – [RECURRING URGENT NEED] South Sudan Water Regulator recommends that all steel water storage tanks be cleaned and inspected on a regular basis and painted as necessary. After five years of the most recent tank painting, it has been recommended that the tank be inspected for paint coating failure, corrosion, rust, and structural integrity annually. It is anticipated that within the ten-year term of this plan that the elevated water storage tank will need to be cleaned at least twice and painted once. The costs associated with inspecting and cleaning is minimal and should be considered normal preventative maintenance and may be paid for by existing budgeted revenues. While tank painting is also routine and necessary at least once every 10 – 15 years (depending on environmental conditions and quality of paint and workmanship), this expense can be expected to cost SSP VVVVV or more. The Association should consider painting its elevated water storage tank only after consultation with a professional engineer's inspection of the tank. The costs associated with this routine maintenance cannot normally be paid for by grant funds and as a result the Association is limited to using existing reserves or loan financing through by the Rubkona County Local Governments and Rural Water Systems Improvements Board or by the Community Loan Fund.

Service Pumps – [RECURRING CRITICAL NEED] Routine pump preventative maintenance is essential to the efficient operation of the Town's two service pumps. Such maintenance includes replacing packing, greasing and lubrication, and the replacement of pressure gauges. It is anticipated that at least one of the pumps will need to be replaced during the ten-year term of this plan. The costs associated with service pump replacement is minimal and should be considered normal preventative maintenance and may be paid for by existing budgeted revenues.

5.4 Water Distribution System Needs

Hydraulic Analysis and Mapping – [URGENT NEED] It is not known when the last hydraulic analysis for Bentiu/Rubkona Water Utility was compiled. Due to the fact that this is essential to understanding the hydraulic needs and deficiencies of the distribution system, it has been recommended that the Association consult with a professional engineer within the next year to begin this process of surveying the system and completing this analysis. The cost of this service may exceed SSP XXXXXX and can be paid for by existing reserves, financed by the engineer, or paid by financing through the Community Loan Fund. It is also an Urgent Need that the Town's existing distribution system be mapped out to include the sizes and types of lines, valves, meters, and fire hydrants. Much of this can be completed by the Public Works Superintendent with no-cost or low-cost technical assistance from outreach. Eventually, a professional engineer will need to incorporate this information for the development of a set of as-built Mylar drawings. All maps and hydraulic analyses should be considered confidential data and safeguarded by Bentiu/Rubkona Water Utility and be used only by its operational staff and consultants for the purpose of operating the system and planning capital improvements.

Meter Replacements – Validity Testing – [RECURRING CRITICAL NEED] It has been recommended that Bentiu/Rubkona Water Utility routinely validate the accuracy of its consumer water meters as with time, these meters will register less water than what actually passes through the meter. A routine meter testing / change out schedule should be adopted so that every meter will be validated at least once during a five-year period. Because there has not been a routine procedure of testing and changing out meters in the past, it is anticipated that at least XX % of the Town's consumer water meters may need to be replaced. While the costs associated with this should be considered routine maintenance, because this maintenance has been deferred, it may cost as much as SSP XXX. This should be paid for out of the Town's reserves or budget and if necessary, can be financed by the Rubkona County Local Governments and Rural Water Systems Improvements Board or by the Community Loan Fund.

Water Main Valves – [RECURRING OTHER NEED] It has been recommended that Bentiu/Rubkona Water Utility routinely exercise water main valves and clean valve boxes. All valves should be located, marked, and identified on system maps. It is anticipated that at least one valve every year will need to be replaced. This normal operational cost is minimal and should be paid for by existing budgeted revenues.

Fire Hydrants / Flush Plugs – [RECURRING OTHER NEED] It has been recommended that Bentiu/Rubkona Water Utility routinely exercise and lubricate fire hydrants and flush plugs. All fire hydrants and flush plugs should be located, marked, and identified on system maps, and periodically painted. It is anticipated that at least one fire hydrant or flush plug will need to be replaced every year. This normal operational cost is minimal and should be paid for by existing budgeted revenues.

Water Mains – [CRITICAL NEED] Due to the fact that Bentiu/Rubkona Water Utility has a wide variety of water main materials and some substandard sizes, it has been recommended that Bentiu/Rubkona Water Utility consult with a professional engineer to develop a plan to replace the older cast iron and asbestos cement pipes in addition to the installation of larger lines where substandard sizes exists. Because the costs associated with such a project will be considerable, financial assistance must be obtained. Grant funds can be obtained through the Rubkona County Development Authority and the USDA-Rural Utilities Service. Loan funds can be obtained through the same agencies and the Rubkona County Local Governments and Rural Water Systems Improvements Board. Interim financing may be obtained through the Community Loan Fund.

5.5 Electrical Control System Needs

There are no significant deficiencies known to exist with the water system's electrical control system. However, integration of this system with the auxiliary power generator(s) and transfer switch will be necessary in addition to normal routine maintenance and replacement of electrical control components. This is a recurring need and should be paid for by existing budgeted revenues.

Current Year Capital Improvements Checklist

August 1, 2003 (Date*)

Appendix A

Immediate Facility Needs to be Addressed This Year:

System Component Water Source & Auxiliary	Recommended Corrective Action	Needed? (Check if Yes)	Date Completed
Well Pumping Tests	Annual Pumping Tests	X	
Well Pump Repair-Replacement	Once Every 15 Years		
Auxiliary Tie-In to other PWS	Connect to other PWS for Auxiliary Source	X	
Auxiliary Power	Generator(s) for Treatment Plant, Wells, and Pumps	X	
New Water Well Development	If System exceeds 90% Design Capacity		
Water Treatment			
Aerator Cleaning	10 – 15 year max		
Lime Feeder			
Chlorinator			
Ejector			
Chlorine Booster Pump			
Other Treatment Equipment			
Storage & Pressurization			
Tank(s) Inspection	(5-year max)	X	
Tank Cleaning	As Necessary per Tank Inspection		
Tank Painting	As Necessary per Tank Inspection (Max 15-years)		
New Storage Tanks			
Booster Pump(s) Replacement			
Distribution System			
Hydraulic Analysis	As Necessary (At least Once every 15-years)	X	
Mapping	As Necessary (Update at least Once every 5-years)	X	
Consumer Meter Testing	As Necessary (At least Once every 5-years)	X	
Consumer Meter Replacement	As Necessary (Depending on Validity Tests)	X	
Valve Replacement	As Necessary	X	
Hydrant / Plug Replacement	As Necessary	X	

Main Line Upgrades	As Necessary (Excessive Leaks – Substandard Pipes)		
Electrical Controls			
Replacement of Flow Level Probes	As Necessary (5-year max)		
Replacement of Hour Meters	As Necessary	X	
New Electrical Controls			
Signature of Board President		Signature of Board Secretary	

*Complete this Checklist Each Year by reviewing your 10-Year plan and scheduled CIP Needs. Keep this record in your permanent file as an attachment to your Comprehensive Business Plan.

Bentiu/Rubkona Water Utility

Annual Budget

For the Year Ending May 31, 2004
Ten-Year Capital Improvements Master Plan

Checklist

From **August 1, 2003** To **June 30, 2014**
(Year 1 of CIP) (Year 10 of CIP)

Appendix B

Capital Needs to be Addressed within 10-Years:

		Needed?	Date
System Component Water Source and Auxiliary	Recommended Corrective Action	(Check if Yes)	Completed
Well Pumping Tests	Annual Pumping Tests	X	
Well Pump Repair - Replacement	Once Every 15 Years	X	
Auxiliary Tie-in to other PWS	Connect to other PWS for Auxiliary Source		
Auxiliary Power	Generator(s) for Treatment Plant, Wells, and Pumps	X	
New Water Well Development	If System exceeds 90% Design Capacity		
Water Treatment		X	
Gravity filter(s)	Media Replacement (10-year max)	X	
Filter Cleaning	10 – 15 year max		
Chlorinator	10 – 15 year max	X	
Chlorine Booster Pump		X	
Other Treatment Equipment		X	
Storage & Pressurization			
Elevated Tank(s) Inspection	(5-year max)	X	
Tank Cleaning	As Necessary per Tank Inspection	X	
Tank painting	As Necessary per Tank Inspection (Max 15-years)	X	
New Storage tanks		X	
Booster Pump Replacement		X	

Distribution System			
Hydraulic Analysis	As Necessary (At least Once every 15-years)	X	
Mapping	As Necessary (Update at least Once every 5-years)	X	
Consumer meter testing	As Necessary (At least Once every 5-years)	X	
Consumer meter Replacement	As Necessary (Depending on Validity Tests)	X	
Valve Replacement	As Necessary	X	
Hydrant / Plug Replacement	As Necessary	X	
Main Line Upgrades	As Necessary (Excessive Leaks – Substandard Pipes)	X	
Electrical Controls			
Replacement of Flow Probes		X	
Replacement of Hour Meters	As Necessary (5-year max)	X	
New Electrical Controls	As Necessary	X	

Signature of Board President

Signature of Board Secretary

Table 5: Prioritization Matrix

System Component	Identified Need Prioritization Recurring?	Year(s) To Complete		Financing Needed?	
Auxiliary Power		Urgent	No	2004	Probably
Hydraulic Analysis		Urgent	Yes	2004	Probably
Mapping		Urgent	Yes	2004	No
Elevated Tank(s) Inspection		Urgent	Yes		No
Tank Cleaning		Critical	Yes		No
Tank Painting		Critical	Yes	2005 (projected need)	Probably
Main Line Upgrades		Critical	No	2005 (projected need)	
Chlorinator	Replacement – Rebuild	Critical	Yes	2005 (projected need)	
Ejector	Replacement – Rebuild	Critical	Yes	2005 (projected need)	
Chlorine Booster Pump	Replacement	Critical	Yes	2005 (projected need)	
Aerator	Cleaning and Replacement of Force Draft Fans	Critical	Yes	2005 (projected need)	
Well Pump Repair-Replacement	Pump Maintenance Replacement	Critical	Yes	2005 (projected need)	
Soda Ash Pump	Replacement	Critical	Yes	2005 (projected need)	
Gravity Filter(s)	Media Replacement	Critical	Yes	2005 (projected need)	
Media Replacement	Annual Pumping Tests	Critical	Yes	2005 (projected need)	
Consumer Meter Testing		Critical	Yes	2005 (projected need)	
Consumer Meter Replacement		Critical	Yes	2005 (projected need)	
Flow Level Probes	Cleaning - Replacement	Critical	Yes		
Hour Meters	Replacement	Other	Yes		
New Electrical Controls		Other	Yes		
Gravity Filter(s)		Other	Yes		
Valve Replacement		Other	Yes		
Hydrant / Plug Replacement					

6.0 Annual Budget

Rubkona
Annual Budget
For the Year Ending May 31, 2004

		2004
Revenue		
	Water Sales	SSP 594,00
	Contracted Maintenance	71,000
	Misc. Construction & Meter Connections	20,000
	Membership Fees Received	1,200
	Total Revenue	697,000
Operating Expenses		47,000
	Water Purchase	15,000
	Electricity and Utilities	63,000
	System Repair	2,800
	Service Supplies	6,500
	Testing and Analysis	150
	Bad Debt Expense	37,000
	Bank Charges	3,500
	Contract Labor	112,598
	Continuing Education	17,000
	Depreciation	42,000
	Fuel and Oil	5,000
	Insurance	5,000
	Legal and Accounting	5,000
	Miscellaneous	5,000
	Office Expense	4,800
	Postage	4,800
	Repairs and Maintenance	13,000
	Retirement Expense	4,000
	Salaries	150,000
	Taxes and Licenses	18,000
	Telephone	11,000
	Truck Expense	2,500
	Uniforms	3,000
	Total Operating expenses	602,348
	Net Operating (Loss) Profit	94,652
Other Income and Expenses		
	Interest Income	SSP 23,000
	Gain on Sale of Equipment	-0-
	Interest Expense	(69,741)
	Total Other Income & Expenses	(46,741)
	Increase in Net Assets from Operations	47,911

Water Regulations to Support By-laws

Rubkona/Bentiu Water Utility

Water regulations to support the By-laws

ORDINANCE NUMBER ____________

An ordinance establishing definitions, policies, charges and rates for the ____________Water Utility for the town of (town), Unity State, South Sudan.

Be it ordained by the Commissioner and Board the of the (city/town) of Unity State, South Sudan, as follows:

ARTICLE I.

DEFINITIONS

The following words and terms when used in this ordinance are intended to mean and shall mean as follows to wit:

Townhall mean the town of (city/town), Unity State, South Sudan.

Customer shall mean the owner of the property served by a water connection, or tenant, lessee, renter, establishment or occupant of such property, or the person in or against whose name the water connection for such property is listed on the books and records of said city/town, and who is responsible to said town for payment of bills for water furnished to such property and for use by such property of the public water system of said city/town, either or both.

Consumer shall mean any person, establishment, or unit or space served on or through any water meter other than the customer in whose name the meter is listed or from whom payment may be required.

Gender shall be extended and be applied to females and as well as to males.

Shall is mandatory; May is permissive.

ARTICLE II.
SERVICE AND CONNECTIONS

Section ____ Application required for service.
All persons desiring water service shall file a written application with the (department/office). Such application shall be signed by the owner of the property to be served or his duly authorized agent and shall state the purposes for which the water is to be used and all other facts and information as the (department/office) requires. Such applicant shall agree in writing to abide by all existing or future ordinances, regulations, and rules or provisions of this chapter and the (department/office) __, and the applicant shall pay the fees and deposits as prescribed at the time of filing such application.
Section ____ Using water without proper application prohibited.

Should any person move into premises or buildings and find the water supply turned on without having been applied for by him, he shall immediately report the fact to the (department/office) for attention and correction. Use of the water without making proper application for same subjects the violator to prosecution.

Section ____ Delinquent using name of another to obtain water prohibited.
Water shall not be supplied to any premises, either directly or indirectly, when the occupancy is in arrears at the place then occupied. This section is intended to prevent the use of another's name, by subterfuge, in order to obtain a water supply by a delinquent.

Section ____ supplying water to sub-lessee when original tenant in default prohibited.
Water shall not be turned on or supplied for a sub-lessee of any premises when the original tenant is in default for water supplied to the same premises so long as the premises or any part thereof are occupied by the person in default.

Section ____ Water service connections – Authorization to make connections.
All connections to the water lines, and extensions thereof, shall be made by employees of the (department/office) or the designees of the city/town, except for extensions or installations of unusual magnitude which may require materials, skill or equipment not possessed by or otherwise available to the (department/office) or the city/town, but in such cases such work must be done under the supervision of the (municipality personnel) of the (department/office) or his authorized representative or designee.

Section ____ Water service connections - Size.
The size of the service connection or tap on any water main shall be governed by the use indicated in the original written application therefore. No connection or tap shall be made to any water main without the written consent of the (municipality personnel) or his authorized representative or designee.

Section ____ Water service connections - Separate connection required for each premises.
Each premises shall be required to have a separate connection to the water main so that service to the premises can be discontinued without affecting any other customer; and, in case any property owner shall have divided his premises so that two or more customers can be serviced through one connection to the water main, he shall provide a proper shutoff valve for each separate connection so that service may be discontinued to one customer without affecting any other, and all such shutoff valves shall be so arranged or installed that they can only be operated by employees of the (department/office) or by authorized bonded plumbers.

Section ____ Extension of lines.
Cost borne by city/town. The (department/office) will hereafter extend, lay or construct all necessary and feasible water mains to serve any given lot or tract of land a distance of (number) feet or less including the front footage of the lot or tract of land to be served.

Cost borne by applicant.

(a) Where the property for which any person desires water connections is located more than (number) feet, including the front footage of the lot or tract of land for which the service is desired, from existing water mains, the (municipality personnel) of the (department/office) or his authorized representative or designee shall specify the size and type of pipe to be laid and cause an estimate to be made of the total cost of the extensions.

Section ____ Meters - Ownership.
All meters and their several parts hereafter installed by the (department/office) or its representatives or designees will remain or become the property of the (department/office).

Section ____ Meters - Separate meter required for each premises.
A separate water meter shall be required for each individual premises, house, lot or subdivision thereof, except auxiliary premises or buildings upon the main premises, lot or subdivision thereof which auxiliary building or premises is controlled by the occupant of the main building or premises; but, if such auxiliary building or premises constitutes a complete living unit, including kitchen facilities, such auxiliary building or premises shall be provided with a separate meter and separate connection to the water main.

Section ____ Meters - Obstructing.
It shall be unlawful for any person to obstruct any water meter of the town with any lumber, brick, wood, dirt or other building material or with any ashes, paper, trash, grass or vegetation, rubbish or substance of any kind.

Section ____ Meters - Failure.
Whenever, for any cause, a water meter fails to operate, a reasonable estimate shall be made by the (municipality personnel) or his authorized representative or designee with his final approval, of the amount of water supplied during the period such meter fails to operate based on whole or in part on the estimated amount of water supplied.

Section ____ Meters - Testing.
The town will at its own expense make periodic tests and inspections of its water meters in order to maintain a high standard of accuracy. The town will make additional tests or inspections of its meters at the request of a customer.
However, if such tests show that the meter is accurate within (number) percent (high or low), no adjustment will be made in the customer’s bill, and a test fee in accordance with the town’s current rate schedule will be added to the customer’s bill. In case the test shows the meter to be in excess of (number) percent high, an appropriate adjustment shall be made in the customer’s bill over a period of not more than (number) days prior to the date of such test and replacement of meter, and there shall be no charge for the meter test.

Section ____ Meters - Reading checks.
There shall be no charge for meter reading checks if an error in reading is detected. In addition, each customer shall be entitled to (number) free reading check(s) per calendar year where no error is detected. There shall be no carry over from year to year for unused free reading checks.

Section ____ Authority to shut off water in emergencies.
The water supply to all of the town may be shut off by the (department/office) at any time the necessity may arise, or any shutoff may be confined to a smaller area of the city/town, governed by the location of the valves. Employees of the (department/office) shall, promptly after determining the need to implement the shutoff, make every reasonable and appropriate effort to notify all consumers affected by a shutoff to advise the consumer of the shutoff and to advise the consumer to take necessary steps to provide a temporary water supply and adopt safety measures.

The town may impose restrictions or limitations on the amount of water allowed to be consumed or used and/or the purposes for which water is allowed to be consumed or used in all or part of the town. Such restrictions or limitations shall be reasonable under the circumstances. Timely and appropriate notice of such restrictions or limitations shall be given to all consumers subject to the restrictions or limitations. Such notice may be made by personal contact or by leaving notice on the door of the most appropriate entryway to the residence, office or structure if within a limited area or through the media if affecting a larger area of consumers. The notice shall include a statement of the restrictions and limitations and the penalty for violation thereof.

Section ____ Transfers.
No person shall be entitled to transfer his water service from one location to another, except as herein set forth. When premises are vacated, or the use thereof discontinued by a water customer, he shall pay his bill in full for the old location and make all necessary arrangements for the new cut-in before being entitled to any further water service, and the customer shall pay a fee of SSP ____for transfer of water service from one location to another. Relocation, at the request of an owner or customer, of a water meter, connection or tap on the same property shall require payment of a charge determined from time to time as reflected on the official minutes. No person shall be entitled to a water cut-in or to water service at any location if s/he is in arrears for water service rendered at that or any other location.

Section ____ Disconnection of service - Voluntary.
Any person who applies for and obtains water service at a particular location, or upon any premise and who desires to discontinue the use of such water at any such place shall notify the (municipality personnel) , in writing, of the time when the use of the water by him will be discontinued. In the event of the failure to give such notice, such person shall remain and be liable for any and all water used at the location until the (municipality personnel) shall acquire actual personal knowledge that the person who so applied for such water at the location has discontinued use thereof.

Section ____ Discontinuance of Service - Temporary.
Customers wishing to have their water service cut off for a temporary time may do so; either by paying the monthly minimum charge, if any, or by paying a turn-on fee of SSP ____.

Section ____ Turning on water after service disconnected.
No person, not authorized by the (department/office), shall turn on the water supply after it has been shut off by the (department/office) for non-payment.

Section ____ Resale of Water Prohibited.
All purchased water service (other than emergencies or standby service) used on the premises of a customer shall be supplied exclusively by the town, and the customer shall not directly or indirectly sell, sublet, assign, or otherwise dispose of the water service, or any part thereof unless authorized by the town through Board minutes.

Section ____ Supplying free water prohibited.
No free water shall be furnished to any user.

Section ____ Stealing water prohibited.
No person shall be allowed to take and carry away water from any public school fixtures, Church, Mosque, Hospital, Market, public buildings such as ministries thereof unless authorized by the town through Board minutes. It shall be the duty of all town employees to report promptly any infraction of this section to the police or the (department/office).

Section ____ Using water for unauthorized purposes prohibited.
No consumer shall use, or permit to be used, water from the town's system except for the purposes stated in the application, nor shall he supply water to any non-consumer for any purpose without a written permit, which permit shall state for what purpose the water is to be used and for how long. The consumer shall not permit non-consumers to use the hose attachments, nor leave them exposed for use by non-consumers even though the water supply comes through a meter. A violation of this section may subject the offender to a discontinuance of the water supply and to penalties otherwise provided.

Section ____ Tampering with or obstructing town-owned equipment.
(a) No person, except the employees of the (department/office) , the fire and life safety division, or the public safety department , and those to whom the (municipality personnel) of the (department/office) may grant special permission, shall tamper with, make connections to or otherwise use or operate the fire hydrants, meters, locks or any other town-owned equipment associated with, or attached to, the water system, and no person shall place or install or cause to be placed or installed anything or object which will impede free access to fire hydrants or meters, but a distance of not less than (number) feet shall be clear entirely around each of such hydrants and meters.
(b) If any person tampers with, makes connections to or otherwise uses or operates the fire hydrants, meters, locks or any other town-owned equipment associated with, or attached to, the water system, that person shall be charged a fee of not less than SSP ____nor more than SSP ____, plus the actual cost required to repair the damaged equipment and to compensate the town for any related harm or loss caused by the tampering.

Section ____ Right of Access.
The Water Utility employees shall have access to customer's premises at all reasonable times for the purposes of reading meters, testing, repairing, removing or exchanging any or all equipment belonging to the Water Utility.

Section ____ Inspections.
The Water Utility employees shall have the right to, but shall not be obligated, to inspect any installations before water is introduced or any later time as to a possible cross connection or any conditions detrimental to its present or future customers and reserves the right to disconnect any service until the potential hazard has been remedied.

ARTICLE III.

USER CHARGES AND RATES

Section ____ Deposits.
Any water customer or consumer shall not be entitled to any water service or supply unless and until such person makes a meter deposit with the Water Utility as follows, to wit:
(a) All residences: SSP ____ per family unit.
All rental and commercial property: SSP ____per unit.
(b) For a (number) inch tap or larger, a meter deposit shall be required on advance, in such amount as shall be determined from time to time as reflected in the official minutes of the town.
(c) The size of the meter installed shall be determined by the (Water Utility personnel), who shall give consideration to the estimated consumption and use of water by the respective customer and consumer. Any deposit made shall not bear interest but shall be refunded after termination of the water service and

supply and after the payment of all sums due for water theretofore furnished. The making of any such deposit shall not affect the right of the Water Utility to discontinue water service for non-payment of the charge and bill therefore. However, in the event of any non-payment, the Water Utility may cut off and discontinue the services if the charges or statement remain in default for more than (number) days after the date of the statement.

(d) The Water Utility may, at its option, apply any such deposits toward payment of any amount due the Water Utility for water theretofore furnished.

(e) Any and all water meters installed by the Water Utility shall remain the exclusive property of the Water Utility.

Section ____ Connection fees.

Each customer of the water system requiring that a new tap be made for connection to the town water system, shall pay in advance of any tap being made, non-refundable tapping fees for the new tap according to the following schedule:

(a) For each residential or commercial connection within or without the limits for a (number) inch meter SSP ____.

(b) For each residential or commercial connection within or without the limits for a water meter in excess of (number) inch, an amount of money equal to the cost of the water meter and all other materials necessary to make the connection from the water system of the town to the customer's water service line.

Section ____ Connection fees – Developers.

A charge (Developer's Connection Charge) shall be assessed to any party, developer or otherwise, including but not limited to developers constructing subdivisions of record, industrial parks, large commercial or industrial enterprises, mobile home parks, apartment complexes, condominiums, and other similar property improvements to which all facilities required to serve the premises have been installed by the developer. This charge is intended to represent each consumer's pro rata part of the supply base, which included the wells, tanks, and large distribution mains. This amount is in addition to the cost of providing service to the development and the cost of the extension of the water main, if necessary, to the nearest property boundary, which cost shall be paid by the developer. The developer's connection charge shall be SSP ____for each residential consumer or equivalent thereof joined to the system. This charge shall be paid by the developer prior to acceptance of any distribution system by the town.

In the event that the developer pays for the construction or improvements to the town's water system, which are not located within the development, but which are necessary to provide service to the development, the Board may waive payment of the developer's connection charge or any portion thereof upon a finding that the waiver of such charge is in the best interest of the town. In making such decision, the Board should consider the total cost of the off-site improvements, the need created by the development, the benefit to areas of the town outside the development and the general need for the improvements in the area.

Section ____ Late fees; Bill payment.

If any charges for the services of the systems shall not be paid by the (number)th day of the month in which it shall become due and payable, a delayed payment charge of (number) % of the amount of the bill shall be added and collected upon payment. If the (number)th day of the month is a holiday or weekend, payment shall be accepted without penalty on the next business day.

Section ____ Cut-offs and fees.
If any bill for the service of the system shall remain unpaid after (number) days following the rendition of the bill, the water supply for the premises affected shall be cut off and shall not be turned on again except upon payment in full of the delinquent charge and service charges.

Section ____ Water Rate Schedule.
(a) The monthly water rates to be charged to residential consumers of water in the town of
(____Water Utility, Unity State, South Sudan, except as may be hereinafter provided otherwise, shall be as follows:
For (number) 20L Jerrycans of water or less used, SSP ____minimum. For (number) to (number) 20L Jerrycans, SSP ____per (number) 20L Jerrycans.
For (number) to (number) 20L Jerrycans, SSP ____per (number) 20L Jerrycans.
For over (number) 20L Jerrycans, SSP ____) per (number) 20L Jerrycans.
(b) The monthly water rates to be charged to commercial/industrial consumers of water in the town of (municipality), Unity State, South Sudan, except as may be hereinafter provided otherwise, shall be as follows:
For 1 No. 20 Litre Jerrycan of water or less used, SSP ____minimum shall be required.
For 1 No. 30,000 Tone Truck, SSP ____per 1 No. 20 Litre Jerrycan
For 1 No. 20 Litre Jerrycan, SSP ____per 1 No. 20 Litre Jerrycan

Section ____ Billing for separate meters.
All private homes and residences, and all trailer parks an apartment complexes having two or more users to a water meter shall pay a straight monthly charge of SSP ____per 1 No. 20 Litre Jerrycan of water, with no quantity discount. For commercial customers a straight monthly charge of SSP ____ per 1 No. 20 Litre Jerrycan of water.

Section ____ Billing Errors.
If a bill is believed to have an error, an informal hearing may be requested. This request shall be made to the (Water Utility personnel) in writing no less than (number) days prior to the cut-off date.

Section V: Bids and Contracts

The following the same guidelines can help prevent overspending and help reduce the possibilities of legal action because of questionable or uncertain business practices.

The primary objectives of regulatory policies include specifications for purchasing equipment, materials, and services for the organization. Policies provide outlines for purchasing at the lowest cost if the goods or services are of comparable quality and can be delivered in a timely fashion. The objectives direct the goods or services to the proper location so transactions are completed.

Water associations, water districts, and municipalities contract for tanks, wells, and services that often require expenditures of several hundred thousand dollars or even millions of dollars. Following the same guidelines as the municipalities helps ensure association users, district users, or members that boards are conducting business in an efficient and open manner. Guidelines help protect board members from taking business actions that make them vulnerable to lawsuits.
The guide also helps the boards relate to the water-consuming public that they are operating in the best interests of their consumers.

Closely examine your purchasing and contracting policies by using the municipal requirements as guidelines. Policies need to fit the needs of your particular organization. Nonprofit corporations are encouraged to examine and possibly amend their bylaws to establish purchasing policies and rules if this has not been addressed. Any policies adopted cannot violate Unity's nonprofit corporation laws as well the Republic of South Sudan laws.

The notice of intention to let contracts or purchase equipment shall list the contracts to be made or types of equipment or supplies to be purchased, and, if all plans/specifications are not published, refer to the plans and/or specifications on file. If no local newspaper is published in the locality or the county, notices shall be posted at the court house or city hall and two (2) other public places, and notices shall be posted for two (2) consecutive weeks in some newspaper having circulation in the area.

Agencies shall also maintain a vendor file for bid solicitation and a bid file that lists vendors to whom bid information is mailed. Specifications pertinent to such bids shall not be written to exclude comparable equipment domestically manufactured. A registered engineer or architect may write specifications requiring specific equipment available from limited sources if the purchase can be justified under the existing rules and regulations of the appropriate authority.

Purchases and contracts may be made from the lowest and best bidder including freight and shipping charges. If a bid other than the lowest bid is accepted, a written narrative, along with the necessary calculations and dollar amounts of each bid, is required explaining why the accepted bid was determined to be the lowest and best bid. Bids cannot be based on items not included in the specifications. If only one bid is received, the bid may be accepted if the bid is opened and the bid is within the funds allocated for the project.

If the lowest and best bid is no more than ten (10) percent above the funds allocated for a construction or renovation project, the board or agent is permitted to negotiate with the lowest bidder to enter a contract not to exceed the funds allocated. For timely completion of projects or for ready availability, no more than two (2) alternate bids may be accepted. An alternate bid cannot be used unless the lowest and best bid that was accepted, for reasons beyond the bidder's control, cannot deliver the commodities or contract contained in the bid. If the low bidder accepted cannot deliver, one (1) alternate bid can be accepted.

After a construction contract is made and it is determined that contract modifications are necessary or would better serve the purpose, the organization may order the changes without further public bids if the changes are made in a commercially reasonable manner and do not circumvent purchase rules. The engineer or architect hired by the purchaser shall have authority to authorize changes when the change requires expenditures that are less than one (1) percent of the contract amount.

If an emergency situation is determined and the delay caused by the competitive bidding process would be detrimental to the interests of the municipality or the water users, the rules of competitive bidding will not apply and the board or the board's agent can make the purchase or purchases. The purchases can be made only for purchases directly related to the needs of the emergency. The purchaser is responsible for explaining the emergency to the board at the next regular board meeting and documenting the purchases with a description of the item or service along with the appropriate prices and costs. Other rules related to emergencies are normally included in the bylaws of water associations or organizations or the ordinances of the municipalities.

Equipment repairs made in the private sector are excempted from bid requirements unless the repair is for a complete unit such as an engine, a transmission, a rear axle, or other units where the total component replacement is known before disassembly. If repairs are made, the specific repairs, the specific repair part identified by number

Purchasing Rules and Ethics

Conflict of interest situations and nepotism rules may prohibit purchasing from certain individuals or companies. Directors and board members of municipalities and water associations have laws regarding conflict of interest transactions. In small communities where the only local option available to purchase may involve nepotism or a conflict of interest problems often arise. Take every precaution when purchasing from or when hiring family members of boards of directors. Make sure that these decisions are made under the advisement of the board attorney

Checklist for Purchasing and Contracting Policies

Use the following list as you prepare to make purchases and contract for services. Check each box (   ) as you proceed through the process.

- [ ] A system for purchasing goods and services has been developed. We used the board attorney to ensure that the system developed follows all the legal directions and mandates of the municipal codes and any other laws lthat apply to purchasing and contracting.

- [ ] We have a board attorney who is capable of verifying our purchasing and contracting policies.

☐ We have developed purchase forms, contract forms, and all other acquisition forms to be used by the organization for making purchases and contracts. Space has been provided on the forms for:

- ☐ product or service requested
- ☐ quantity needed
- ☐ written justification
- ☐ proper signatures

A board member has been designated with the responsibility of purchases and contracts and with making sure that the rules of the purchase system are followed.

A purchasing agent has been designated for the organization.

Approval procedures and authorizations have been established for small purchases and for large purchases. This includes the following:

- ☐ Our reimbursement policy and a description of small purchases that require receipts.
- ☐ A description of purchases where purchase forms are required.
- ☐ A description of purchases and contracts requiring board approval.
- ☐ Proper authorizations

☐ The specifications for this item or contract, if required, were developed by a certified engineer or architect.

☐ We follow the purchase system we developed. Municipal purchase systems and associations adopting the municipal codes have to follow specific rules regarding the size of the purchase or contract.

☐ We know the rules regarding the amount of purchase or contract and know that the amount is

- ☐ three thousand five hundred dollars ($3,500) or less.
- ☐ from three thousand five hundred dollars up to fifteen thousand dollars ($3,500 to $15,000).
- ☐ over fifteen thousand dollars ($15,000) and for bid openings, over fifteen thousand dollars ($15,000).

- [ ] The required number of bids for the amount of the contract or purchase has been met.
- [ ] The bids received were all submitted on a proper bid sheet with the proper signatures.
- [ ] The required notices for bids have been posted or published in the local paper for the required number of days.
- [ ] The published notice contained the proper information regarding the exact nature of the purchase or project and had reference to the specifications of the job or product.
- [ ] The date for opening bids was properly established and met the requirement for the specified number of days between the bid opening and the last published notice.
- [ ] If the lowest bid was not accepted, a narrative in writing explains why the bid accepted was the lowest and best bid. The proper dollar figures are attached, and this information is presented to the board and included in the board minutes.
- [ ] If the best bidder is not able to fulfill a contract, we accept one alternate bid from the only two alternate bids that we allow to be submitted.
- [ ] If the lowest bid was within ten (10) percent of the funds allocated for the purchase or project, we negotiated with the low bidder who agreed to accept the allocated funds.
- [ ] If after a bid is accepted our engineer determines that some contract modifications would better serve the purpose, we make these changes without public bids if the changes are less than one (1) percent of the contract amount.
- [ ] We do not accept any bids that include items not found in the specifications.
- [ ] We do not use the normally required bidding process if we are in an emergency situation and it is in the best interest of the public or water users that we do not delay the purchase. We document the emergency, and we purchase only products or services necessary to meet the emergency.
- [ ] We make repairs to wells and equipment without soliciting bids, but we do not replace complete units or total components without following bid rules. Repairs are well documented with respect to specifying items or parts, labor hours and costs, and total costs of the project.
- [ ] We have guidelines regarding repeated purchases from a vendor. We use one purchase order for purchases made during a month, but new purchase orders are required for a new month.
- [ ] We do not solicit bids for projects of one hundred fifty thousand dollars ($150,000) or more if the contract cannot be started within a 24-month period.

☐ Where conflict of interest or nepotism questions arise, we contact our attorney before we make any decisions.

Construction Punch Lists Restriction

Purpose – Limit the number of List of Problems to Correct

The Architect, Engineer of the representative of designated by the agency or governing authority that is contracting for public construction or renovation may prepare and submit to the contractor only one (1) preliminary punch list of items that do not meet the contract requirements at the time of substantial completion and one (1) final list immediately before final completion and final payment.

Construction Contracts

This is only a Sample. The values will be dependent of the Ministry of Housing, Roads and Infrastructure, Unity State laws as well as the Republic of South Sudan laws
Note – Reference Only

Purpose – Special Provisions for Constructions and Public Works

1. A. **Performance Bonds** – requires bonds for faithful performance in an amount not less than contract
   B. **Payment bonds** – Requires bonds for each person for labour and materials used in job in an amount not less than the contract.
   C. **Liability Insurance** – requires general liability insurance prior to the agency contract in excess of SSP 25,000 or governing authority contract in excess of SSP 25,000, for coverage in an amount in an amount not less than 1 million SSP.

2. **Certificate of responsibility:** contractors of all public projects in excess of 50,000 SSP must have a Certificate of Responsibility. All bids for such projects must show Certificate number on the face of the bid envelope.

3. **Professional Engineering and Architectural Services:** A licensed Engineer and Architect is required to prepare specifications and estimates, and to supervise the contract work of public works in excess of 75,000SSP. Such services are only required for House Public works in excess of 150,000SSP

4. **Bid Bonds -** Bid Bonds may be required if a policy is adopted by the Utility

Penalties

The laws of the State and the Republic of South Sudan shall be applied accordingly and shall define what is criminal and what is civil

Technical Capacity

T1 **Does the water system have any significant deficiencies?**

T2(1) **Was the water treatment process functioning properly?** Corrosion control plants: within +/- 0.5 of target pH (approximately 8.4, Langlier Index, or 7.2-7.8 if adding phosphate for corrosion AND minimum phosphate residual of 0.5 mg/L as P or 1.5 mg/L as PO4 (most test kits)), Iron removal plants: finished water Fe < 0.3 mg/l, Chlorine: Adequate at plant to provide free residual throughout system, spot checked on system, Systems adjusting Fluoride: 0.7 - 1.3 mg/l with optimum dose at 0.7 mg/l.

T2(2) **Was needed water system equipment in place and functioning properly at the time of survey?**
Adequate security: locked fence around wells/treatment plant/tank (6' or 5' + barbed wire at top), locked hatches on water storage tanks (operator verifies), Security Vulnerability Self-Assessment and Emergency Response Plan, both updated annually. Required equipment in place (i.e., phosphate and/or fluoride feeders on all wells if required), major components sized correctly if affects water quality or quantity, major components working at time of inspection unless provisions for repairs made. Must be noted on inspection report.

T2(3) **Were records available to the regional engineer clearly showing that all water storage tanks have been inspected and cleaned or painted (if needed) within the past 5 years?** Maintenance and painting contracts, tank inspection reports, operator can inspect own tank if he/she writes a report and/or takes pictures, painted if needed.

T2(3)1 **Was the certified waterworks operator or his/her authorized representative present for survey?** Operator or representative must be present unless emergency; operator of record shouldn't miss two in a row.

T2(3)2 **Was log book up to date and properly maintained and did it show that Water Utility Minimum JOB Guidelines for W. W. Operators were being met?** Log book: Cl2 recorded as required, pH, Fe, Fluoride, and phosphate where applicable, major events recorded (fix major leaks, replace chlorine cylinder, equipment repairs, etc.) Part time operator must make required entries in log book to show MINIMUM JOB GUIDELINES are met. Major events can be recorded separately (work orders).

T2(3)3 **Was the water system properly maintained at the time of survey?** Grass cut, packing not leaking excessively, plant presentable, etc.

T2(3)4 **Did the operator satisfactorily demonstrate to the regional engineer that he/she could fully perform all water quality tests required to properly operate this water system?** Must have appropriate test kits, fresh reagents, and able to perform tests (where applicable: chlorine, pH, iron, fluoride, phosphate). Town Engineer may perform tests to verify operator's results. Chlorine test must be performed by operator at all inspections.

T4(1) **Does water system routinely track water loss and were acceptable water loss records available for review by the regional engineer?** Requires metered connections and master meter or annual pump test with run time. Must show calculating water loss at least quarterly.

T4(2) **Is the water system overloaded?** Cannot exceed the design capacity, consecutive systems overloaded if supplier overloaded or based on hydraulic calculations or pressure recording.

T4(4) **Was there any indication that the water system is/has been experiencing low pressure in any part(s) of the distribution system?** Documented by hydraulics or pressure recording, or verified by operator. Must be documented on inspection report

T4(2) **Does the water system have a usable backup source of water?**

Managerial Capacity

MI **Were all required records maintained in logical and orderly manner and available for review?** In one location, sample results, utility correspondence, report, etc.

M2(1) **Have acceptable written policies and procedures for operating this water system been formally adopted and available for review?** Must have water users agreement (connection fees, late charges, deposits, wastewater requirements) and subdivision/line extension policy (written procedure requiring developer/system obtain Utility approval before construction begins) and either By-laws or Job Description for Employees (employee handbook), plus at least two of the following: Emergency or contingency plan (chain of command, phone numbers, etc.), Flushing program (flushing schedule w/ records), Fire hydrant policy (maintenance schedule, flow tests, agreement w/ fire dept.), Updated distribution map (can be updated by operator), (report of hazardous chemicals, quantity, location provided to local and state fire, law).

M2(2) **Have all Board Members (in office more than 12 months) completed Board Member Training?** Must have certificate (or copy) available for review. This does not apply to County with population over 10,000.

M2(3) **Does Board meet monthly and were minutes of Board meetings available for review?** Allow quarterly meetings with full time manager. Manager must be appointed by the board and documentation of appointment provided.

M3 **Has the water system had any Safe Drinking Water violations since the last Capacity Assessment?** Engineer's records

M4 **Has the water system developed a long-range improvement plan and was this plan available for review?** Hydraulic analysis, engineering report, completed State Needs Survey Form or list of goals prepared by operator and adopted by board, can give credit for major improvement project within past 5 years. Plan in use should indicate progress towards improvements. Water systems will need to provide proof of annual review by the governing body of the water system.

M5(1) **Does the water system have an effective cross connection program in compliance with Unity State regulations?** Shall include the following: Cross connection policy, records of backflow preventers installed on the system, current test results for each backflow preventer on system.

Was a copy of the Water Utility approved bactiriogical sample site plan and lead and copper sample site plan available for review and bactiriogical results show site plan is followed? Copy of sampling site plans available and bactiriogical results show plan is being followed.

M5(2) **Was a copy of the South Sudan Government approved bactiriogical sample site plan and lead and copper sample site plan available for review and bactiriogical results show site plan is followed?** Copy of sampling site plans available and bactiriogical results show plan is being followed.

Financial Capacity

F1 **Has the water system raised water rates in the past 5 years?** Credit also allowed if revenue exceeds expenditures (excluding out of pocket for major improvements and depreciation) by 10% for past five years.

F2 **Does the water system have an official policy requiring rates routinely reviewed and adjusted if necessary?** Must be in minutes showing adopted

F3 **Is the water system following an official cut off policy?** Must be published (in minutes or on bills), must follow policy (cut off customers who by policy should be cut off)

F4 **Was a copy of system's adopted annual budget available for review and does financial accounting system clearly and accurately track receipts and expenditures?** Must provide copy of budget and balance sheet (income statement) for review.

F5 1) **Has the water system filed financial report with State Auditor and copy available (Rural) for review?** List of violators, copy in records, can accept audit report. Financial report must be filed with the Secretary of State within 90 days of the close of the fiscal year, on forms provided by the State Auditor. 2) **Does the latest report show that receipts exceed expenditures?** Excluding out of pocket for major improvements

NON-TRANSIENT, NON-COMMUNITY FORM

FY 2016 Public Water System Capacity Assessment Form

NOTE: This form must be completed whenever a routine sanitary survey of a public water system is conducted by a regional engineer of the Bureau of Public Water Supply

PWS ID#: Class:................................ Survey Date:........................ County:...........
Public Water System:............................. Conn:.................................
Certified Waterworks Operator: Pop:..

CAPACITY RATING DETERMINATION

Technical (T) Capacity Rating: [.............] Managerial (M) Capacity Rating [............]

Capacity Rating $= \dfrac{T + M}{2} =$

Overall Capacity Rating =
......

Completed by on....................................

Comments:...
....

Technical Capacity Assessment	Point Scale	Point Award
[T1] Does the water system have any significant deficiencies? [Y N]	N - 1pt. Y - 0pt.	
[T2] 1) Was the water treatment process functioning properly? [Y N] (i.e. Is pH, iron, free chlorine, fluoride, etc. within acceptable range?) 2) Was needed water system equipment in place and functioning properly at the time of survey? [Y N] (NOTE: Equipment deficiencies must be identified in survey report.) 3) Were records available to the regional engineer clearly showing that all water storage tanks have been inspected and cleaned or painted (if needed) within the past 5 years? [Y N NA] (NOTE: All YESs required to receive point)	All Y - 1 pt. Else - 0 pt.	
[T3] 1) Was the certified waterworks operator or his/her authorized representative present for the survey? [Y N] 2) Was log book up to date and properly maintained and did it show that Minimum JOB Guidelines for W. W. Operators were being met? [Y N] 3) Was the water system properly maintained at the time of survey? [Y N] 4) Did operator satisfactorily demonstrate to the engineer that he/she could fully perform all water quality tests required to properly operate this water system? [Y N] (NOTE: All YESs required to receive point)	All Y - 1 pt. Else - 0 pt.	

[T4] 1) Does water system routinely track water loss and were acceptable water loss records available for review by the regional engineer? [Y N] 2) Is water system overloaded? (i.e. serving customers in excess of WATER UTILITY approved design capacity)? [Y N] 3) Was there any indication that the water system is/has been experiencing pressure problems in any part(s) of the distribution system? [Y N] (based on operator information, customer complaints, WATER UTILITY records, other information) (NOTE: YES FOR #1 & YES OR N/A FOR #4 AND NOs FOR #2 & #3 required to receive point)	1)Y - pt. 2)N - pt. 3)N - pt. 4)Y - pt.	
[T5] 1) Does the water system have the ability to provide water during power outages? (i.e. generator, emergency tie-ins, etc.) [Y N] 2) Does the water system have a usable backup source of water? [Y N] (NOTE: Must be documented on survey report)	All Y - 1 pt. Else - 0 pt.	
TECHNICAL CAPACITY RATING = [................] (Total Points)		

PWS ID#: Class:................................ Survey Date:........................ County:...........
Public Water System:............................. Conn:................................
Certified Waterworks Operator: Pop:...

MANAGERIAL CAPACITY ASSESSMENT	Point Scale	Point Award
[M1] Were all BUREA OF STANDARDS required records maintained in a logical and orderly manner and available for review by the regional engineer during the survey? [Y N]	Y - 1pt. N - 0pt.	
[M2] 1) Have acceptable written policies and procedures for operating this water system been formally adopted and were these policies available for review during the survey? [Y N] 2) Have all board members (in office more than 12 months) completed Board Member Training? [Y N NA] 3) Does the Board of Directors meet monthly and were minutes of Board meetings available for review during the survey? (NOTE: Quarterly meetings allowed if system has an officially designated full time manager) [Y N NA] (NOTE: ALL YESs or NAs required to receive point. NA - Not Applicable)	All Y - 1 pt. Else - 0 pt	
[M3] Has the water system had any Drinking Water Quality Standards violations since the last Capacity Assessment? [Y N]	N - 1pt. Y - 0pt.	
[M4] Has the water system developed a long-range improvements plan and was this plan available for review during the survey? [Y N]	Y - 1pt. N - 0pt.	
[M5] 1) Does the water system have an effective cross connection control program in compliance with the Government of South Sudan regulations? [Y N] 2) Was a	All Y - 1 pt.	

copy of the Bureau of Standards department approved bacteriological site plan and lead/copper site plan available for review during the survey and do the bacti results clearly show that this approved plan is being followed? [Y N] (NOTE: All YESs required to receive point)	Else - 0 pt.	
MANAGERIALS CAPACITY RATING = [.................] (Total Points)		

FINANCIAL Capacity Assessment	Point Scale	Point Award
[F1] Has the water system raised water rates in the past 5 years? [Y N] (NOTE: Point may be awarded if the water system provides acceptable financial documentation clearly showing that a rate increase is not needed, i.e. revenue has consistently exceeded expenditures by at least 10%, etc.)		
[F2] Does the water system have an officially adopted policy requiring that water rates be routinely reviewed and adjusted as appropriate and was this policy available for review during the survey? Y N]		
[F3] Does the water system have an officially adopted cut-off policy for customers who do not pay their water bills, was a copy of this policy available for review by the regional engineer, and do system records (cut-off lists, etc.) clearly show that the water system effectively implements this cut-off policy? [Y N]		
[F4] Was a copy of the water system's officially adopted annual budget available for review by the engineer and does the water system's financial accounting system clearly and accurately track the expenditure and receipt of funds? [Y N]		
[F5 - Municipal Systems] 1) Is the municipality current in submitting audit reports to the State Auditor's Office? [Y N] 2) Was a copy of the latest audit report available for review at the time of the survey? [Y N] 3) Does this audit report clearly show that water and sewer fund account(s) are maintained separately from all other municipal accounts? [Y N] (NOTE: Yes answer to all questions required to receive point.)		
[F5 - Rural Systems] 1) Has the rural water system filed the required financial reports with the State Auditor's Office and were these reports available for review? [Y N] 2) Does the latest financial report show that receipts exceeded expenditures? [Y N] (NOTE: Yes answer to both questions required to receive point)		
FINANCIALS CAPACITY RATING = [.................] (Total Points)		

Public Water System Capacity Assessment

A key element of this capacity development program is a rating system used by the Water Utility to determine the technical, managerial, and financial capacity of each public water system. The technical capacity pertains to the certified waterworks operator's duties and responsibilities in relation to the public water system in which he or she serves. The managerial capacity pertains to the governing body's duties and responsibilities for the water system in which they direct. The financial capacity pertains to all financial aspects that are needed to properly sustain a public water system. A Capacity Rating Form is used to evaluate these three areas and determine the capacity rating for each water system. The form is reviewed annually by the Water Utility to determine if changes and/or additions are needed to more accurately assess the current capacity public water systems.

The capacity assessment inspection is performed on an annual basis to ensure that public water systems are not only complying with regulations set forth by state agencies, but to also provide guidance for systems to take needed actions to increase their sustainability and capacity to provide a safe and affordable supply of drinking water to its customers.

The annual inspection is performed by engineers and is in fact an "open book test" since the water systems are aware of the questions and the necessary requirements to receive credit during the assessment. The rating scale ranges from 0.0 to 5.0, with 5.0 indicating that the system is doing an excellent job in meeting the goals outlined in the inspection. Systems scoring 3.0 or below are usually strongly encouraged to take action to improve capacity. The Capacity Assessment Forms (CAFs) consist of three major sections: Technical, Managerial and Financial. Each of these sections includes key questions designed to identify those tasks that a public water system must routinely accomplish in order to demonstrate capacity and to comply with all current and proposed requirements of the Safe Drinking Water Act. The following list of documents and policies should be used to prepare for inspections to limit oversights by operators, clerks, board presidents, mayors or board members when preparing for each annual inspection. These oversights often lead to the deduction of points on the capacity assessment.

The following documents are subject for review by the regional engineer during the inspection and were provided by the State Ministry of Housing, Roads and Infrastructures and the City Council.

Board Planning and Policies

- Minutes of Board meetings
- Vulnerability Assessment and Emergency Response Plan
- Water User's Agreement
- Subdivision/Line Extension policy
- By-laws or Job Description for employees
- Certificates of Board member Training if required
- Long-range Improvements plan
- Cross Connection policy
- Record of last rate increase or results of last rate study
- Policy requiring rate to reviewed annually
- Cut-off policy and copy of current cut-off list
- Annual budget
- Audit Report filed with State Auditor's Office

Operations

- Records of last tank inspection or painting for all metal water tanks
- Operator's current log book
- Percent water loss calculated at least quarterly for the past year
- Records of flushing program
- Updated distribution map
- Results from recent pumping test on wells
- Monthly Operating Reports (if 4-log)
- Current number of active connections
- Usage records from any commercial or industrial customers using significantly more water than a typical resident

Sampling/Testing/Evaluation

- Water Quality Analysis test results
    - Microbiological/Bacteriological and Turbidity Analyses – 5 years
    - Chemical Analyses– 10 years
- Sanitary Survey and Annual Inspection reports – 10 years
- Communications, including violations, related to
- Significant Deficiencies – 10 years
- Communications related to Violations not previously mentioned – 3 years
- Consumer Confidence Report (CCR) from previous Year
- Test results showing all backflow preventers tested in past 12 months
- Approved Lead and Copper site plan
- Approved Bacteriological and Disinfection Byproducts site plans

Public Water System Peer Review Program

The Public Water System Peer Review Program is a technical, managerial, and financial evaluation of the water system. The purpose of the program is to prepare public water systems for the annual inspection performed by the Public Health Department, the Bureau of Standards and the Ministry of Water (MEDIWAR). It is provided at no cost to any Unity State public water system that makes a request. Volunteer water system operators and technical assistance providers conduct these Peer Reviews. The operators conducting the reviews will assist with numerous things such as any technical problems your system may be having and preparing the necessary paperwork. These operators will be able to give you advice and recommendations for improving the system's technical, managerial, and financial capacity, which can result in a significant improvement in next year's Capacity Assessment Rating. Most importantly, this program will help the water system provide service to its customers more efficiently and effectively. The results of the Peer Reviews are strictly confidential.

Planning, Budgeting, and Rate Setting and My Water System:

A Self-Assessment

Please respond to the following statements that relate to your water system management. Select one answer. The answers reflect the opinion of the board member making the assessment, but the joint opinions of the board members should reflect the strengths and weaknesses of the board and help identify areas where improvement is needed.

1. To help keep up with trends in total water used in our water system, we
   A. keep records for up to 10 years on the annual gallons of water used, the number of users, water used by different classes of users (if applicable), monthly water use, and annual water use per customer; we have estimates of water losses from leaks and unmetered sites.
   B. keep records for up to 5 years on annual water use, number of users, use per customer, and we estimate water losses each year.
   C. have historical records on file of water use, number of users, and average use per customer, but there are some gaps in the records.
   D. keep some records, but they are scattered and these are based on rough estimates.
   E. keep no records of water use and water losses.

2. For my water system,
   A. every water user is metered and records are kept on each customer's usage.
   B. all private users are metered, but some public users are not metered and no records of water use can be kept on these.
   C. most but not all private users are metered and billed, and we do not meter public users.
   D. we use meters, but the location of every meter is not known or is not read on a monthly basis.
   E. we do not use meters but charge everyone equally, regardless of water consumption.

3. Our board
   A. requires that we keep monthly records of our expenses and income by major categories and that we summarize these into annual reports. We use these for preparing annual budgets and for long-term planning.
   B. requires that we keep records of monthly income and expenses by categories, and we use these in planning but do not prepare budgets each year. We make long-term plans when we feel they are needed.
   C. has monthly income and expense records but do not categorize them to help identify exactly where our money is coming from and where our money is going.
   D. has some financial records, but we do not keep them long enough for them to be of much use in our financial planning.
   E. does not keep detailed records of income and expenses.

4. For our inventory of machinery and equipment, our board

A. requires that permanent records include the age, expected life, date and cost of major repairs, annual maintenance checks, and dates and plans for major repairs or replacements, projected costs of repairs, and plans for new purchases.
B. requires that records be kept on maintenance and major repairs but we do make plans for replacement on an item-by-item basis.
C. asks that operators and managers make repairs when needed and report to the board when major repairs or purchases are needed as well as reporting periodically on the status of the machinery and equipment inventory. No written records are maintained.
D. asks that operators or managers keep up with equipment repair and replacement needs, but no records or reports are required.
E. keeps no inventory records on purchases or repairs.

5. Our financial record-keeping system is
    A. computerized, kept current, income and expenses are categorized, and accurate financial information can be generated for board use anytime it is needed.
    B. computerized income and expenses are categorized, and financial reports can be generated anytime they are needed. Often recent income and expense items have not been included.
    C. not computerized, but we have an organized system so that income and expense statements can be generated monthly from deposit receipts, checkbooks, and bank statements.
    D. based mostly on the monthly bank statements that we use to put together financial reports when required.
    E. poorly maintained, and it is difficult to develop accurate reports when they are needed.

The Economics of Small Rural Water Systems

The most important function of the board of directors of small rural water systems is the economic management of the water system. The purpose of the board is to provide its customers with an abundant and consistent supply of good-quality water at a fair and reasonable price. The rates for customers of municipal systems outside the one-mile buffer zone outside the city limits can be no more than 150 percent of the rates of the regular water system. Water system users organize themselves into a business organization that can accomplish this purpose, or a town council assumes this as a major function of the city.
Critical elements of the rural water system business are record keeping, long-term planning and budgeting, financing, and setting rates. The success of using these financial tools depends on knowing the projected number of users and the proper sizing of the system to fit the present and future water demands. Although a rural water association or a small city water service department is a nonprofit entity, it must be managed with the same scrutiny of a private business. Customers or water association members must know that their water is provided as economically as possible and without the future of the water system being jeopardized. To do this, the board has the following responsibilities:

- Maintain records related to quantity of water used by types of users, total water metered, water losses, and water production;
- Maintain accurate financial records;
- Consistently monitor expenses and incomes and set procedures that ensure expenses are monitored and that all due incomes are received;
- Use short-term and long-term budgets to plan for the maintenance, improvement, and expansions of the system;
- Keep abreast of any grants available and the best sources for financing loans for the system; and
- Set fair rates and keep the rate structure in line with financial needs and plans.

Developing Rate-Related Policies, Rate Structures and Setting Rates

An important part of managing a water system and keeping it financially strong is to maintain accurate records. On a regular basis, decision makers should ask, "How much water did we produce or buy, and how much did we sell?" The answers to these questions affect your system's operation and income, including the rates you set.

The income from the sale of water and services determines whether or not your system will prosper. A successful water system operates according to sound business principles. Systems must charge a fair price for the services they provide. Some customers argue that water should be free, but testing, treating, storing, pumping, and delivering a constant supply of water is expensive. Water system leaders must set rates that are sufficient to pay for the services their system provides and to meet their future needs. The rate structure is the engine that keeps the water system organization in business. Board members of nonprofit associations often refuse to make needed rate increases. The boards of directors and the managers of small rural water systems are not only responsible for the system operating as efficiently as possible but also are responsible for generating enough funds to meet emergency needs and to maintain the long-term viability of the system. The rate structure must be fair to all its members or water customers. Annual planning helps prevent large and abrupt changes in rates caused by new capital outlays or emergency repairs or replacements.

- However, the rate structure is only one part of the picture. There are many other considerations that affect the financial performance and sustainability of the system. Consider the following factors before adjusting rates:
- Raising rates because of inefficiency and poor management results in animosity by the consumers toward the board of directors and water system employees.
- Poor management cannot be overcome by raising rates. A loss of confidence and support will occur, often resulting in the failure of the existing organization and an expensive reorganization.
- Other factors related to job losses by customers, decreases in personal incomes, and people moving out of the district may make it difficult even under the best management conditions.

Why Water Systems Need to Increase Income

There are many factors that can affect water system finances. These include the following:

- **Increases in operating expenses** – Like any business, water systems are subject to increasing expenses. When operating expenses go up, income must go up, too. Higher operating expenses can be caused by increases in inflation, interest rates, labor costs, and power costs.
- **System expansion or renovation** – Some systems may need to expand their facilities to keep up with the needs of a growing community. Others may be faced with expanding or renovating their treatment facilities to meet federal or state requirements. Regardless of the cause, expansion and renovation can be some of the biggest costs a water system can have.
- **Changes in the customer base** – The customers of a water system are what form its customer base. If there is a change in the customer base, there is a change in the system's income. For example, if a major manufacturer or an agricultural customer leaves an area, the system may lose a significant portion of its income. The system may have to increase rates or cut operating expenses to accommodate the loss.
- **Emergencies** – Eventually, most systems experience an emergency. Tornado, flood, or other disastrous damage can require immediate capital to cover repair and rebuilding costs.
- **Water shortages** – During times of severe drought, a system may have to ration water or raise rates to buy water from another system. By increasing rates, systems may encourage customers to conserve water.
- **Water treatment requirements** – Some systems may have to raise rates to pay for expensive water treatment. This can be caused by new or stricter federal and state regulations, water contamination, or the addition of new water sources.
- **Loss of a source of financial support** – The operational expenses of some types of water systems may be supplemented from property tax revenues or the operation of other utilities. If systems lose this, they may be faced with either cutting costs or raising rates.
- **System operating policies and procedures** – In some cases, incorrectly set operating policies and procedures may actually be costing the system money. For example, overdue accounts, low water rates, inefficient operations, or excessive water loss all cut into the system’s money reserves.
- **Environmental and health regulations** – Increases in required testing, changes in structural requirements, and increases in required procedures have added to the costs of doing business. More technical knowledge, more expensive equipment, and increased labor requirements add to the costs of operating rural water system associations and/or water departments. The water system boards have no choice in meeting these requirements.

How Can a System Increase Income Without Raising Rates?

While raising a system's rates is certainly one way of increasing income to meet operating and capital expenses, it is not the only way. In many cases, you can increase income without increasing rates. You may do the following:

- Conduct a water audit
- Revise system policies
- Reduce expenses

Conduct a water audit

Your system might cut costs by conducting a water audit. A water audit helps you find water that is unaccounted for in your system. For example, according to system records, you distributed 1,000,000 gallons last month, but customers' meter readings only totaled 800,000 gallons. The remaining 200,000 gallons are unaccounted for. The "unaccounted for" water may actually be caused by inaccurate records or meters. Unaccounted for water may also be the result of distribution leaks, unmetered connections, or water theft.

Errors in records and meters. Errors can be costly to your system. If your records aren't accurate, you may provide more water than you are getting paid for. The first step in a water audit is to verify records for accuracy. Another source of errors is meter inaccuracy. Start a meter testing program and establish a meter change out policy if your system does not have one. Some systems routinely replace meters that have registered a certain number of gallons or have been in service for a number of years.

Unmetered connections. Regardless of the billing procedure, consider metering every connection on your system. Unmetered connections result in a loss of revenues. Some systems do not use meters at all. Typically, these systems charge a blanket rate. In these cases, it is impossible to estimate the operating efficiency of the system and set adequate billing rates. The American Water Works Association and the National Rural Water Association recommend that all water system connections be metered.

Water theft. Another cause of lost income is water theft. Periodically, check your system for illegal taps, reversed water meters, and other signs of theft. Some systems have strict cash penalties for people caught stealing water. In some states, water theft is a felony.

Leak detection. No system is leak free, but some systems have more leaks than others. You can find leaks yourself, or you can contact the professional water association in your state or a leak detection service for help. Successful leak detection surveys often pay for themselves by finding costly leaks. An important reason for reading meters is to check the system for leaks and meter inaccuracy. Your system may be able to save hundreds of dollars if you discover leaks or defective meters as soon as a problem occurs. Your water system operator should regularly monitor tanks and lines for leaks. Also, installing master meters at water sources will enable the system to compare the amount of water produced/treated with the amount of water sold to customers. This comparison is a good indicator of the amount of leakage in the distribution system.

Often the only way to find leaks in these areas is to have special checks and leak detection programs. Contact the Rural Water Association for help in developing a leak detection program and a pumping test program. Water losses add to the electricity and pumping costs and wear out the equipment, resulting in higher costs to users.

Revise system policies

Some policies and practices listed below reduce the problems associated with rate increases and should occur before any rate changes are made. These have already been addressed in previous chapters but are listed here for review purposes:

In addition to providing water, systems provide customers with a range of services, including installation and repairs. If the price of service has increased steadily during the last 5 years but your rates and fees have remained the same, it may be time to revise system policies.

All rural water system associations should have specific rules regarding dates of billing, deadline dates for payments without interest charges, and deadlines before disconnections. Reconnecting fees should be also specified. These rules should be part of the association's bylaws and be strictly enforced. Stealing water is illegal and the board should see that violators are reported.

Not following approved collection policies is unfair to customers who pay bills and support the water organization whether it is publicly or privately owned. Written exceptions may be enacted for those who have temporary financial difficulties and health problems, but exceptions should be legitimate and approved by the board. Cutting water off for customers who have health problems exposes an organization to lawsuits that can greatly affect its economic viability. Consider any exceptions carefully because exceptions tend to feed on other exceptions, and the board will face difficult choices, will be put in difficult positions, and its overall effectiveness diminished. Funds may be created to help customers who have emergencies and financial difficulty. The board and the billing clerk should make sure that both a mailing address to send bills and a drop-off location for paying bills directly are known by all its customers.

All systems have some customers who prefer paying directly with cash. The board should have a policy of charging a fee for checks that are returned because of insufficient funds. Charges should at least cover bank charges that are deducted from the organization's bank account for handling these transactions. Other policies include:

Establish a late-payment charge: Late and overdue payments cost your system money. They deprive you of the gross income for the water the customer used and the interest on the money if it were in the bank. Late payments are also unfair to those customers who pay on time. You may also want to consider charging a fee for returned checks. One way to make up for the interest your system loses is to add a late-payment charge to the customer's bill. At a minimum, charge the current interest rate for the money your system would have made if the payment were in your system's bank account. (Be sure to check the laws in your state about this practice.) Mark it clearly on the bill that if the customer does not pay the full amount on time, the system will assess a penalty.

Charge a fine to disconnect and reconnect service: Some systems may not charge customers to have their service disconnected and/or reconnected. Although these services seem minor, they still cost your system money. Not only must your system pay for equipment and tools to do the job, but it must also pay for the labor to get the job done. During a year's time, these small service calls can add up. If possible, charge customers at least the cost of labor to connect or disconnect service.

Generate front-end charges. One way to increase income without raising rates is to require all new customers to pay a front-end charge before starting service. Front-end costs include membership fees, deposits, and construction costs for new installations. Water co-ops usually charge new customers a membership fee. Memberships provide a system with immediate cash and are typically nonrefundable. Some systems require new customers to place a deposit on their water service. Many customers may prefer placing deposits, because they are returnable when services are discontinued. Deposits benefit the system by allowing it to use the money for system improvements and expenses as long as the customer remains on the service.

Establish a strict cut-off policy. Another way to encourage customers to pay promptly is to establish a strict cut-off policy. If customers do not pay their bills by a given date, disconnect their service until they have paid their bills in full. Check your state and local laws regarding utility disconnections for customers who do not pay their bills. You may also choose to charge a service fee to have their water service reconnected.

Let your money make money. Some systems have sizeable cash reserves in noninterest-bearing accounts or low-yield certificates of deposit. Be sure your assets are earning the maximum for your system. If your system now bills quarterly, consider changing to a monthly billing system. This puts more money to work faster for your system. Be aware, however, that a change from quarterly to monthly billing can be a major adjustment for system staff and customers.
Some systems have considered a change from monthly to quarterly billing to save on meter reading. Consider this carefully, because this can prove to be a false assumption.

Charge for extra services. Make certain that all extra services, such as road bores, are fully paid for by the customer who receives the service.

Reduce expenses

Another way for a system to increase cash flow is to operate more efficiently. When you consider ways to cut system costs, think of the system as a business. Good business practice involves paying attention to the smallest details involving operating costs. Techniques for cutting system costs are reviewed below. You may do the following:

Upgrade your billing system. Some systems may be able to increase their income by adopting a computer billing system. A good computer billing system can save employee work hours and allow bills to be sent more quickly. An efficient billing system can also improve cash flow and interest income.

Perform an energy audit. Another way you may cut system expenses is to perform an energy audit. Check all electrical devices such as pumps and motors to make sure they are operating at top efficiency. For help in performing an energy audit, contact a manufacturer's representative or professional water association in your area.

Purchase items in bulk. Whenever possible, purchase items you will need for the year in bulk. If storage space is a problem, your supplier might send you partial shipments as you need them. You must pay for the supplies in advance, but you do not have to worry about storage space.

Make cooperative purchases. Your system may be able to save even more money if it makes a cooperative purchase with neighboring water systems. By purchasing enough supplies for two or more systems, you may receive a quantity discount.

Water meters. Every water system user should have a meter and receive a water bill. Exceptions to this rule should be very limited. Public areas such as parks, public buildings, and other community facilities are often excluded, but even these should be metered and monitored.
Approve any exceptions at membership meetings or city council meetings, and make them a part of written policies open to the membership or public. Private exceptions, unless approved in this manner, usually create uncertainty and distrust and are perceived as unfair. Systematically check meters for accuracy. Older meters or other meters that malfunction are far more likely to slow down and thus favor the customer at the expense of the water association, water department, or business.

Contracting and work projects/equipment. The policies and practices that the board follows for contracting can have a considerable impact on the costs of doing business and/or the income earned by the organization. The board must weigh the costs of buying equipment and hiring employees to complete work projects against the costs of contracting projects to outside businesses. Larger system managers may find it more economical to do most of their own work, and small systems managers may find it too costly to buy expensive equipment and hire full time employees. The availability of qualified employees and qualified contractors and the timeliness of getting work completed are critical factors in these decisions. When expensive equipment is owned and often sits idle, a lease-out program may be a way of earning extra dollars. Operators of the equipment are often hired out with the equipment to help prevent improper uses and damage to the equipment. If emergencies occur during lease-out periods, these must get priority over outside jobs. All water system associations and departments will contract for wells, pumps, and tanks as well as professional services. Professional engineers are used to develop specifications for water systems. Policies should be established for bidding procedures that insure the association or department of getting quality work at the best price. Contracting decisions are based on needs and experience, and individual boards are qualified to make the best decisions.

Increasing Income by Raising Rates...the Last Resort

In some cases, water system decision makers must adjust water rates regardless of their efforts to increase income in other ways.

Timing rate adjustments. The timing of rate adjustments is important. Systems may meet with less resistance if decision makers time a rate hike wisely and explain why the increase was necessary. Some times are more appropriate than others for rate increases. If possible, avoid raising water rates during the following times:

- Holidays
- Back-to-school time
- Legislative sessions or election time
- High water-consumption months, unless for conservation Purposes

How often should a system adjust rates? Some systems adjust rates only when they are in debt. Rates should be adjusted when the system's income does not pay its expenses despite efforts in other areas of system operation. A system's financial status usually dictates the cost of water. In rare cases, systems have lowered rates. Most often, though, a rate adjustment actually means a rate increase. Systems may want to consider adjusting rates annually based on projected revenue needed for the next year. Some systems review their rates during the annual budgeting process. Rate adjustments are met with less resistance if they are in small increments each year rather than a large adjustment every 3 years. Some systems use rate indexing, which is a set percentage of increase every year to keep up with inflation.

Informing the public about rate adjustments.

Regardless of the way your system chooses to adjust rates, keep your customers informed. Don't let them discover rate hikes with the next bill. There are several factors that should be understood when dealing with a system's financial situation. Many of these have already been touched on, but a more detailed discussion is needed in order to understand and evaluate the system's viability.

Understanding Your System's Finances

All too often, a board thinks that its only option to change the financial situation of the system is to adjust (usually raise) rates. However, adjusting rates should be done as a last resort and only after the board has a complete understanding and performed a thorough examination of the system's financial picture.

The following sections provide the basis for an analysis of a system's financials. Understanding financial components, examining reporting and analysis tools and developing an overall plan and budget for the system will be followed by a discussion of the various types of rate structures and considerations in choosing a structure and rate level that works best for your system.

Record Keeping

Accurate record keeping is an indispensable first step in not only understanding the system's finances, but also in properly managing the water system and planning for future improvements. On a regular basis, decision makers should ask, "How much water did we produce or buy, and how much did we sell?"

Many water system organizations keep detailed records on computers, but a large number of rural water system boards do not do a good job of keeping either financial or production records. Keeping poor records makes it impossible for the system to practice good financial planning and usually results in burdening your customers with unnecessary charges. Financial record keeping forms the basis for financial management, long-term financial planning and for setting rates. Without a good record-keeping system, the capability of making meaningful long-term decisions is severely limited. Computer record-keeping systems that are inexpensive, easy to understand, and greatly reduce the time required to keep records and generate customized reports are good investments for most water associations. Boards should consider selecting good record-keeping/billing programs and hiring bookkeepers with computer experience who can be trained to use the programs selected. Computer programs and equipment are on the market with the following capabilities:

- Entering and recording meter readings that can be transferred to computers for billing purposes;
- Transforming meter readings into bills and printing bills for mailing;
- Entering all income, expenses, and investments; and
- Generating reports to determine current economic conditions and providing input for short-term and long-term budgeting. Several programs specifically designed for water systems are available. Investigate these and select those that fit the needs and budgets of your system. If a computerized program is not selected, then organize the manual record keeping procedures so that the same data can be generated for keeping current income and expense totals and for preparing financial budgets.

Whether you select a computerized or a manual bookkeeping system, the next step after the selection of a system is defining the income and expense categories to get the information needed for determining the present economic condition of the association or water department and for budgeting purposes. The number of income and expense categories should be detailed enough give a picture of the business functions necessary to operate the business but not so detailed as to be cumbersome in generating figures to make business decisions. The selection of categories is totally at the discretion of the board and bookkeeper and should be made to fit the particular needs and desires of the board. Examples of expense and income categories are provided later in this chapter.

Financial record keeping includes recording all income received and all expenses paid by the association or water department, preferably on a monthly basis.
Major income and expense items should be set apart so the board knows where money is coming from and where money is being spent. The number of income and expense sectors should be large enough to distinguish major areas but small enough to simplify planning.

Maintain your records on monthly and aggregate yearly bases. For some water system organizations, this may simply be a matter of recording transactions and keeping records that are already being generated. Only if records are filed for several years can trends be observed, and trends are important in long-term planning. Demographic trends will have an impact on new users and users that have moved from your service area. Household income trends impact the ability of users to promptly pay water bills. Physical water use records— such as gallons of water used per customer—help form the basis for planning future water needs and investment requirements.

A map or plat of the whole water system, including wells, tanks, lines, line connections and meters, is beneficial to the planning process. Maps or schematic diagrams should be required to help new board members and new employees, to help professional and contractors who are hired, and to help other utility organizations who use the same areas for their installations. Maintaining plats should be an assignment of managers and operators who do the changes and additions. Appendix Table 1 is designed for recording water use information that would be helpful in long-term planning.

Financial Reporting Tools

Balance Sheet. The balance sheet represents the statement of the firm's financial balances in terms of the following accounting model:

Assets = liabilities + members' equity

Assets are the objects owned by and having value for your water system. Examples are the cash in your bank and the water lines in the ground. Current assets represent cash or other assets that will become cash within one year. Investments and funds include non-current assets other than property, plant, and equipment. These are long-term investments in securities such as stocks, bonds, and notes. Intangible assets represent long-lived assets that have no physical substance. Examples are easements, patents, and trademarks. Items that cannot be categorized go under "other assets."

Liabilities are the opposite of assets. These are obligations or the amount owed to another entity. As with the assets category, current liabilities are obligations that must be paid within a year and include accounts payable, short-term notes payable, and accrued expenses for payrolls, interest, and taxes. Long-term liabilities are bonds payable, notes payable to banks, and lease obligations.

Members' equity represents the difference between the assets and the liabilities and represents the value of the organization if all assets were sold and the proceeds used to retire the system's liabilities.

Table 6: Balance sheet classifications:

Balance sheet classifications:	
assets	current assets investments and funds property, plant, and equipment intangible assets, other assets
liabilities	current liabilities, long-term liabilities
members' equity	benefit units, donated capital, retained earnings

Retained earnings represent the accumulation of income (loss) since the inception of the district.

An accurate balance sheet is one of the best tools your system can have. It is a snapshot of your water district's finances on a given date.

Table 7: Sample balance sheet

Balance Sheet for Water District No. 5 December 31, 1997		
	Assets	
Current assets:		
	Cash and equivalent	$57,000
	Certificates of deposit	60,000
	Accounts receivable	10,857
	Inventories	5,980
	Prepaid expenses	1,000
	Total current assets	134,837
	Bond reserve fund	25,000
	Property, plant, and equipment	207,000
Other assets:		
	Easements	2,000
	Utility deposits	1,500
		3,500
	Liabilities and members' equity	$370,337
Current liabilities:		
	Current maturities of bond payable	$45,000

	Current maturities of capital lease obligations	10,000
	Accounts payable	20,000
	Line extension deposits	14,000
	Accrued liabilities	15,000
	Total current liabilities	104,000
	Note payable, bank, less current maturities	100,000
	Capital lease obligation, less current maturities	13,000
Members' equity:		
	Contributed capital	$55,337
	Retained earning	98,000
	Total members' equity	$153,337

Income Statement. An income statement compares the water system's revenues to its expenses. The revenues are the money that the district receives for items such as water sales and hookup fees; expenses are costs incurred in order to generate revenues.

While the balance sheet and income statement both measure the financial status of the system, they are very different. The balance sheet demonstrates the health of the firm at a given point in time. The balance sheet shows the "vitals" of the business such as the cash on hand that is required to operate, the level of income-generating assets of the firm such as pumps and tanks, and the liabilities or debts that are owed by the firm to its various creditors. The income statement measures the healthy activities of the firm over time by demonstrating the capacity of the firm's income-generating ability to cover the expenses incurred by operations.

The Annual Financial Report for Nonprofit Public Water Systems, found in the Appendix of this manual, provides a snapshot of the financial status of nonprofit water systems to the Office of the State Auditor and is due by July 1 of each year. The financial portion of this report combines elements of the income statement and the balance sheet to demonstrate the degree to which the nonprofit systems are fulfilling their missions. The reverse side of the report provides a listing of the system's board members as well as identification of those board members who have not completed Board Member Management Training as required by Unity state and the South Sudan law.

Income Statement of Revenues and Expenses
for the Year Ended December 31, 1997

Table 8: Income Statement of Revenues and Expenses

<u>Revenue</u>		$ 140,000
	Water sales	$ 200
	Hookup fees	$140,200
<u>Costs and Operating Expenses</u>		
	Water purchase	$52,000
	Salaries and wages	18,950
	Payroll taxes	18,950
	Insurance	2,800
	Depreciation	20,000
	Office supplies	4,000
	Utilities	3,000
	Telephone	1,200
	Mileage	1,000
	Repairs	3,900
	Miscellaneous	1,500
		109,860
Income from operations		$30,340
Nonoperating revenues (expenses):		
	Interest income	$4,000
	Interest expense	(10,850)
		(6,850)
	Net income	$23,490

Analyzing Costs (Expenses) and Incomes (Revenue)

Costs. Before setting rate structures, identify which costs are fixed and which are variable. This helps to provide a clear picture of obligations that must be paid even if the water system were shut down, compared to obligations that depend on the quantity of water produced.

<u>Fixed Costs</u>. Fixed costs are costs that do not vary with the amount of water produced or used by customers at the time that costs are analyzed. Fixed costs must be paid even if pumps are not turned on and water is not being distributed. From the business standpoint, any costs that have already been incurred and paid, and any costs where the obligation to pay cannot be changed become fixed costs. Examples of costs that are often considered fixed by a water association or water department are salaries, insurance, office expenses, debt payments, and reserve funds. Reserve funds are added as fixed costs because of the high priority they should receive in the survival of a water system organization.

Variable Costs. Variable costs are costs that vary with the amount of water produced or the water consumed by the users. These are costs that increase as water usage increases. Examples of costs that are usually considered variable are electricity, chemicals such as chlorine, service labor, and repairs. Because repairs are correlated with use, they are variable. However, because they are unpredictable, businesses often allocate to a repair account and treat this account as fixed. Understanding the difference between costs that are fixed and those which are variable gives the board a logical procedure for dividing the rate structure into a basic rate or base charge and a set of additional rates depending on usage. The fixed costs that must be paid, regardless of the amount of water produced, form the basis for setting the basic rate or the base charge. Variable costs, which increase with water produced or consumed, form the basis for setting the rates based on the number of gallons of water metered or consumed.
Distinguishing between fixed and variable costs is important to a marginal business whose objective is to make a profit (for a nonprofit water system, you can translate this as becoming financially viable and sustainable).

If variable costs are not covered, then the business should not operate or should close, because by continuing to operate, losses would only increase. If variable costs are covered and only parts of fixed costs are covered, it is economical to continue to operate because all of the variable costs are being paid, and some fixed costs are being paid.

However, this cannot continue in the long-run because all costs must be eventually covered. If the purpose of a water system organization is to provide water for residents in its certified area for the long run, then all costs must be covered. Unlike a competitive business for profit, the water system association or department is not competitive and is not going to shut down to change locations or change products. Reorganization, improved management, and rate increases may be the only options if users are to continue to have water supplied where competition does not exist.

Expenses. Expenses include personnel, equipment and vehicles, supplies, insurance, postage, office, contracts, debt payment, reserves, etc.

- Personnel expenses include wages and salaries, health insurance, payroll taxes paid by employer, travel, per diem, reimbursements, and educational fees or training fees for employees and board members.
- Equipment and vehicle costs include parts, small repairs, fuel and oil, vehicle insurance, tags and taxes, and lease payments.
- Supplies include chemicals, pipes and fittings, valves, pump parts, sampling kits, meters on hand, small tools, and shipping costs.
- Insurance expenses include general liability, director and officer liability, employee liability, property, crime bonding, life and casualty.
- Office costs include stamps and postage, envelopes and printed cards, paper, computers and computer equipment, printers, and office equipment repairs.
- Utilities expenses include electricity for pumps and well houses and utilities for the office.
- Telephone costs include office phones, cell phones and phones for managers and operators.
- Contract expenses include those for system repairs and contracts with professionals, engineers, accounting, and legal advisors.
- Debt payments include interest payments on current loans and bonds.
- Reserves include money for emergencies, major repairs on water system, major repairs on equipment, and planned expansions and improvements. At a minimum, this fund should include a reserve for depreciation of existing assets that are not covered by current debt payments plus

amounts set aside for emergencies and for planned expansions that are not going to be covered by additional debt.

Other expenses include water purchases, returned meter deposits, and appropriate miscellaneous costs. Before the board can develop usable, long-term financial plans, it must be able to identify and project the water needs and growth in water use in the service area. These will ultimately determine the income available to the water system. Variables that will determine the system's income include the following:

- New users within the present water service network;
- Expansions outside the present lines but within the service area;
- User density in a new area;
- Alternative sources of water;
- Present users that leave the area or discontinue service;
- Potential tie-in with an adjoining system for emergencies;
- Potential merger with another system;
- Potential for better control of water wasted; and
- High-use periods when water demands are the highest.

The availability of water for users depends on the following:

- The number of wells and other sources of water;
- The productive capacity of the wells and other water sources;
- The control of water losses through leaks or unmetered runoff;
- The capacity of the main water lines and the private lines of the users;
- The storage capacity of tanks and holding facilities; and
- The ability of the water system organization to manage the system effectively. Many water system organizations provide water not only for households and individual families, but also for commercial, agricultural and industrial users. Organize records so these types of users are separately identified, even if rates for different user types are identical. Unity sales tax must be paid by nonresidential users. The distinction of these users may be according to meter size and not by user type. Farm and industrial users are often higher risk users because they are larger consumers, industries may move or relocate, and farm use can be uncertain and dependent upon weather conditions. Potential advantages to a rural water association or a small town system from a new industry's locating in the area include the following:
- Additional demand may result in the expansion of the water system to a more optimum size and in improved economic efficiency.
- New industry could bring in new household users within the water service boundaries and increase the user density if the water system has a sparsely distributed user base.
- Pressure on the board could result in making needed improvements to the system.
- Additional users could raise the revenues enough to reduce water costs per user.
- Arrangements could be made with new industry that would cover all the increases in costs and reduce the risks associated with expanding and improving the water system.

Interested stakeholders and possible leaders could be added who have a definite interest in the success of the water system. Problems that could arise that the board should be aware of include the following:

- Relatively large users (such as industries and intensive irrigation operations) may affect the water table in the area, regardless of their participation in the water association or city water service.

- If water supply is part of an incentive program to attract industry, industrial users may not be subject to the increased costs incurred by the water system.
- Industries may relocate or be forced to shut down, reducing the industrial demand for water and affecting the domestic use when jobs are lost.

Income. Income includes water sales; late charges, penalties, and reconnecting fees; connection fees and meter deposits; interest on reserves; contract work; membership charges; and other incoming money.

- Water sales include water bills paid by customers and water sold to another system.
- Late charges, penalties, and reconnecting fees include interest charges when bills are not paid by the due date, additional penalties charged when bills are not paid by due date or before next billing period, and fees for reconnecting service after meters have been removed for nonpayment.
- Connection fees and meter deposits include income from charges made for original connection to water system, membership charges for joining an association, and deposits made for meter installation and meters less meter deposit returns.
- Interest on reserves include interest earned from money deposited in a reserve bank account for water system emergencies, major repairs, improvements, or expansions.
- Contract work includes work by employees for other systems or equipment or machinery leased out when not in use.
- Other income includes anything appropriate: grants and loans that provide funds for the system but are not normal income.

Financial Management

Financial management for a utility should include providing stability for the utility, careful budgeting, and providing capital improvement funds for future utility expansion. These three areas must be examined on a routine basis to ensure the continued operation of the utility. They may be formally reviewed on an annual basis and when making long-term plans for utility maintenance and expansion.

Financial Ratios

To evaluate the financial condition and performance of an organization, financial analysis uses a ratio, or index, to relate two pieces of financial data to each other. How do you measure financial stability for a utility? There are two simple ratios to help you do this.

The first ratio is the **operating ratio**. This ratio shows the capacity of the utility to generate enough revenues from its normal operations to pay its expenses. A utility that is in financially sound shape will typically have an operating ratio above 1.10.

Calculate total operating revenue by adding all revenue generated by water bills, user fees, hook-up fees, and interest income from security deposits. Calculate operating expenses by summing the expenses of the utility concerned with the production of water including administrative costs, salaries, chemicals, supplies, fuel, depreciation, interest expenses, and miscellaneous expenses attributed to the operation of the system.

Calculating the Operating Ratio and the Coverage Ratio. The operating revenues for a utility are $1,367,600 and the operating expenses are $1,052,000. The debt service expenses are $470,000. What is the operating ratio?

operating revenues = $1,367,600
operating expenses = $ 1,052,000
debt service expenses = $ 470,000

Calculate the operating ratio

$$\text{operating ratio} = \frac{\text{operating revenues}}{\text{operating expenses}}$$

$$\text{operating ratio} = \frac{\$\ 1{,}367{,}000}{\$\ 1{,}052{,}000} = 1.30$$

An operating ratio of 1.3 means that this water district receives $1.30 in revenues on every dollar spent in operating expenses

The second ratio is the **coverage ratio**. This ratio measures the ability of the utility to pay the principal, interest and debt reserve requirements on loans and bonds. Most lenders require this ratio to be at least 1.25. This ratio is calculated by dividing the revenue available for debt service by the level of debt service. The revenue available for debt service is simply operating revenues minus non-debt related operating expenses.

Calculate the coverage ratio

$$\text{Coverage ratio} = \frac{\text{operating revenues} - \text{non-debt expenses}}{\text{debt service}}$$

$$= \frac{\$\ 1{,}367{,}600 - \$\ 582{,}00}{\$\ 470{,}000} = 1.67$$

With a coverage ratio of 1.67, this sample utility has demonstrated the capacity to meet its debt service obligations.

Other Useful Ratios

Liquidity ratios. Liquidity measures your water system's ability to meet current obligations or bills. The two main liquidity ratios are current ratio and quick ratio, with the current ratio being the most widely used. The current ratio represents your water system's ability to meet current liabilities and to stay in business.

Calculating the Current Ratio. Current and quick ratios can help you to measure risk in terms of financial difficulty. The ratio provides a good starting point for looking at the financial strength of the utility. Using this ratio, the manager can measure the financial health of the water system, and can evaluate how well the system performed in comparison with prior years or other systems.

The **current assets** for a utility are **$159,000** and **current liabilities** are **$102,000**.

$$\text{Current ratio} = \frac{\text{Current assets}}{\text{Current liabilities}} = 1.67$$

$$\text{Current ratio} = \frac{\$\,159{,}000}{\$\,102{,}000} = 1.56$$

This ratio means that this water district has $1.56 in current assets for every $1.00 in current liabilities. This means that the firm is liquid and could sell its current assets and use the proceeds to retire all current liabilities or short-term debt.

A Learning Exercise: Financial Reports

Please respond to the following statements and questions. Select the correct answers by circling the appropriate letters. Some statements may have more than one correct answer; circle all letters that are correct.

1. Financial record keeping for rural water associations or water departments should include
    - A. simple income and expense totals so the board will know when rates are not covering expenses.
    - B. categories of expenses and incomes so sources of income and major areas of expense can be evaluated for improvements before rates increases are considered.
    - C. only expense categories because rates can always be adjusted to provide enough income to equal expenses.
    - D. detailed depreciation schedules for every tool and every piece of equipment purchased, regardless of the cost.

2. A current ratio is a liquidity ratio that
    - A. measures a water system organization's ability to pay its current liabilities.
    - B. is defined as current assets/current liabilities.
    - C. is a measure of income compared to expenses.

3. A coverage ratio is
   A. a ratio that determines if you have enough basic insurance coverage.
   B. a ratio of total revenue to total costs.
   C. measures the ability to pay both principal and interest on all debts.
   D. a ratio of total revenue less total non-debt expense to debt service expense.

A water system has the following figures available to calculate the current and coverage ratios. Please answer questions 4 and 5 using the following figures:

total assets	$1,000,000
total revenue	250,000
current assets	150,000
current liabilities	125,000
total liabilities	750,000
total operating expenses	200,000
total debt expenses	20,000
total non-debt expenses	180,000

4. The current ratio is
   A. 7.50
   B. 1.33
   C. 1.2
   D. None of the above
5. The coverage ratio is
   A. 3.5
   B. 1.4
   C. 9.0
   D. None of the above

6. All water systems will legally be required to
   A. keep a financial statement available for inspection.
   B. maintain selected income and expense receipts.
   C. submit a prepared financial statement each year to the Department of Health.
   D. use the same record-keeping system that large systems now use.

7. Accurate financial record keeping
   A. should be a high priority of the board.
   B. is not necessary in determining the basis for setting rates.
   C. provides needed support for the board in conveying needs to the customers or association members.

8. Fixed costs are often used
   A. to form the foundation for scheduling rates based on the quantity of water used.
   B. to determine the amount of funds needed for utilities.
   C. to form the foundation for setting the base rate or basic charge portion of water bills.

9. Which of the following statements would likely improve the management of the water system and reduce costs to its users?
   A. requiring every separate user to have a meter
   B. having leak-detection and water-audit programs to prevent excess water losses
   C. keeping financial records for major expenses and income items and preparing annual budgets that include reserve funds for debt payments, replacements, and emergencies

10. Most of a rural water system's funds come from water bills, late charges, and reconnection fees. Other viable income sources that some water systems have used to increase incomes include the following:
    A. requiring meter deposits and original connection fees
    B. placing reserve funds in interest-earning accounts
    C. leasing specialized equipment for outside jobs when that equipment is idle

11. Which of the following statements should be a requirement for rural water systems in order to safeguard board members?
    A. maintain a complete set of financial records, giving proof of all purchases made and income received
    B. mandate independent financial audits annually
    C. require gun permits for all board members so they can carry concealed weapons if assaults are expected

12. Historically, rural water systems have been more successful and have had fewer problems with customers if they
    A. keep the financial condition of the organization to themselves and inform users only when there is a need to raise rates.
    B. have an open attitude, keep users informed on important business decisions, and communicate with the customers on a periodic basis during the year.
    C. mail the customers detailed records of every financial decision made at every board meeting.
    D. keep business records in a known location so customers can go to that location and review the records anytime during normal business hours.

Please review this exercise after the questions are answered; give yourself a grade. Think about the questions in terms of how some of these ideas could be used to improve your water system management.

■ Long-Range Planning: A Self-Assessment ■

Circle the following letters that correspond to true statements for your board.

1. Our board makes plans for our water system's expansion and improvements
   A. for a long-term period of more than 5 years and usually 8 to 10 years or more
   B. for about a 3-year planning period
   C. for a period of 2 years
   D. only for the next year
   E. only when pressured by the users or when problems arise

2. In planning budgets, our board
   A. has appointed members who work with financial records to get detailed income and expense information together, prepare planning budgets, and recommend rate changes which are presented to the board for study and approval.
   B. depends on income and expense reports from the manager who makes projections and prepares budgets and suggested rate changes which are submitted for board approval.
   C. does not look at expense and income records on a regular basis but depends on our manager and operator to make decisions on expansion and improvements needed.
   D. reviews our investment needs and rate structures every 3-5 years.
   E. reacts to emergencies in planning new investment, capital improvements, and rate changes.

3. Our rates
   A. are reviewed annually and adjusted if income, expense, and planned investments make it necessary.
   B. Annual reviews make adjustments in charges gradual and not unexpected.
   C. are reviewed every 2-3 years and adjusted if projected costs and revenues dictate a change.
   D. are adjusted when big expenses occur. Sometimes adjustments are unexpected and cause concern among our users or customers.
   E. are seldom adjusted, but when they are adjusted, bills almost double.
   F. are adjusted when money is short without much examination of records or budget planning.

4. Our rates, when compared to similar water systems are
   A. about average or lower than other systems and provide enough income for reserves without creating economic problems.
   B. slightly higher than other systems, but our financial condition is strong.
   C. considerably above other systems but provide enough income to keep us financially stable.
   D. much higher than other systems, but we still have financial problems.
   E. much higher than other systems, and our financial condition is poor.

5. Our rates
   A. include a base rate plus charges for gallons used beyond the base, and we have separate categories for household, farm, and industrial users, or our rates are set to account for differences in usage by farms and industries.
   B. include a base rate plus charges for additional use, but we do not differentiate between household, farm, and industrial users. Our rates are not set to account for farm and industrial water usage.
   C. include a base rate plus charges according to use, but our base rate is set so that most users pay only the base rate.
   D. include a base rate plus charges according to gallons used, but we have some problems with getting the meters read at proper intervals.
   E. are flat rates where all users pay the same each month regardless of water used.

6. In estimating the water wasted or lost in our water system, we
   A. require meters for every user, and we meter water leaving the main lines at the pump or tanks.
   B. meter every user, but do not have any way to check meter totals against water produced by the wells.
   C. We do keep up with estimates of water pumped and make loss estimates.
   D. meter all purchasers but not all users and make estimates of water used by those not metered and the total water pumped at each well to estimate water losses.
   E. have some users who are not metered, and we use secondary data to estimate water losses.
   F. do not meter uses and do not make water loss estimates.

7. Our board
   A. has an excellent knowledge of the current financial condition of our association or organization and the future plans for the water system.
   B. has a basic knowledge of the present financial condition and future plans for the water system.
   C. depends on the manager and board chairman to keep up with financial conditions and future needs of the water system, but other members are not that involved except to approve the actions recommended.
   D. does only an average job of keeping up with income and expenses of the water system and depends solely on the manager or bookkeeper to keep up with the finances and recommend improvements or expansions.
   E. does a poor job of keeping current on the financial condition of the organization and of being involved in planning future expenditures and income from the water system.

Budgeting

Budgeting is the process of estimating income and expenses for a future time period. Planning budgets may be for 1 year, for 3 years, for 10 years, or for any planning period the board thinks is appropriate. Budgets are planning tools. Your board should prepare an annual budget each year to assess the financial condition of the water association or water department. In fact, water system lenders, require systems to submit budget proposals and cash flow projections for approval within 1 month of each new fiscal year. Failure to do long-term budgeting can cause many problems such as a lack of funds for emergencies or expansions, poor purchasing patterns, and erratic rate setting. Budgets are plans with dollars attached. They give the following information:

- Here is what we plan to do.
- Here is what it is expected to cost.
- Here is where we will get our income.
- Here is the expected financial position of our water association or water department.

Cash-flow and income/expense budgeting are processes of examining expected cash expenses versus expected cash income. This procedure is very useful in evaluating rate structures.

Budgeting Is a Team Event

Get management and staff together for a work session to look at the last year’s expenses and discuss system needs for the next year. Hold another meeting in a few days for board members or staff to recommend changes to the budget

The Budget-Making Process

- Plan your budget to support your mission, which should be consumer oriented. The purpose of a budget is to accomplish ends that benefit customers.
- Develop policies that provide do's and don'ts about managing budgets and funds.
- Consider whether to pay off debt or to incur more.

During the early nineties, interest rates and the cost of indebtedness were extraordinarily low, but the economic crisis of the late 2000s brought a great deal of uncertainty to borrowing rates.

- Assess your monthly statistics to see if they are the right ones.
- Compare your budget categories with actual practices.
- Use your budget to spot trends. Try to assess how 2.5 percent population growth can increase demand for water in your water system

Using Budgets To Project Revenue and Expenditures

The purpose of financial budgeting is to predict the revenues and expenses of the firm over the planning horizon. If the budget development process is accurate, then the need to spend money that is not contained in the budget is minimized. A critical foundation of budget preparation is the accurate maintenance of financial records. Accurate records allow the system manager or board to understand how the utility's money has been spent over the past year, the needs of the utility that result from these expenditures and the prioritization of those needs.

Budget development has five parts:

- Establishing required debt service reserve levels
- Establishing system financial reserve levels
- Estimating the full cost of operating the system for the next year (including depreciation and obsolescence)
- Estimating system revenue from sale of water
- Adjusting revenues to cover estimated expenses.

Debt Service Reserve. If you borrowed money to build your system, your loan agreement requires you to have a Debt Service Reserve. The Debt Service Reserve is in addition to your loan repayment. The Debt Service Reserve ensures that you can make your debt payments on time even if you have a financial emergency. It should be noted that most lien holders prohibit withdrawals or transfers from a system's Debt Service Reserve without prior approval. Thus, Debt Service Reserves typically are restricted cash assets. If you do not have Debt Service Reserve, find your loan papers and determine how much you need to budget for the next year in order to start meeting your obligation.

System Financial Reserves. Your water system's equipment started to wear out the day water was turned on. With time, equipment will need to be changed and emergencies will happen. The only way to assure your customers of an uninterrupted supply of safe drinking water in the future is to set aside money each month to cover these costs. A System Financial Reserve Account can be set up at the bank in an interest-bearing savings account. Ideally, a system's budgeted depreciation expense is transferred monthly from the operating account to the Financial Reserve Account. This account is unrestricted cash and typically is used for three purposes: planned equipment repair and replacement, emergency repairs, and planned system expansion and improvements. To plan on equipment repair and replacement, make a list of major equipment.

Together with your operator, determine the time between breakdowns and the remaining life expectancy and replacement cost of each piece of major equipment. To estimate how much your system will need next year for emergency repairs, review what emergencies took place in the last 12-24 months and the cost of each to resolve. To plan future system expansions and improvements, estimate the cost of each future expansion the board has agreed to do. Determine how much you will set aside and how much you will finance. The next step in developing a budget is to estimate the full cost of operating your system next year. First, determine your expense categories. Expense categories are the major types of expenses your system has each year. You can review these categories from the budget for the previous year. If you do not have a budget, work with your bookkeeper to make a list of the major expenses your system has each year.

Typical Expense Budget Categories

- Annual Debt Service
- Salaries or Personnel Costs
- Office Utilities
- Operating Utilities
- Telephone Engineering
- Out-of-Town Travel
- Equipment Leases
- Insurance
- Office Rental
- Accounting Auditing, Legal, Engineering Services
- Telephone
- Operating Supplies
- Contract System Repairs

Annual Debt Service should be your first budget category. Examples of expenses in each budget category are given below:

Current Debt Service:

- Annual Payment on Bonds
- Interest and Interest Payment on Loans

Personnel Costs:

- Employee Salaries
- Payroll Taxes
- Workman's Compensation
- Employee Health Insurance Premiums

Insurance:

- Liability Insurance
- Vehicle Insurance
- Bonding of Employees
- Board Liability
- Insurance

Use the following worksheet to calculate how much financial reserves to include in next year's budget for each purpose.

Worksheet for figuring financial reserves

Financial Reserves

Part A: Calculating Planned Equipment Repair and Replacement

Annual Budget Amount = Replacement Cost + Years Remaining Life

Major Equipment:	**Years Remaining Life:**	**Replacement Cost Estimate:**	**Annual Amount To Budget:**
1.		SSD	SSD
2.		SSD	SSD
3.		SSD	SSD
	Total SSD		

Part B: Calculating Emergency Repairs

Potential Emergency		Estimated Costs
1.		
2.		
3.		
	Total SSD	

Part C: Calculating Planned System Expansion and Improvements

Annual Budget = Portion of Cost To Be Self-Financed ÷ Number of Years Until Start of Project

Proposed Capital Projects:	**Years Until Start of Project:**	**Portion To Be Self-Financed:**	**Annual Amount To Be Budgeted:**
		SSD	SSD
		SSD	SSD
		SSD	SSD
	Total SSD		

Table 9: Worksheet for figuring the expense budget

Expense Budget				
	Column A	Column B	Column C	Column D
Budget Category	Last Year's actual Expense $	Current Year's Expenses $	Changes in Next Year's Budget $	Next Year's Estim. Exp. $
1.Annual Debt Service				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
		Total Operating Expenses $		
Debt Service Reserve				
Debt	Total To Be Accumulated	Current Amount in Reserve Fund		Annual Installment
1.				
2.				
3.				
	Total Budgeted for All Debt Service Reserves $			
Financial Reserves				
1.Equipment Repair and Replacement				
2.Equipment Repair and Replacement $ Emergency Repair				
3.Planned Expansion and Improvements				
	Total Amount Budgeted for All Financial Reserves $			
	TOTAL ALL EXPENSES $			

Calculate last year's expenses on each of the proposed budget categories, which you can list in Table 4 in column A. Column B is your current year's expenses. You can calculate them by adding the actual expenses up to date to the estimated expenses for the remaining months of the year. Calculate how much you've spent this year in each budget category. If you are in month 9 of your fiscal year, divide total expenses to date in each category by 9 to get monthly average expenses. Multiply this number by 12 to get the current year's expenses. Record these expenses in column B. When you compare last year's expenses and the current year's expenses, you will notice changes in some categories. Your next year's expenses will change. Some will go up, and some will go down. Overall, the budget will probably increase. When filling out column C, think about expenses in each category that are likely to increase or decrease and by how much. Column C calls for decisions by the entire committee.

You've estimated current year expenses and changes in next year's budget. Now you can estimate next year's expenses. Take time to estimate each category of expense as accurately as possible. To estimate TOTAL ALL EXPENSES at the end of Table 9, do not forget to include the Debt Service Reserves and System Financial Reserves from Table 10.

Estimating System Revenue and Balancing the Budget

When estimating budget revenues, count only operating revenues. Most systems have two types of income – operating revenue and non-operating revenue.

Operating revenue comes from the following sources:

- sales of water
- connection fees
- late payments, penalties, and reconnection fees
- forfeited meter deposits.

Non-operating revenue comes from the following sources:

- interest on checking account
- interest on reserve account
- meter deposits.

Table 10: Worksheet for estimating next year's revenues

Column A Month	Column B Last Year's Revenue	Column C Current Year's Revenue	Column D Change in Revenue	Column E Next Year's Estim. Rev.
1.	$	$	$	$
2.	$	$	$	$
3.	$	$	$	$
4.	$	$	$	$
5.	$	$	$	$
6.	$	$	$	$
7.	$	$	$	$
8.	$	$	$	$
9.	$	$	$	$
10.	$	$	$	$
11.	$	$	$	$
12.	$	$	$	$
TOTAL				

Column B in Table 5 includes last year's operating revenues for each month. For column C, fill in operating expenses for each month you've completed. Add the columns, and divide the answer by the number of months added together. It will give you the average monthly revenue. Use this figure to complete remaining months of the current year. Column D is simply a difference between column B and column C. To figure next year's estimated revenue, look at the figures in columns B, C and D, and try to predict the change for the next year.

The following can affect revenue:

- Rate increase
- Drought
- Uncollected bills
- Losing customers
- New customers
- Temperature

Try to estimate revenues as accurately as possible. Add the total revenues to get a 12-month total for each column.

Monitoring the Budget

At this point, you've prepared your budget. Monitor the budget to keep your water system financially stable. Your bookkeeper must gather and report financial information to the board every month. Table 6 can be used to present the financial information. In sections I and II for column A, you use Revenue and Expense line items that you used in your budget. Section III represents your reserves. You should write a check monthly to Reserve Account equal to at least 1/12th of the budgeted amount. Section IV is the difference between your revenues and expenses plus reserves. If your revenues exceed expenses plus reserve, you have an operation gain; if not, you have an operation loss.

Table 11: Worksheet for calculating a monthly financial report

A	B	C	D	E	F[7]
Budget Category	Actual Current Month	Actual Year-to-date	Annual Budget	Projected Performance (C ÷ Month Number X 12)	Percent Budget D
REVENUES					
Water Sales					
Connection Charges					
Customer Deposits					
Other					
Subtotal Section I.					
II EXPENSES					
Subtotal Section II.					
III TRANSFERS TO RESERVES					
Customer Deposits					
Debt Service Reserve					
Financial Reserves					
Subtotal Section III.					
IV. OPERATION GAIN(LOSS)					
(Total = Section I - Section II + Section III)					
V. RESERVE ACCOUNT STATUS					
	Checking	Customer Deposits		Debt Service Reserve	Financial Reserve
Beginning of Period					
End of Period Change					
VI. TOTAL PAST DUE OWED					

In column B of Table 6, report amount of money the system actually received and spent during the month. Column C shows all revenues and expenses in all previous months of the fiscal year, including current

[7] To find percent budget, divide column C by column D.

month. Column D shows the budgeted numbers adopted by your board before the start of this fiscal year. To estimate column E (projected performance), divide each line item in column C by the number of the month for which you are preparing this report to find monthly average (for the month of June, divide by 6). Then multiply the monthly average by 12 to estimate the annual projected performance of each line item. Column F is the outcome of dividing column C by column D. This column should help you to monitor your performance and compare it with the budgeted amounts. Study this report carefully. Check whether revenues exceed expenses for the month. If not, analyze why not. See whether the transfers to reserves are being made. If some expenses are higher than budgeted, see what you should do to reduce them. Take actions on uncollected amounts from past due water bills. If needed, reduce or control expenditures and increase revenues.

Revisiting the Budget

Revisiting the annual budget is not recommended unless estimated revenues and expenses change significantly from actual revenues and expenses. Use Table 6 to guide you in reducing expenses and increasing revenues. Only in case of an increase in water rates, significant increase in operating costs, or a significant change in system revenues will you need to formally revisit the budget. Section V shows actual cash on hand. Section VI shows the total past due amounts customers owe to your system. Never should a water system's past due accounts receivable balance exceed 10 percent of the projected annual revenues. Calculate this total by using Table 7 shown below

Table 12: Sample of past due account summary

Date Prepared ______________________			
	Number of Accounts		Amount Due
Days Past Due			
0-30			
31-60			
61-90			
Over 90			
		Total $	

Capital Improvements and Long-Term Planning

Developing a Facility Master Plan

Most small systems develop a 5-year plan for future needs and revise this plan each year. A capital improvements fund must be a part of the utility budget and account for expanding service, upgrading quality of water treatment, and replacing worn-out equipment. A plan should contain a financial estimate for each year and possible sources of financing so that when the time comes, you will have money to pay for these improvements. The first step in the capital planning process is to evaluate carefully the various factors that can affect the type and size of the facilities or improvements your system will need in the future. These influential factors include the following:

- growth in demand for drinking water;
- deterioration of your system's major components;
- system's latest Sanitary Survey;
- requirements and methods of financing. The second step is to develop a facility master plan. Begin this by making a list of all improvements that need to be made over the next few years. Hold a meeting with your system operator, administrative staff, bookkeeper, board members, and a consulting engineer to identify capital improvements that will be needed within the next 5-year period. At the end, you will have a list of the capital items and rationale for determining why each is needed. You should then place the items in priority order and determine how much it's going to cost to meet each capital need.

Table 13: Sample of funds available

Funds Available To Meet Capital Needs SmallSYS #5 Inc.	
Annual revenues from water sales, current year	$83,500
Annual expenses (operating and debt), current year	76,000
Annual $ available for capital improvements	7,500
Annual $ appropriated for capital improvements	5,000
Total $ appropriated during 5-year period (5 x $5,000)	25,000
Plus:	
Current cash reserves	15,000
Cash reserves transferred for capital improvements	8,000
Total initial amount dedicated to capital improvements (line 5 + line 7)	$33,000

Determining Existing Resources

The purpose of identifying existing financial resources is to determine how much your system can fund using its own resources and how much you can finance from outside sources.
First, identify the dollar amount your system can devote to meeting capital improvement needs. Then, consider financial alternatives from outside, such as banks and state and federal programs.

Projecting Future Revenues and Expenses for a 5-Year Period

From the previous section, you have an initial amount dedicated to capital improvements over a 5-year period. However, to confirm this amount is actually available, it is necessary to project revenues, expenses, and reserve balances over the next 5 years. In making a 5-year financial projection, you will need to make assumptions about the system's future.

Some things that can be taken into consideration:

- Actual figures for revenues and expenses for the previous 3-5 years
- Would the average monthly water bill continue to be same amount per connection
- The number of new customers who will be added to the system, and how much revenue and costs will increase because of them.

Line 1 in Table 9 shows the numbers for projected total annual revenues. The number for the current year is $83,500, and this number is taken from Table 6. To come up with figures for Year 2, the planning committee of this water system followed the assumption that they would add 15 new customers the first year. The revenues from those connections, $4,050/year ($22.50 x 12 months x 15 customers), were added to the first year's revenue ($83,500 + $4,050 = $87,550). This number was multiplied by 0.005 (the half of one percent assumed growth in revenue annually) and added to the first year's revenue to find the projected revenue for Year 2, which is $83,938 ($87,550 x 0.005 = $438; $438 + $83,500 = $83,938). The third year revenue was calculated by multiplying revenue for Year 2 by 0.005 and adding this number to the second year's revenue: $83,938 x 0.005 = $420; $420 + $83,938 = $84,358

Try to calculate the revenue for the remaining years in Line 1. The last column in Line 1 is the total revenue for 5 years.

Line 2 shows projected total operating and debt expenses. The number for current year expenses is taken from Table 6. To determine expenses for Year 2, multiply expenses for Year 1 by 0.02 (2% increase in yearly expenses is assumed). This increase was added to the first year's expense: $76,000 x 0.02 = $1,520
$1,520 + $76,000 = $77, 520

Each year's total was projected by multiplying the previous year's total by 0.02. The last column in Line 2 shows the total expenses for 5 years.

Line 3 is the difference between Line 1 and Line 2 in each column. This figure represents the total surplus in operating revenue for each year.

Line 4 represents the amount that you have decided to dedicate to capital projects each year of the planning period. Using Table 8, this amount is $5,000 per year.
Because the operating surplus for Years 4 and 5 is less than $5,000, put in the Line 4 amount from Line 3 for these years.

Now you are ready to complete the table of financial projections.

Table 14: Sample of financial projections

Projected Funds Available for Capital Improvements - 5 Years SmallSys. # 5 Inc.							
	Current Year $	Year 2 $	Year 3 $	Year 4 $	Year 5 $	Year 6 $	Totals $
Projected Total Annual Revenues (Enter Current Amount Projected at One-half of 1% per Year [.005])	83,500	83,938	84,358	84,779	85,203		421,778
Projected Total Operating & Debt	76,000	77,520	79,070	80,651	82,264		395,505
Service Expenses (Enter Current Amount Projected at 2% per Year [.02])							
(3) Projected: Operating Surpluses or Deficits (Line 1 Minus Line 2 Equals Line 3)	7,500	6,418	5,288	4,128	2,939		26,273
(4) Annual Amount: Transferred to Capital (Enter Current Year - Project Future Years at $7,000/Year)	5,000	5,000	5,000	4,128	2,939		22,067
(5) Excess Revenues: Transferred to Reserves (Line 3 Minus Line 4 Equals Line 5)	2,500	1,418	288	0	0		4,206
(6) Current Year: System Reserves (Enter Current Balance)	15,000						N/A
(7) Current Year Amount: Transferred to Capital (Enter Current Year Transfer)	8,000						8,000
(8) Current Year Balance: System Reserves (Line 6 Minus Line 7 Equals Line 8)	7,000						N/A
(9) Projected System Reserve Balances (Add Year End Totals From Line 5 to		9,500	10,918	11,206	11,206		N/A

Current and Future Year Balances)							
(10) Future Reserve Balances Transferred to Capital (Enter Capital Transfer Amounts for Future Years)					5,500		5,500
(11) Ending Balance-System Reserves Year 6 (Year 5, Line 9 Minus Line 10, Insert Result in Year 6)						5,706	N/A
(12) Projected: Total Capital Funds Available per Year (Add Lines 4, 7, and 10)	13,000	5,000	5,000	4,128	8,439		
Total Capital - 5 Years							**35,567**

Line 5 is the difference between Line 3 minus the projected operating surplus and Line 4 minus the annual amount transferred to capital.

Line 6 shows the amount of reserves accumulated.
The number in **Line 7** is taken from Table 8 and equals $8,000, which is cash reserves. SmallSys # 5 Inc. decided to transfer $15,000 from the cash reserves.

Line 8 is the difference between Line 6 and Line 7, $15,000 – $8,000 = $7,000.

Line 9 is calculated by adding $2,500 (Line 5) to $7,000 (Line 8). This equals $9,500, which is the reserve balance for Year 2. Add this number to the excess revenues transferred to reserves for Year 2 to get the projected system reserve balance for Year 3 ($9,500 + $1,418 = $10,918). And so on for all 5 years. In Year 5, this water system has projected a reserve balance of $11,206. The system transferred $5,500 of the excess reserves to capital improvements in Year 5.

Line 10 shows the future reserve balances transferred to capital and equals $5,500 in Year 5. The amount is based on the assumption that the system will grow and incur additional costs related to the expansion.

Line 11 is the difference between Line 9 and Line 10 for Year 5. Put this number in the column for Year 6 ($11,206 – $5,500 = $5,706).

Line 12 is the sum of all amounts shown in Lines 4, 7, and 10. At the end of the table, show the Total Capital for 5 years: $13,000+$5,000+$5,000+$4,128+$8,439= $35,567

Create an identical table for your system to project funds for capital improvements.

Setting Your Spending Priorities

In setting spending priorities for capital items, you will weigh the importance of meeting capital needs in terms of the following factors:

Relative Importance of the Need. You would answer questions such as the following: What is absolutely essential to undertake? And why? Which improvements directly impact the health of the customers? Which improvements have been mandated by the state regulatory agency or as a result of water quality testing? What is the deadline that the system must meet for mandated projects? What are the consequences of not undertaking each proposed improvement?

Relative Benefits to the System and Customers. Which projects would provide the greatest benefit to your customers? Which projects would help increase revenues or decrease operating expenses of the system?

Relative Costs of Improvements. Can urgent improvement be funded in-house? Which projects require outside financing? For the projects requiring financing, is it available? What are the terms of financing? Should the system consider a possible rate increase to finance the "high" cost projects?

Time. How urgent is it to meet each capital need or improvement? Is there a deadline from regulators for some projects? Are the costs required to meet a particular need likely to increase over time?

Types of Needs

Critical Needs. Critical needs are those projects that are absolutely essential to complete. Critical projects are those that have a direct impact on public health or a great negative impact on the system if they are not completed.

Urgent Needs. Urgent needs are those needs that are required for the system to meet mandated deadlines for completion. Consider projects urgent if they have been delayed for a long time, or if their cost will increase considerably if you hold off. Some projects can be considered critical and urgent at the same time. Replacement of a flow meter or chlorinator could be critical and urgent.

Table 15: Sample of prioritizing needs

Capital Needs/Projects	Total Estimated Cost
Critical and Urgent Needs	
Replace Flow Meter on Well #1	$1,800
Replace Chlorinator on Well #2	2,000
Critical Needs	
Storage Facilities:	
Clean/Paint/Repair Water Tank	35,000
Urgent Needs	
Distribution:	
Add 15 New Customers (Line Extension/Adjusted Cost)	2,490
Implement Urgent Meter Change-Out Program	5,639
Other Important Needs	
Equipment:	
Backhoe Acquisition (On Hold)	0
Administration	
Computer and Software Acquisition	2,800
Total Estimated Cost	**$49,729**

Use the following table for prioritizing needs. Your water system will have different critical and urgent needs; examples are given for illustration only. You are ready to begin scheduling projects.

Table 16: Sample of scheduling capital projects and defining financial strategies

Schedule and Financing Plan for Capital Improvements SmallSys Inc. # 5									
	Total Cost		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	
Capital Needs		Beginning Balance	$13,000	$5,000	$5,000	$4,128	$8,439	0	Totals
		Carryover Funds from Prev. Year	0	6,710	11,710	16,710	20,838	0	
		Loan Capital-Outside Financing	0	0		0	0	0	
		Total Available -This Year	13,000	11,710	16,710	20,838	29,277	0	
Critical and Urgent Needs									
a) Replace Flow Meter on Well #1	$1,800	Project Completed - Year 1	$1,800						$1,800
b) Replace Chlorinator on Well # 2	2,000	Project Completed - Year 1	2,000						2,000
Critical Needs									
a) Clean/Paint/Repair Water Tank	35,000	To Be Completed - ?					35,000		35,000
Urgent Needs									
a) Add 15 New Customers (Line Extension)	2,490	Project Completed - Year 1	2,490						2,490
b) Implement Urgent Meter Change-Out Program	5,639	Project Completed - Year 5					5,639		5,639
Other Important Needs									
Computer & Software Acquisition	2,800	To Be Acquired - Year 5					2,800		2,800
Total Estimated Cost	$49,729	Total Expenditures/This Year	$6,290	0	0	0	$43,439	0	**$49,729**
		Balance - Year End	$6,710	$11,710	$16,710	$20,838	$(14,162)	0	

The first two columns of this table are copied from Table 10. Using Table 9, take numbers from Line 12 and put them in the beginning balance category in this table. There were no carryover funds and loan capital for the first year. Thus, total available for this year is $13,000. List projects and their costs that are to be completed in this first year. Place the total costs of the projects in the total expenditures category in the Year 1 column ($1,800 + $2,000 + $2,490 = $6,290). The next category is the balance year end. It is the difference between the total available this year and the total expenditures line. Put this number in the category carryover funds from previous year. To calculate the totals column at the far right of the table, add each project cost for 5 years. Then sum the projects' costs in the totals column.

After the evaluation of this table, the planning committee decided that the tank project should be completed after 4 years. Because there will not be enough funds created by that time to cover the cost of this project, the system faces three possible choices: raise water rates to accumulate reserves more quickly, pull money out of the system's operating reserves, or borrow money to complete the projects. The planning committee decided to borrow funds from an outside source. The system will need to borrow $14,162.

Table 17: Sample of scheduling capital projects and defining financial strategies with outside financing

Schedule and Financing Plan for Capital Improvements With Outside Financing SmallSys Inc. # 5									
	Total Cost		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	
Capital Needs		Beginning Balance	$13,000	$5,000	$5,000	$4,128	$8,439	0	
		Carryover Funds From Prev.Year	0	6,710	11,710	16,710	20,838	0	
		Loan Capital-Outside Financing	0	0		14,162	0	0	Totals
		Total Available - This Year	13,000	11,710	16,710	35,000	8,439	0	
Critical and Urgent Needs									
c) Replace Flow Meter on Well #1	$1,800	Project Completed - Year 1	$1,800						$1,800
d) Replace Chlorinator on Well # 2	2,000	Project Completed - Year 1	2,000						2,000
Critical Needs									
b) Clean/Paint/Repair Water Tank	35,000	Project Completed - Year 4					35,000		35,000
Urgent Needs									
c) Add 15 New Customers (Line Extension)	2,490	Project Completed - Year 1	2,490						2,490
d) Implement Urgent Meter Change-Out Program	5,639	Project Completed - Year 5					5,639		5,639
Other Important Needs									
Computer & Software Acquisition	2,800	To Be Acquired - Year 5					2,800		2,800
Total Estimated Cost	$49,729	Total Expenditures/This Year	$6,290	0	0	$35,000	$8,439	0	**$49,729**

Because repayment of the loan will begin in Year 5, go back to Table 11 and make some changes: $14,162 was borrowed in Year 4. This loan would come from a loan program administered by a state agency. This amount would be repaid at a 5 percent interest rate over a period of 5 years. Repayment will start in Year 5 with annual repayment of $3,090, as determined by the bank. After revising Table 9 to accommodate the loan repayment of $3,090, the number for Line 2 of the column Year 5 of Table 13 will change. Add to this number the amount of the loan repayment ($82,264 + $3,090 = $85,354). Line 3 of Table 13 will change ($85,203 – $85,354 = –$151). The last column of totals will change. At the end of Year 5 in Table 12 $5,639 will be available. You may want to pay back your loan more quickly than was originally planned, or another critical or urgent project might appear in a couple of years.

Table 9 and Table 11 are very important tables. You will update these tables over time. You can add a new Year 5 after completing Year 1, and continue to use these tables for future planning.

Table 18: Sample of capital improvement plan

Projected Funds Available for Capital Improvements - 5 Years SmallSys. # 5 Inc.							
	Current Year $	Year 2 $	Year 3 $	Year 4 $	Year 5 $	Year 6 $	Totals $
Projected Total Annual Revenues (Enter Current Amount Projected at One-half of 1% per Year [.005])	83,500	83,938	84,358	84,779	85,203		421,778
Projected Total Operating & Debt	76,000	77,520	79,070	80,651	85,354		398,595
Service Expenses (Enter Current Amount Projected at 2% per Year [.02])							
(3) Projected: Operating Surpluses or Deficits (Line 1 Minus Line 2 Equals Line 3)	7,500	6,418	5,288	4,128	(151)		23,183
(4) Annual Amount: Transferred to Capital (Enter Current Year - Project Future Years at $7,000/Year)	5,000	5,000	5,000	4,128	2,939		22,067
(5) Excess Revenues: Transferred to Reserves (Line 3 Minus Line 4 Equals Line 5)	2,500	1,418	288	0	(3,090)		4,206
(6) Current Year: System Reserves (Enter Current Balance)	15,000						N/A

(7) Current Year Amount: Transferred to Capital (Enter Current Year Transfer)	8,000						8,000
(8) Current Year Balance: System Reserves (Line 6 Minus Line 7 Equals Line 8)	7,000						N/A
(9) Projected System Reserve Balances (Add Year End Totals From Line 5 to Current and Future Year Balances)		9,500	10,918	11,206	8,116		N/A
(10) Future Reserve Balances Transferred to Capital (Enter Capital Transfer Amounts for Future Years)				14,162	5,500		19,662
(11) Ending Balance-System Reserves Year 6 (Year 5, Line 9 Minus Line 10, Insert Result in Year 6)						2,616	N/A
(12) Projected: Total Capital Funds Available per Year (Add Lines 4, 7, and 10)	13,000	5,000	5,000	18,290	8,439		
Total Capital - 5 Years							**49,729**

Asset Management

One of the most important issues facing public water systems in today's environment involves managing the system's assets in order for the system to become or remain sustainable and to continue to provide a safe and affordable supply of drinking water to residents. Asset management, also called life cycle management or capital budgeting, is a comprehensive planning process that involves inventorying assets of the water system, evaluating the likelihood of those assets' failure in a specified time frame, and developing a method for replacing or refurbishing those assets.

The Process

As previously mentioned, the asset management process consists of three basic steps. The overarching goal of the process is to supplement the systems long-term financial plan.

Inventorying Assets

The first step in the process is to inventory the system's assets. These assets include storage tanks, treatment equipment and facilities, distribution lines, meters and hydrants. There are several factors to consider when inventorying these assets, including:

The current asset replacement or refurbishment cost

The current age of the asset (typically expressed in years)

The current condition of the asset. This can be done on any type of scale you care to use. A common method is to use a scale of 1 to 5 with 1 signifying that the asset is in very poor condition and 5 indicating a very good condition.

The expected life of the asset. This is not the depreciable life that is listed in the Internal Revenue Service tax tables, but rather the expected serviceable life. Two significant factors that affect this life are the quality of the raw water that is being treated and the quality of maintenance that has been performed on the equipment or facilities in the past.

Sources for this type of information include the professional experience of your certified waterworks operator or other operators in the region and your consulting engineer.

Developing an inventory of the major system assets such as storage tanks, filters, wells, pumps, etc., is relatively simple due to the low number of these assets on each system. For most systems, inventorying assets such as distribution lines, meters, and fire hydrants would be a very challenging task. Therefore, most systems divide their lines into an area or section scheme (commonly distribution loops or trunks) and attempt to implement regular line and meter change out policies on a rotating basis for each area.

Prioritizing Assets

After the system inventory has been developed, the next challenge is to determine the most likely failure points. While much of this could be accomplished reasonably well by a cursory examination of the system inventory, a more objective method may be to multiply the asset's condition score by its expected remaining life (the asset's expected life minus its age).

This calculation provides a guide to identify assets that need more immediate attention. A relatively low score suggests that the asset is due for replacement or refurbishment fairly soon. Higher scores suggest that asset replacement or refurbishment is not as immediate a concern.

The following table provides an example of how assets might be prioritized.

Table 19: Remaining Condition Prioritization

Asset	Life	Score	Score
Elevated Storage Tank	25	5	125
Chlorinator Heads	3	2	6
Line Segment 1	20	4	80
Line Segment 1	4	1	4

In this example, we can see that the two assets requiring more immediate attention are the chlorinator heads and Line Segment 2. While in this simple example, it is fairly obvious that concern for the elevated storage tank and Line Segment 1 can be postponed due to their expected remaining lives, an objective approach such as this provides a more concrete guide to asset management than cursory examinations. Once the assets are prioritized for replacement or refurbishment, the system then needs to develop a strategy for acquiring the funds needed for replacement or refurbishment. A fairly prevalent strategy in the past has been to rely on grants to fund projects, but this type of strategy will likely not be feasible in the future.

While the system inventory and prioritization tasks are likely to be the responsibility of the certified waterworks operator, the decisions regarding funding must be made and implemented by the board. Given the declining availability of hundred percent grants and forgiveness loans, the board must likely decide on whether to pay for the asset's replacement/ refurbishment from its own funds or to supplement a loan with existing funds. In either case, the board must develop a strategy to accumulate sufficient funds to implement the strategy. This will likely involve the establishment of a set aside or "sinking" fund that has a sole purpose of financing the system's asset management strategies. There are several steps involved in the funding decisions. The first step is to determine the expected remaining useful life of the asset in its present state. This provides a guide to the time available to accumulate the funds.

Next, determine the likely cost of the asset's replacement or refurbishment. In calculating this cost, it is important to remember that the asset's original price is irrelevant. Through the counsel of your certified waterworks operator, consulting engineer and vendors, ascertain the present cost of replacement or refurbishment. Then develop an estimate of the annual percentage increase in this cost.

This estimate can be developed in several ways. The most accurate method may be to get the asset's cost for the past few years from vendors and use an average of these annual price increases as an estimate of the asset's inflation rate. This type of estimate is particularly useful if the asset is to be replaced. If the system is going to use the same type (size, construction, etc.) of asset as replacement, a good indicator of the annual percentage price increase would be to subtract the asset's original cost from its current cost and divide that ratio by the asset's age in years. This yields the average price increase per year. Dividing the average annual price increase by the original purchase price provides the annual percentage increase in the cost of the asset.
For refurbishment, the information contained in the previous example may be difficult to obtain. In this case, an annual average of the overall inflation rate for the past several years could be the best estimate to use as a guide in making the funding level decision. Regardless of the method of estimation chosen, remember that like any other part of the long-range financial plan, the cost increase numbers that are used must be updated (at least) annually in order to be effective. After the annual cost rate has been determined, it is possible to estimate a future cost for the asset. To do this, multiply the current asset cost by one plus the annual percentage increase for the number of years in the remaining life of the asset. For example, if the cost of a chlorinator head is $2,000 and its expected remaining life is 4 years, then the expected future cost of the chlorinator (assuming that you expect the cost of the heads to increase 3 percent each year) is:
$\$2,251 = \$2,000 \times (1+0.03) \times (1+0.03) \times (1+0.03) \times (1+0.03) = \$2,000 \times (1+0.03)4$

Now that we know the asset's expected remaining life and future cost, we need to begin the hard part: developing a plan to finance our asset replacement/refurbishment strategies.
The initial step in developing this plan is to examine each asset's information individually and determine a feasible strategy for paying for that asset. Given our previous assumption regarding the future availability of 100 percent grants (and loans), we will limit our funding discussion to setting aside system monies to at least partially offset the amount of loan funding that will be required. There are several factors that will determine the level of system funding that is desired for asset replacement and refurbishment. External factors such as the cost of credit (the interest rate charged by the financing institution) and the availability of credit are factors that the water system cannot influence, at least in the short term.
However, the system can affect some of the internal factors that influence the level of funding that can be set aside and, in turn, the amount that will have to be borrowed. The first of these is its capacity for not

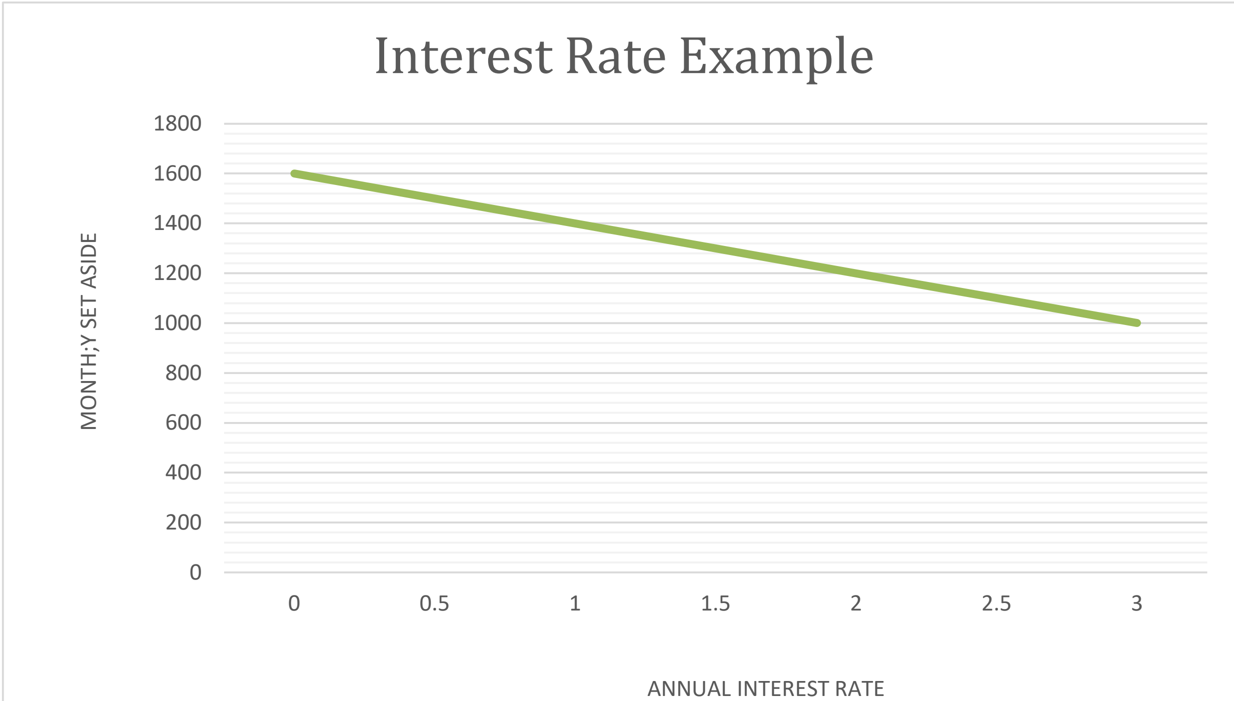
only increasing the amount that the system contributes toward the replacement or refurbishment of a major asset, but will also increase the willingness (and therefore lower the cost) of financial agencies to lend capital to the system. This capacity can be increased in two distinct ways. All too often, we think about the revenue side of the system and assume that increasing rates is the optimal way to increase the nonprofit system's carryover funds. Rates are very important and should be examined regularly to determine if there is a need for adjustment.

However, expenses should also be regularly examined in order to determine if the management has been good stewards of the system's resources. A good customer relationship strategy would be to publicize the fact that the system's board regularly undergoes a comprehensive review of expenses in order to be able to cut the cost of water to its customers. The review may not result in cost savings in any given year, but your customers will always appreciate a good faith effort to save their funds.

Once the future asset cost has been estimated and the amount that the system will contribute toward replacement or refurbishment costs has been determined, then the system must determine the method that it will use to accumulate the funds necessary to reach these goals.
Let's assume an example of an elevated storage tank that will need to be replaced in 20 years. If the current cost of the tank is $600,000 and we expect the average cost of tanks to rise three percent per year, then we can estimate that the future cost of the tank is $1,083,667.

If our goal is to borrow $700,000 in 20 years, then we need to accumulate $383,667 of system funds. An easy way of estimating the amount of our set-aside funding is to divide this goal by the number of years (20) or months (240) to determine the amount invested in the set-aside account each year or month.

However, this method ignores the "magic" of compounded interest. If the system is diligent in maintaining the set-aside fund, then compounded interest can greatly reduce the amount that is required to be saved to meet the asset management goals. In our example, setting aside the $383,667 needed in 20 years to purchase a new tank would require approximately $1,600 per month if the funds were deposited into a checking account that earned no interest. However, even with low interest rates (for our example, use a 2 percent annual rate), then the amount required to be set aside each month would only need to be $1,300. The following graphic demonstrates the effect of changing interest rates on the amount of monthly investments to the set-aside fund that would have to be made for this example. While it would be to the system's benefit to set more dollars than are needed aside to fund future planned improvements and unplanned emergencies, the system can save $72,000 by investing the funds in a stable, safe instrument. The following chart shows the amount of funds that would need to be invested in the set-aside account each month for our example using various interest rates.



Long-Range Financial Planning: A Learning Exercise ■

Please respond to the following statements and questions. Circle the letter or letters for the correct answer or answers.

Statements and questions may have more than one correct answer.

1. The major planning steps in the budgeting and rate setting process are done in this order:
   A. examining the current water use, examining the current income and expenses, looking at the future of the region and the impact of changes on the rural water service area, planning replacements and additions to be made to the system, projecting annual costs, and setting rates to cover these costs.
   B. estimating changes in the system, identifying current income and expenses, and setting rates to cover the expenses.
   C. increasing rates, comparing receipts to costs, and adjusting costs to equal expected receipts.
   D. projecting changes and their impact on the service area, projecting customer additions to the water system, comparing the costs of adding new customers to the additional revenues received, and adjusting the rates if necessary.

2. Before making a decision on rate changes, the board should make sure that
   A. the collection policies and procedures are such that all the income due is being collected each month.
   B. the water system is consistently monitored for water losses and an ongoing leak detection program is followed.
   C. the amounts budgeted for reserve funds and/or debt payments are sufficient to pay all note payments and to build enough funds for replacements and expansions of the water system.
   D. none of the above.

3. In the future, rural water associations and small town water departments should:
   A. deduct expected grants from annual expenses before considering rate changes.
   B. expect grant funds to expand and expect grant proposals to cover all major replacements and added wells, tanks, and lines.
   C. adjust income needs only for grants already received.
   D. discontinue its practice of applying for grants because grant funds are shrinking.

4. In setting rates, the boards of rural water systems should
   A. recommend rates that produce enough income to equal all expenses for the year including the total costs of replacing wells and tanks scheduled for replacement for that same year.
   B. recommend rates that cover only the variable costs for the year.
   C. recommend rates that cover all expenses except those expected to be offset by grants or loans.
   D. recommend rates that cover all annual costs including debt payments and contributions to a reserve account.

5. Board member I.M. Helpful has been given the responsibility of determining the costs that must be covered by the funds from water bills. The Rubkona board of directors has the following information from their records:

Cost of new well and pump	$200,000	Outstanding debt	100,000
Annual note payments	25,000	Price of new truck	40,000
Reserve fund for emergencies	30,000	Annual equipment expenses	50,000
Personnel expenses	60,000	Utilities	10,000
Supplies for the year	15,000	Expected bank deposits	210,000
Office expenses	10,000		

6. What is the total that should be used for determining rate schedules?
   A. $300,000
   B. $740,000
   C. $200,000
   D. $440,000

7. Boards of nonprofit rural water associations in planning their business operations
   A. cannot accumulate funds for reserves because this is considered profit and is illegal.
   B. should not borrow money under any circumstances because paying back notes and paying interest are never good board decisions.
   C. should always keep the rates as low as possible even if this means not providing funds for reserve accounts.
   D. Should always budget for reserves and should not be opposed to having outstanding loans when the long-term best interest of the association is being served.

8. Setting a flat charge so that every customer or water user pays the same amount each month
   A. always saves money for the organization because meters do not have to be purchased and no one has to be paid for reading meters.
   B. usually is more costly in the long run because big consumers do not pay their fair share, water is wasted, and there is usually excessive wear and tear on the water system.
   C. makes it much easier for the board to make decisions regarding new water demands and identifying new wells that are needed.
   D. gives users an incentive to reduce the amount of water used so that everyone's rates can be lowered.

9. If water tables are being rapidly lowered each year, the number of customers is rapidly increasing, and the supply of water is a major concern, a rural water system board would logically select
   A. a decreasing rate schedule.
   B. an increasing rate schedule.
   C. a uniform rate schedule.
   D. no particular rate scheme because monitoring is needed, and the structure of the rate schedule has no impact on water consumption.

10. In making sound business decisions rural water system managers and boards would select this order of business:
    A. plan system changes, set rates, select record-keeping system, determine present expenses and income, examine projected demographic changes, and prepare a planning budget.
    B. determine present expenses and income, examine demographic changes, plan the budget, select the record-keeping system, plan the water system changes, and set rates.
    C. select the record-keeping system, determine present expenses and incomes, examine demographic changes, plan the water system changes, prepare the budget, and set rates.
    D. none of the above.

11. The rate schedule for the Big Usesome Water Association is a $10 base charge for the first 2,000 gallons, $2per 1,000 gallons from 2,000 - 10,000 gallons, and $1 per 1,000 gallons for all usage over 10,000 gallons. If Mr. B.G. Dripp's consumption for the month was 28,000 gallons, then his monthly water bill would be
    A. $48
    B. $58
    C. $44
    D. none of the above

12. The rate schedule for the Bone Dry Water Association is $12 for the first 1,500 gallons, $3 per 1,000 for 1,500 - 7,500 gallons, $4 per 1,000 for 7,500 - 19,500 gallons, and $8 per 1,000 for all over 19,500 gallons. Mr. N.A. Bind filled his small fish pond in August and used 44,500 gallons for that month. His water bill for August was
    A. $278
    B. $313
    C. $54
    D. none of the above.

13. The Prudent Home Water Board estimated that the projected total annual costs for determining their rate schedule was $216,000, with one-third of these costs being fixed costs. The average household uses 10,000 gallons of water per month, and there will be 600 customers. The board wants to select the best rate schedule, and this selection is likely to be
    A. $12 for the first 2,000 gallons and $2 per 1,000 for all over 2,000 gallons.
    B. $20 for the first 2,000 gallons and $1.25 per 1,000 for all over 2,000 gallons.
    C. $10 for the first 2,000 gallons and $2.50 per 1,000 for all over 2,000 gallons.
    D. none of the above.

14. In examining the business operations of a small rural water system, when costs are believed to be rising too rapidly the first priority should be
    A. increasing rates
    B. analyzing which costs are increasing, finding out why costs are increasing, and looking for ways to reduce costs
    C. deciding if customer income levels have risen enough to justify rate increases
    D. examining other ways to raise incomes before looking at rates

15. Historically, rural water systems have been more successful and have had less problems with customers if they
    A. keep the financial condition of the organization to themselves and inform users only when there is a need to raise rates.
    B. have an open attitude, keep users informed on important business decisions, and communicate with the customers on a periodic basis during the year.
    C. mail the customers detailed records of every financial decision made at every board meeting.
    D. keep business records in a known location so customers can come to that location and review records anytime scheduled during normal business hours.

Please review this exam after the questions are answered, and give yourself a grade. Think about the questions in terms of how some of these ideas could be used to improve your water system management.

Rates

If a thorough examination of the system's finances indicates that a rate adjustment is in order, then the system should look at both its rate structure and water levels to ensure that its long-term goals and objectives can be met.

Considerations for Selecting a Rate Structure

When considering a rate structure for your system, consider the following questions carefully:

- Does the rate structure accommodate the current and anticipated expenses?
- Does the rate structure promote water conservation?
- Is the rate structure fair to every category of customer?
- Does the rate structure generate enough income after the base minimum is set?

System expenses. It isn't enough for a system simply to "break even" in its business operations. Systems must also be financially prepared to pay for expenses over which they have little control. There are many system expenses, such as:

- Increases in treatment costs, electricity bills, equipment repair and maintenance, etc.
- Seasonal changes in water use
- Natural disasters such as flooding or drought
- Emergencies
- Escalating insurance rates
- Changes in customer demand

Promoting conservation. In many areas, groundwater sources are becoming more difficult to find and are more costly to treat because of stricter National Government and state regulations and contamination. For all systems, water conservation is becoming a more serious concern. As the comparison of water rates on the following pages will show, some rates encourage customers to save water, whereas others may actually encourage customers to waste it. Customer account categories. Not all customers have the same needs. Because of this, it would not be fair to place all customers in the same broad category. For example, a family of three doesn't place the same demands on a system as an area concrete company does, using thousands of gallons each day. The categories of customer accounts are the following:

- Residential
- Public service
- Commercial
- Industrial/agricultural

Residential customers include owners or renters of homes and mobile homes. Often, the majority of water system customers are residential customers.

Public service customers are agencies and organizations that provide special community services. Public service customers may also include neighboring communities or bulk purchasers. Public service customers include the following:

- Fire departments
- Flushing the Water Utilities
- Back-washing filters

Commercial customers include small businesses, restaurants, and mobile home parks on a single master meter.

Industrial/agricultural customers may use more water than the other three categories combined. Industrial customers may use water for manufacturing or construction.
Agricultural customers may include dairies and feed lots. Base minimum. Before you decide which rate structure to use, consider setting a base minimum. A base minimum is the first component of all rate structures except for the one-charge or blanket rate. Base means the customer pays a minimum rate regardless of the amount of water used. This minimum covers a major portion of a system's costs. It generates enough income to cover fixed expenses of a system, such as insurance, bond payments, and other nonproduction costs.
Once you have identified your system's needs, conservation policy, categories of customers, and base minimum, you are ready to select a rate structure.

Projecting Revenue from Rate Schedules

The accuracy of a Board's revenue projection depends on maintaining detailed records of water use. Accurate records of total gallons sold for each rate is essential. Having customer profiles on water usage adds to the accuracy of estimating future customer usage. The more detailed the information, the more accurate the results; but more details require proper recording forms that categorize customers according to the amount of water consumed on a monthly and yearly basis. If customer profiles are not available, water consumption by base charges and by rate classification is necessary. Blank tables in the Appendix are for estimating water production, listing loans and grants, for budgeting and planning, and for setting water rates. If there is no computerized program for doing this, then the proper rate has to be selected by trial and error.

How Much Do We Charge?

The total cost of operation for your system and your projections for the future will dictate how much income your system needs. Rates should be set based on actual expenses of the system, depreciation, and the needs for the next year. You can use a financial audit to determine the amount your system needs to generate. When you determine the amount, you may want to examine the types of rate structures used to generate income. In what follows, you will learn more about how to select a rate structure that meets the needs of your system.

Now we will examine five basic types of rate structures. Each one will be evaluated according to how well it covers system needs, how well it encourages water conservation, and how fair it is to customers. These rates are as follows:

- Flat rates
- Block rates
    - Decreasing block rates
    - Increasing block rates
    - Uniform rates
        - Fixed Minimum Charge
        - No Minimum Charge

Flat Rates. Flat rates are the most basic type of water rate. This rate structure is sometimes referred to as a one-charge or blanket rate. Systems with flat rates charge every customer the same amount for water each month regardless of how much is used. A flat rate is the simplest rate structure for a system to administer. Billing does not change from one period to the next, and the system doesn't have to buy, read, or maintain meters. The following the disadvantages of the flat rate structure:

Income vs. Expenses: Poor. Flat rates may not provide systems with the necessary money they need to cover system needs and expenses. During the summer, when water usage is higher, production costs increase, whereas income remains the same.

Conservation: Poor. Flat rates encourage waste. Regardless of how much customers use, their bills will always be the same. A flat rate may place an added burden on a system's wastewater system. Because systems using flat rates seldom use meters, operators may be unaware of costly leaks and other causes of water loss. Because repaired leaks do not affect the income of the system, there is less incentive for the system to find and repair leaks.

Fairness to Customers: Poor. Flat rates are unfair to different customer categories. In a flat rate structure, a single customer using only 100 gallons a day pays the same as a local industry that uses thousands of gallons of water each day.

Decreasing Block Rates. In a decreasing block rate structure (sometimes referred to as declining or descending), each additional unit (typically 1,000 gallons) of water costs less than the previous units the customer used. A base minimum may also be used in the decreasing block rate structure. Here is an example of a decreasing block rate structure with a base minimum:

Amount	Unit Price
First 2,000 gal	$13.00
Next 1,000 gal	$2.50
Next 1,000 gal	$2.00
Next 1,000 gal	$1.50

Decreasing block rates are commonly used, but they are currently becoming less popular in drought-common areas.

Income vs. Expenses: Fair. A decreasing block rate is somewhat better than a flat rate when it comes to matching income to expenses. If organized carefully, a decreasing block rate can adequately pay a system's expenses, but it may not provide enough income to cover unexpected demands and future needs.

Conservation: Poor. Decreasing block rates actually discourage water conservation. To the customers, the more they use, the less they will have to pay for it. Because of this attitude, many water systems in states where water shortages are common have abandoned the decreasing block rate structure.

Fairness to Customers: Fair. Decreasing block rates may be unreasonable for small household customers. People who only use a few thousand gallons pay more per gallon than businesses that use much more water. Decreasing block rates reward heavy users with quantity discounts.

Increasing Block Rates. In an increasing block rate structure (sometimes referred to as ascending), each additional unit of water costs slightly more than the previous units the customer used. A base minimum may also be used in the increasing block rate structure.

Amount	Unit Price
First 2,000 gal	$13.00
Next 1,000 gal	$2.00
Next 1,000 gal	$2.00
Next 1,000 gal	$3.00

Income vs. Expenses: Excellent. If increasing block rates are set correctly, they will usually provide income for system operation and future needs. Increasing block rates are an excellent way to increase income for the system. This is because income increases as expenses on the system increase.

Conservation: Excellent. Increasing block rates encourage customers to use water wisely. Many systems facing seasonal water shortages use increasing block rates to discourage unnecessary water use. Customers are more likely to use water wisely if they know they will have to pay more for each unit of water they use.

Fairness to Customers: Fair. Unless they are used for conservation reasons, increasing block rates may be unreasonable for large families, municipal customers, businesses, and industrial/agricultural customers. Most small households and businesses should not be affected by increasing block rates.

Uniform Rates, with a Fixed Minimum. In a uniform rate with a fixed minimum, the unit price for water is constant. A base minimum may also be used in the uniform rate structure. For example:

Amount	Unit Price
First 2,000 gal	$13.00
Next 1,000 gal	$2.00
Next 1,000 gal	$2.00
Next 1,000 gal	$2.00

Income vs. Expenses: Excellent. If uniform rates are set correctly, they will allow the system to keep up with customer demands and expenses. Even during peak demand periods, a system may expect to receive enough income to cover production costs and future needs.

Conservation: Good. Since everyone pays the same amount for each unit consumed, there is no incentive to waste water as with flat or decreasing block rates. If uniform rates are set properly, conservation is encouraged.

Fairness to Customers: Good. Of all the rates covered, the uniform rate is probably the most fair to all categories of customers. Because all customers pay the same price per unit used, household, business, and industrial customers are treated equally. Although some high water users may argue that uniform rates penalize them, uniform rates allow systems to keep the price per unit lower than in other rate structures.

Uniform Rates, with No Fixed Minimum. In the uniform rate with no fixed minimum, there is one cost per thousand gallons. For example: $4.50 per thousand gallons.

Amount	Unit Price
First 1,000 gal	$4.50
Next 1,000 gal	$4.50
Next 1,000 gal	$4.50
Next 1,000 gal	$4.50

Another scenario that will show the cumulative cost of this rate structure:
• 1,000 gallons will cost the customer $4.50
• 8,000 gallons will cost the customer $36.00

The single rate structure can greatly benefit a water system because it is easy to administer and it removes the need to police multiple hookups on a single meter. One area that it may discourage is large economic growth but if a water system is proactive they can make arrangements accordingly to continue to have economic development.

Income vs. Expenses: Good. The single rate structure does produce adequate revenue to meet financial needs, but the rate structure may not be the best for the small water system. The block rate will typically need to be higher than would be the case if a minimum rate were to be charged. Also, because there is no minimum base that the system can count on throughout the year, revenues tend to have wider seasonally fluctuations than would be the case in a rate structure with a minimum charge. A water system would need to review their current rate structure and customer consumption before transferring to the single rate considering there is no fixed minimum that will for sure be paid in every month. Also, high end users may consume less as a result of the price signal; this would result in less revenue being generated, for the water system. So, if a single rate structure is used, the rate should take into account a drop in consumption from the high end users.

Conservation: Excellent. The single rate structure actually sends a price signal to customers, which promotes them to conserve. Minimal users will likely not change their consumption due to the fact of their water bill will be lower. These rates would encourage higher usage customers to act more responsibly.

Fairness to Customers: Excellent. This equalization of water rates would be fair to all users by only paying for water that is registered by the meter. Fixed income users, realtors, builders, and others who only use a minimal amount would pay less and multiple and extra users that are not paying multiple minimums will pay their fair share. The proportion of customer consumption to revenue generated by the customers becomes closer to equal.

Table 20: Sample of fixed and variable costs

Item	Fixed Costs	Variable Costs	Total Costs
Personnel	$50,000	$25,000	$75,000
Equipment and Vehicles	30,000	30,000	60,000
Supplies	0	50,000	50,000
Office Expense	5,000	0	5,000
Utilities	0	12,000	12,000
Telephone	2,000	0	2,000
Contracts	2,000	8,000	10,000
Debt Payment	20,000	0	20,000

Table 21: Comparison of Rate Structures on Expenses

	Fixed Costs†	Fixed Revenue	Variable Costs†	Variable Revenue	Total Costs†	Total Revenue	Operating Ratio
Flat Rate	$129,000	$192,000	$125,000	$ 0	$254,000	$192,000	0.76
Block Rate-Decreasing	$129,000	$192,000	$125,000	$80,580	$254,000	$272,580	1.07
Block Rate-Increasing	$129,000	$192,000	$125,000	$121,500	$254,000	$313,500	1.23
Uniform Rate- Fixed Minimum	$129,000	$192,000	$125,000	$101,040	$254,000	$293,040	1.15
Uniform Rate- No Minimum	$129,000	0	$125,000	$313,740	$254,000	$313,740	1.24

Revenue and Expenses will be based on 800 customers using 69,720,000 gallons annually (87,150 gallons/customer/ year or 7,265.5 gallons/customer/month)
†The Fixed and Variable costs when compared to Fixed and Variable revenue will be the same as the Total Fixed costs for all rate structures.

1. Flat Rate = The flat rate is $20 per customer.
2. Block Rate-Decreasing =The fixed rate is $20/First 2,000 gallons, the flow rate will be $2/Next 1,000 gallons, then $1.50/per 1000 gallons after.
   - 0-2,000 gallons is $20.00
   - 2,001-3,000 gallons is an $2.00
   - 3,001 and up is $1.50 per 1,000 gallons

3. Block Rate-Increasing = The fixed rate is $20/First 2,000 gallons, the flow rate will be $2/Next 1,000 gallons, then $2.50/per 1000 gallons after.
   - 0-2,000 gallons is $20.00
   - 2,001-3,000 gallons is an $2.00
   - 3,001 and up is $2.50 per 1,000 gallons

4. Uniform Rate-Fixed Minimum = The fixed rate is $20/First 2,000 gallons, the flow rate will be $2/per 1000 gallons after.
   - 0-2,000 gallons is $20.00
   - 2,001 and up is $2.00 per 1,000 gallons
5. Uniform Rate-No Minimum = All customers will pay $4.50/per 1,000 gallons of consumption.

Assumptions associated with Table 15

- All customers are using the exact same amount of water monthly. This is assumed for simplicity for this example. Very rarely, if ever, will all customers use the exact same amount of water in a particular time frame.
- For the **Block Rates (BR)**, there are only two (2) rate blocks after the fixed rate. This is done for ease of calculation; most systems will have more blocks.
- An addition of another block to the example's **Block Rate-Decreasing** structure would result in a decrease in variable revenue (fixed revenue would remain constant). This would result in a decrease in the system's operating ratio.
- An addition of another block to the example's **Block Rate-Increasing** structure would result in an increase in variable revenue (fixed revenue would remain constant). This would result in an increase in the system's operating ratio.
- If all of the customers did not use the exact same amount of water but did consume the total amount listed, there would be no change in Total Revenue and Operating Ratio for the **Flat Rate** and the **Uniform Rate-No Minimum**.
- If customers did not consume the same amount of water, fixed revenue for the **Block Rate-Decreasing, Block Rate-Increasing**, and the **Uniform Rate-Fixed Minimum** structures would remain unchanged. There would be an increase in variable revenue due to an increase in gallons above the minimum (assuming that some customers will not consume the 2,000-gallon minimum). In this case, the system's operating ratio would increase.

Rate Structures:

For each rate structure scenario, the same cost information is used. The example system has 800 customers using 69,720,000 gallons annually. In these examples each customer uses exactly the same amount of water (7,263 gallons) for each of the twelve (12) billing cycles. Table 14 provides an annual summary of the system's expenses (costs): Table 15 provides the fixed and variable cost totals (personnel, equipment and vehicles, office expense, telephone, contracts, debt payments, and reserves are fixed costs and personnel, equipment and vehicles, supplies, utilities, and contracts are variable costs).

In our flat rate example, each customer is charged $20 for their total consumption. This results in fixed revenue of $192,000 and no variable revenue since the amount that the customer is charged is not based on use. Total revenue is divided by the total cost to get an operating ratio of 0.76. This shows that this rate structure at this amount only generates enough revenue to cover 76% of costs.

Four different types of block rate structures are also presented in Table 15. The Block Rate-Decreasing has a fixed minimum charge of $20 for the first 2,000 gallons of consumption. The flow rate after the first 2,000 gallons is $2 for usage of 2,001-3,000 gallons and then $1.50 per 1,000 gallons for consumption over 3,000 gallons. With this structure, $192,000 in fixed revenue is collected from the fixed minimum charge and $80,580 in variable revenue is collected from the flow rate for gallons above the minimum. This results in total revenue of $272,580 making the operating ratio 1.07. If additional blocks were implemented, decreases in variable revenue, total revenue and the operating ratio would result.

The Block Rate-Increasing structure has a fixed minimum charge of $20 for the first 2,000 gallons. As before, this results in $192,000 of fixed revenue. The flow rate after the first 2,000 gallons is $2 for usage of 2,001-3,000 gallons and then $2.50 per 1,000 gallons for consumption over 3,000 gallons. This structure's variable revenue is $121,500, total revenue is $313,500 and the operating ratio is calculated as 1.23. If additional blocks were implemented, variable revenue, total revenue, and the operating ratio would all increase.

The Uniform Rate-Fixed Minimum, charges $20 for the first 2,000 gallons and the flow rate is $2 per 1,000 gallons of consumption over 2,000 gallons. As before, this results in $192,000 of fixed revenue and the structure's variable revenue is $101,040. This makes the total revenue $293,040 and the operating ratio is calculated as 1.15.

The Uniform Rate-No Fixed Minimum, charges the same flow rate regardless of usage but has no minimum fee. The structure's rate used is $4.50 per 1,000 gallons of consumption. There is no fixed revenue collected because if a customer were to have no usage then they would pay nothing. The variable revenue is $313,740 and because there is no fixed revenue, $313,740 is also the total revenue making the operating ratio as calculated is 1.24.

Planning, Budgeting, and Rate Setting and My Water System: A Self-Assessment

Please respond to the following statements that relate to your water system management. Select one answer. The answers reflect the opinion of the board member making the assessment, but the joint opinions of the board members should reflect the strengths and weaknesses of the board and help identify areas where improvement is needed.

1. To help keep up with trends in total water used in our water system, we
A. keep records for up to 10 years on the annual gallons of water used, the number of users, water used by different classes of users (if applicable), monthly water use, and annual water use per customer; we have estimates of water losses from leaks and unmetered sites.
B. keep records for up to 5 years on annual water use, number of users, use per customer, and we estimate water losses each year.
C. have historical records on file of water use, number of users, and average use per customer, but there are some gaps in the records.
D. keep some records, but they are scattered and these are based on rough estimates.
E. keep no records of water use and water losses.

2. For my water system,
A. every water user is metered and records are kept on each customer's usage.
B. all private users are metered, but some public users are not metered and no records of water use can be kept on these.
C. most but not all private users are metered and billed, and we do not meter public users.
D. we use meters, but the location of every meter is not known or is not read on a monthly basis.
E. we do not use meters but charge everyone equally, regardless of water consumption.

3. Our board
A. requires that we keep monthly records of our expenses and income by major categories and that we summarize these into annual reports. We use these for preparing annual budgets and for long-term planning.
B. requires that we keep records of monthly income and expenses by categories, and we use these in planning but do not prepare budgets each year. We make long-term plans when we feel they are needed.
C. has monthly income and expense records but do not categorize them to help identify exactly where our money is coming from and where our money is going.
D. has some financial records, but we do not keep them long enough for them to be of much use in our financial planning.
E. does not keep detailed records of income and expenses.

4. For our inventory of machinery and equipment, our board
A. requires that permanent records include the age, expected life, date and cost of major repairs, annual maintenance checks, and dates and plans for major repairs or replacements, projected costs of repairs, and plans for new purchases.
B. requires that records be kept on maintenance and major repairs but we do make plans for replacement on an item-by-item basis.
C. asks that operators and managers make repairs when needed and report to the board when major repairs or purchases are needed as well as reporting periodically on the status of the machinery and equipment inventory. No written records are maintained.
D. asks that operators or managers keep up with equipment repair and replacement needs, but no records or reports are required.
E. keeps no inventory records on purchases or repairs.

5. Our financial record-keeping system is
A. computerized, kept current, income and expenses are categorized, and accurate financial information can be generated for board use anytime it is needed.

B. computerized income and expenses are categorized, and financial reports can be generated anytime they are needed. Often recent income and expense items have not been included.
C. not computerized, but we have an organized system so that income and expense statements can be generated monthly from deposit receipts, checkbooks, and bank statements.
D. based mostly on the monthly bank statements that we use to put together financial reports when required.
E. poorly maintained, and it is difficult to develop accurate reports when they are needed.

The following policies are provided by Community Resource Group, Inc. These templates can be used when developing policies for your individual water system. All names of communities are fictitious. Any similarities between names used in these examples and actual communities are coincidental.

Standard Operating Procedures

Comprehensive Customer Service Policy

Municipal Water Utility Policy

Water Utility Long-Range Plan

_______________________________ Water Association

Water System Standard Operating Procedures

General

The information contained within this document shall serve as a guideline for the employees, contractors and / or board officers in carrying out their duties with the association's potable water supply system. These standard operating procedures shall be adhered to and anyone having knowledge of non-compliance must inform the board's point of contact immediately. Anyone who willingly ignores this policy or repeatedly fails to follow it may be subject to disciplinary actions or termination. The purpose of these operating procedures are to ensure that all responsible entities carry out their duties cooperatively and diligently to ensure that public health and the association's investment in its water system are protected. The Board of Directors of the _______________________________

Water Association reserves the right to amend these procedures in any way provided that all applicable employees and contractors are notified of any proposed changes. All applicable employees and contractors will be provided with copies of any amendments.

I. Definitions

Secretary: The person who is responsible for all accounts receivable and accounts payable operations including billing, collecting, and posting customer payments as well as posting meter readings and generating necessary accounts receivable reports. The Secretary is also responsible for disbursing funds to approved claims as well as maintaining an active filing system of all correspondence, accounts receivable, and accounts payable information.

Contract Operator: The person who is responsible to ensure that all daily operation and maintenance duties performed on the water system are in compliance with the BUREA OF STANDARDS as well as any state regulations pertaining to potable water systems. The _______________________________ Water Association is a Class "___" system and is required to employ or contract with a person having a Class "___" or higher WATER UTILITY certification.

Meter Reader: The person responsible for the reading of all meters between the _________ and the _________ of each month. The Meter Reader shall also cut grass at all well sites and tanks as directed by the schedule designated by the Board.

Contract Repair Service: The Contract Repair Service shall work under the guidance and direction of the Secretary and the Contract Operator to ensure proper maintenance on the water system.

Board Point of Contact: ________________________________ shall serve as the point of contact for the ______________________________ Water Association's water system. Any employee, contractor, agency or other entities wishing to address the board regarding the water system must first address the Board Point of Contact (POC) or the Delegated Alternate Point of Contact. The Delegated Alternate Point of Contact is

______________________________.

Preventative Maintenance Procedures

A. Wells, pumps, and related equipment
   1. The Contract Operator shall personally inspect the wells, pumps, and equipment and record all findings including operating pressures, run-time meter readings, and flow meter readings on the Daily Well Logs at least two (2) days each week.
   2. The Contract Operator shall initialize all Daily Well Log entries as well as record the date and time of PM inspection in his Water Utility issued Operators Log Book.
   3. The Contract Operator shall use the Daily Well Logs to compile a Monthly Production Report.
   4. The Contract Operator shall recommend to the Board POC when a necessary pumping test is needed.
   5. The Meter Reader shall perform grass-cutting services twice each month at the well site from spring until Fall of each year.

B. Tanks
   1. The Contract Operator shall periodically make a visual inspection of the exterior of any ground storage tanks, hydropneumatics tanks, and elevated tanks for signs of paint oxidation, rust, or leaks.
   2. The Contract Operator shall report to the Board POC when a necessary professional tank inspection is needed.

C. Fire Hydrants
   1. The Contract Operator shall periodically exercise and lubricate all fire hydrants to ensure that they are functioning.
   2. The Contract Operator shall maintain a Fire Hydrant Drawdown and Testing Log to document each hydrant's condition and inspection.
   3. The Contract Operator shall use the Fire Hydrant Drawdown and Testing Log to compile the water account ability section of the Monthly O-M Report.

D. Water Mains
   1. The Contract Operator shall locate and mark the necessary water mains within 48 hours of notice of a request by a citizen or contractor to excavate within 10 feet of a water main or service line. The Contract Operator shall also document any request for line locates as well as any leaks or breaks caused by excavators and present this information to the Board POC.

2. The Secretary shall coordinate a leak detection survey if unaccountable water dosage exceeds 30% of the total water produced or if it is recorded that there is a 10% increase in unaccountable water during a one-month period.
3. The Secretary shall periodically perform visual leak detections to ensure that unaccountable water dosage is located and repairs are scheduled.

E. Meters and Service Connections
1. The Meter Reader shall document each month while reading meters any indications of leaks and nonfunctioning meters.
2. The Secretary shall periodically generate a computer report detailing possible non-functioning meters.
3. At the direction of the Secretary, the Contract Repair Service shall perform on-site meter validity inspections and necessary meter change-outs.

Scheduled Maintenance Repairs

A. Leak Repairs
1. The Secretary shall contact the Contract Repair Service for all scheduled leak repairs and obtain a preliminary estimation of the costs before proceeding with the repairs.
2. The Contract Repair Service shall notify the Secretary if the water will have to be shut-off in order to complete the repairs. In turn, the Secretary shall contact the Contract Operator to inform him of the temporary water outage.
3. If the main lines are cut for splicing or tie-ins, the Contract Operator shall personally ensure that the proper amount of HTH Chlorine is poured into the main to ensure adequate disinfection. The Contract Repair Service should flush the nearest fire hydrant down line and take a free chlorine residual test before leaving the site.
4. If the Contract Operator determines that a voluntary boil water notice must be issued, Secretary shall be contacted first before notifying customers that will be effected. The Contract Operator will determine which method of notification is appropriate and will contact the Water Utility Engineer for guidance if necessary.
5. After bacteriological test results are reported clear by Water Utility , the Contract Operator shall notify the Secretary to lift the notice.

B. Equipment Repairs and Replacement
1. The Contract Operator shall notify and secure the approval of the Secretary before proceeding with scheduled repairs on equipment including but not limited to electrical controls, well pumps & motors, and chlorine disinfection equipment.
2. The Secretary shall either approve the scheduled equipment repairs or replacement or postpone them until the board can make an official decision.

C. Meter Change-Outs
1. The Secretary shall schedule meter change-outs periodically with the Contract Repair Service. The Contract Repair Service shall provide documentation of the results of the on-site meter validity inspections to the Secretary.

Emergency Repairs and Water Outages

A. Emergency Repairs – Repairs that if not completed immediately will cause detrimental damage to the water system, cause the entire system to lose pressure, or could result in a threat to the safety and health of the town’s citizens, employees, or contractors.
   1. The Secretary shall also notify the Contract Repair Service as soon as possible regarding the extent and location of the emergency repair. The Secretary shall also contact the Contract Operator if the area effected has lost pressure and if so, the Contract Operator shall proceed with issuing a boil water notice.
   2. If the main lines are cut for splicing or tie-ins, the Contract Operator shall personally ensure that the proper amount of HTH Chlorine is poured into the main to ensure adequate disinfection.
   3. The Contract Repair Service shall flush the nearest fire hydrant or flush plug down line and take a free chlorine residual test before leaving the site.
   4. If a Boil Water Notice is issued and after bacteriological test results are reported clear by Water Utility , the Contract Operator shall notify the Board POC so that customers can be notified that the water is safe.

B. Water Outages – A substantial loss of pressure on the water system due to a mechanical or electrical failure or a water main break. Immediate issuance of Boil Water Notices are required for all Water Outages.
   1. The Secretary shall notify the Contract Operator immediately and give a full report of the extent of the water outage.
   2. The Contract Operator shall contact Water Utility immediately for guidance in preparing the Boil Water Notice.
   3. The Contract Operator shall be available to answer any questions that the public may have regarding the water outage, quality of water, and the necessity of the boil water notice.
   4. Once pressure is restored, the Contract Operator shall gather the necessary bacteriological samples and submit them immediately to the ___________________ County Health Department Office.
   5. Once Water Utility has determined that the samples are clear and notifies the Contract Operator, the operator must notify the Board POC and the affected customers that the boil water notice is lifted and the water is safe to drink.

Record Keeping

A. Maintenance Records
   1. The Contract Operator shall:
      A. Be responsible for maintaining a Water Utility approved Operator Log Book detailing his activities at Rubkona County. Water Utility requires that the Contract Manager keep these records for at least five years.
      B. Prepare and maintain copies of the Monthly and Annual Production Reports as well as supply a copy to the Secretary. The Production Reports must be maintained for five years.
      C. Prepare the water accountability section of the Monthly O-M Report and maintain a copy of each report for at least five years.
      D. Prepare the Annual O-M Report and supply a copy to the Secretary. The Annual O-M Report shall be maintained for at least ten years.
      E. Prepare the Water Utility Sampling Log and maintain for at least ten years.

2. The Secretary shall:
    a) Prepare the Water Utility Annual Report, and maintain in a file for three years.
    b) Maintain copies of all reports generated by the Contract Operator and retain for the specified time periods listed above.

B. Water Utility Test Results and Correspondence
    1. The Contract Operator shall be responsible for maintaining copies of all Water Utility correspondence, test results, sanitary surveys, and annual reports.
    2. The Secretary shall be responsible for maintaining originals of all Water Utility correspondence, test results, sanitary surveys, and annual reports.

C. Pumping Test, Surveys and Engineering Plans
    1. The Secretary shall maintain all well pumping test reports, camera surveys, professional leak detection surveys, and as built engineering plans.

D. Bookkeeping Records
    1. The Secretary shall maintain all water customer receipt books for at least three years.
    2. The Secretary shall maintain all cut-off reports, aged account reports and billing registers for at least two years.
    3. The Secretary shall maintain all month ending detailed transaction reports for at least three years.
    4. The Secretary shall maintain all daily payment transaction reports for at least two years.
    5. The Secretary shall maintain all reports prepared by the accountant and other reports and official correspondence for at least seven years.
    6. The Secretary shall prepare monthly bank reconciliation reports and check disbursement journals to be maintained for at least seven years.

E. Customer Files and Records

1. The Secretary shall maintain files of all customers and place all users agreements, Water Utility notices of intent, hardship payment plans, payment extension agreements, and any correspondence within these files. The
Customer Files shall not be purged or archived unless directed by the Board of Directors.

F. Correspondence Files
    1. The Secretary shall maintain separate files for all mortgage holders and regulatory agencies and shall file all correspondence received as well as copies of all correspondence mailed to these agencies. These official correspondence files shall not be purged or archived unless directed by the Board of Directors.

G. Personnel Records

The Secretary shall maintain the individual personnel files for the Secretary, the Contract Operator, and the Contract Meter Reader. Included in these files will be copies of the actual contracts, Water Utility Annual Operating Agreements, and certification of insurance.

H. Insurance Policies and Records
    2. The Secretary shall maintain all commercial insurance policy files and correspondence relating to coverage of the water system for at least seven years.

Testing and Monitoring

A. Chlorine Residual Tests
   a) The Contract Operator shall check twice each week the total and free chlorine residuals randomly at sites approved by Water Utility .
   b) The Contract Operator shall document the chlorine residual test results on the Chlorine Testing and Hydrant Flushing Log.
   1. If the free chlorine residual is tested as 0.5 mg/l or less, the Contract Operator shall take the necessary steps including adjusting the chlorine feed rate and flushing to increase the free chlorine residual.

B. Bacteriological Tests
1. The Contract Operator shall collect the monthly bacteriological samples at Water Utility approved sampling sites and deliver them to the __________________ County Health Department on or before the deadline each month.

a) The Contract Operator shall make copies of the test results to be maintained in his files and notify the Secretary immediately upon receipt of the results. Board Secretary shall maintain a file of the original bacteriological tests results. The Contract Operator shall maintain a file of copies of the tests results.
b) If the test results indicate a presence of coliform bacteria, indicate confluent growth, or are in any way not satisfactory, the Contract Operator shall contact the Secretary, the Engineer and take the immediate necessary actions prescribed by Water Utility including public notification and resample procedures.
2. The Contract Operator shall collect bacteriological samples on the resample card should he suspect contamination at any time. The Contract Operator shall contact the Water Utility regional engineer immediately and submit the sample(s) to the __________________ County Health Department. Voluntary public notification and boil water notices will be issued to those effected.

C. Other Required Testing, Reporting, and Monitoring
1. All other required testing, reporting and monitoring specified by the Bureau of Standards and / or directed by Water Utility shall be completed by the Contract Operator following the Water Utility prescribed guidelines and by the date that such testing, reporting, or monitoring is specified.
a) Upon receipt of any official correspondence from State Ministry of Housing Roads and Infrastructure, the Contract Operator shall contact the Secretary immediately. The Secretary shall maintain files of all original correspondence and tests results. The Contract Operator shall maintain alternate files of copies of such correspondence and test results.
b) If the ______________________________ Water Association has been found to be in noncompliance with the Bureau of Standards due to monitoring violations or exceedance of MCL standards, the Contract Operator shall contact the Secretary and the Engineer immediately.

Accounts Receivable and Accounts Payable Operations

A. Accounts Receivable Operations

The Secretary shall refer to and strictly adhere to compliance with ________________________________ W.A.'s Bylaws and Customer Service Policy concerning Accounts Receivable Operations.

B. Accounts Payable Operations

1. The Secretary shall compile all vendor claims including invoices and statements each month and prepare a claims docket to be presented to the Board of Directors at each monthly meeting.
2. The Secretary shall prepare all checks for approval, signature, and disbursement prior to each monthly meeting.
3. The Secretary shall mail all checks to the appropriate vendors following approval of claims the next day after each board meeting.
4. The Secretary shall prepare checks for mortgage notes and electrical utility bills and mail within five days prior to the due date. These are the only disbursements that have been granted pre-approval.

Meter Installations, Service Extensions, Connection of New Customers

A. Meter Installations, Service Extension, Connection of New Customers

1. The Secretary shall refer to and strictly adhere to compliance with ________________________________ W.A.'s Customer Service Policy (Service Extension Policy) when accepting applications and or requests for new customer service.
2. If ________________________________ W.A. has been officially notified by Water Utility or any other regulatory agency that it is not permitted to add any new customers, the Secretary shall furnish a copy of the official letter or administrative order to the applicant along with an explanation of what steps the board is taking to correct the situation that has caused such an order. Under no circumstances, shall the Secretary accept monies, or complete a User's Agreement if such an order has been issued. However, the Secretary shall document any and all applicants that have been denied water service.
3. The Secretary shall deposit all membership, deposit, and connection fees into the appropriate association bank accounts before the end of the month for all Users Agreements completed within the month.
4. The Secretary shall attach the original Water Utility Notice of Intent, or Affidavit Waiver to the User Agreement and shall file in the customer file.

Reporting

A. The Secretary shall make a report to the board each month at The ________________________________ Water Association's scheduled meeting concerning maintenance, compliance, and finances of the system. The Secretary shall present the Monthly O & M Report as well as Financial Records to the board.

B. Periodically, the Contract Operator shall give the board an update of compliance results with the Bureua Of Standards and concerns and recommendations that he may have regarding problems that may cause the system to be found in noncompliance.

C. The Board Secretary shall present all pending claims including invoices, statements, and a claims docket to the board at the monthly business meeting.

Acknowledgement of Receipt and Understanding of the _________________________________
W.A. Standard Operating Procedures

I, ___________________________________ hereby acknowledge that I have been given a copy of the ________________________________ Water Association Standard Operating Procedures. I also acknowledge that I have read the SOP and fully understand my duties contained herein.

Assessing Vulnerabilities

The maintenance and security of all Public Water System facilities and resources are critical to prevent contamination of the public water supply and encourages the preservation of the system's critical assets. Complex water treatment components, capital intensive assets, and vital system data can be compromised if site security is lacking. The Security Vulnerability
Assessment is verified annually through an inspection. Exercise through simulations twice a year are also highly encouraged. Many of the weaknesses recognized in the assessment are noted as significant deficiencies by regional engineers during this inspection. Also, not completing the Security Vulnerability Assessment can be listed as a significant deficiency itself. All Public Water Systems must complete a Security Vulnerability Assessment to be eligible for Rural Development funding.

The Security Vulnerability Assessment is a self-assessment tool used to help identify the potential threats to the water system and identify any of the system's weaknesses in preparedness and security. It allows system officials create a list of critical assets, identify weak points, prioritize actions to address the weaknesses, and develop an emergency contact list. The Security Vulnerability Assessment should be incorporated as part of the system's short and long-range plans for improvement and should be discussed with all employees to ensure preparedness. Any vulnerability identified through the assessment should be addressed in a timely manner to prevent being classified as significant deficiencies on the system's next Capacity Assessment

Security Vulnerability Self-Assessment Guide for Rubkona Public Water Systems

NAME OF PUBLIC WATER SYSTEM

NUMBER(S)

Date Completed

Date Last Updated
(Should be updated annually)

Print clearly with an Ink pen in capital letters

Ministry of Housing, Roads and Public Infrastructure, Unity State

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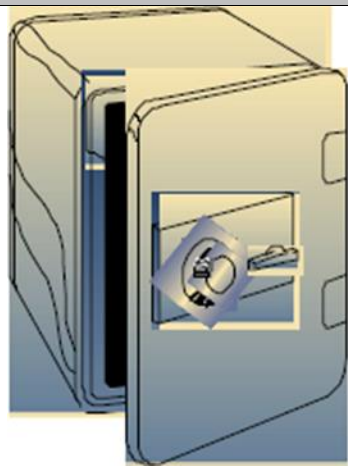
<table>
<tr><th colspan="2">A note about Security for this documents</th></tr>
<tr><td></td><td>This document contains sensitive information about the security of your water system. Therefore, it should be treated as Confidential Information and should be stored in a secure place at your water system. A duplicate copy should also be stored in a secure off-site location.</td></tr>
</table>

Acknowledgements

This document is the result of collaboration among the Association of Drinking Water Administrators (ABUREA OF STANDARDS), the U.S. Environmental Protection Agency (U.S. EPA), the U.S. EPA Drinking Water Academy, and the National Rural Water Association (NRWA). We also thank NWRA for the template that was used as the foundation for this project.

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Security Vulnerability Self-Assessment Guide for Public Water Systems

Introduction

Water systems are critical to every community. Protection of public drinking water systems must be a high priority for local officials and water system owners and operators to ensure an uninterrupted water supply, which is essential for the protection of public health (safe drinking water and sanitation) and safety (fire fighting).

Adequate security measures will help prevent loss of service through terrorist acts, vandalism, or pranks. If your system is prepared, such actions may even be prevented. The appropriate level of security is best determined by the water system at the local level.

This Security Vulnerability Self-Assessment Guide is designed to help public water systems determine possible vulnerable components and identify security measures that should be considered. A "vulnerability assessment" is the identification of weaknesses in water system security, focusing on defined threats that could compromise its ability to provide adequate potable water, and/or water for firefighting. This document is designed particularly for systems that serve populations of 3,300 or less. This document is meant to encourage smaller systems to review their system vulnerabilities, but it may not take the place of a comprehensive review by security experts. The Self-Assessment Guide has a simple design. Answers to assessment questions are "yes" or "no," and there is space to identify needed actions and actions you have taken to improve security. For any "no" answer, refer to the "comment" column and/or contact your state drinking water primacy agency.

How to Use this Self-Assessment Guide

This document is designed for use by water system personnel. Physical facilities pose a high degree of exposure to any security threat. This self-assessment should be conducted on all components of your system (wellhead or surface water intake, treatment plant, storage tank(s), pumps, distribution system, and other important components of your system).

The Assessment includes an emergency contact list for your use. This list will help you identify who you need to contact in the event of an emergency or threat and will help you develop communication and outreach procedures. Filling out the Emergency Contact List is an important step toward developing an Emergency Response Plan, which provides detailed procedures on how to respond to an emergency.

You may be able to obtain sample Emergency Response Plans from your state drinking water primacy agency.

Security is everyone's responsibility. We hope this document helps you to increase the awareness of all your employees, governing officials, and customers about security issues.
Once you have completed this document, review the actions you need to take to improve your system's security.
Make sure to prioritize your actions based on the most likely threats. Please complete the Certificate of Completion on page 27 and return only the certificate to your state drinking water primacy agency. Do not include a full copy of your self-assessment.

Keep this Document

This is a working document. Its purpose is to start your process of security vulnerability assessment and security enhancements. Security is not an end point, but a goal that can be achieved only through continued efforts to assess and upgrade your system. Don't forget that this is a sensitive document. It should be stored separately in a secure place at your water system. A duplicate copy should also be retained at a secure off-site location. Access to this document should be limited to key water system personnel and local officials as well as the state drinking water primacy agency and others on a need-to-know basis.

Keep this Document

This is a working document. Its purpose is to start your process of security vulnerability assessment and security enhancements. Security is not an end point, but a goal that can be achieved only through continued efforts to assess and upgrade your system. Don't forget that this is a sensitive document. It should be stored separately in a secure place at your water system. A duplicate copy should also be retained at a secure off-site location. Access to this document should be limited to key water system personnel and local officials as well as the state drinking water primacy agency and others on a need-to-know basis.

Record of Security Vulnerability Self-Assessment Completion

The following information should be completed by the individual conducting the self-assessment and/or any additional revisions.

Name:	
Title:	
Area of Responsibility:	
Water System Name:	
Telephone Numbers	
Date Completed	

Date Revised:		Signature:	
Date Revised:		Signature:	
Date Revised:		Signature:	
Date Revised:		Signature:	
Date Revised:		Signature:	
Page #-----of------			

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Inventory of Public Water System Critical Components

Component		Number & Location (if applicable)	Description
Source Water Type			
	Ground Water		
	Surface Water		
Treatment Plant			
	Buildings		
	Pumps		
	Treatment Equipment (e.g., basin, clearwell, filter)		
	Process Controls		
	Treatment Chemicals and Storage		
	Laboratory Chemicals and Storage		
Storage			
	Storage Tanks		
	Pressure Tanks		
Power			
	Primary Power		
	Auxiliary Power		
Distribution System			
	Pumps		
	Pipes		
	Valves		
	Appurtenances (e.g., flush hydrants, backflow preventers, meters)		
	Other Vulnerable Points		
Offices			
	Buildings		
	Computers		
	Files		
	Transportation/Work Vehicles		
Communications			
	Telephone		
	Cell Phone		
	Radio		
	Computer Control Systems (SCADA)		

NOTE: Use additional pages if necessary to fully document all equipment.

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General Questions for the Entire Water System The first 13 questions in this vulnerability self-assessment are general questions designed to apply to all components of your system (wellhead or surface water intake, treatment plant, storage tank(s), pumps, distribution system, and offices). These are followed by more specific questions that look at individual system components in greater detail.			
QUESTION	ANSWER	COMMENT	ACTION NEEDED/TAKEN
Do you have a written emergency response plan (ERP)?	Yes No	It is essential that you have an ERP. If you do not have an ERP, you can obtain a sample from your state drinking water primacy agency. As a first step in developing your ERP, you should develop your Emergency Contact List (see Attachment 2). A plan is vital in case there is an incident that requires immediate response. Your plan should be reviewed at least annually (or more frequently if necessary) to ensure it is up-to-date and addresses security emergencies. You should designate someone to be contacted in case of emergency regardless of the day of the week or time of day. This contact information should be kept up-to-date and made available to all water system personnel and local officials (if applicable). Share this ERP with police, emergency personnel, and your state primacy agency. Posting contact information is a good idea only if authorized personnel are the only ones seeing the information. These signs could pose a security risk if posted for public viewing since it gives people information that could be used against the system.	
Is access to the critical components of the water system (i.e., a part of the physical infrastructure of the system that is essential for water flow and/or water quality) restricted to authorized personnel only?	Yes No	You should restrict or limit access to the critical components of your water system to authorized personnel only. This is the first step in security enhancement for your water system. Consider the following:	

		• Issue water system photo identification cards for employees, and require them to be displayed within the restricted area at all times. • Post signs restricting entry to authorized personnel and ensure that assigned staff escort people without proper ID.	
General Questions for the Entire Water System The first 13 questions in this vulnerability self-assessment are general questions designed to apply to all components of your system (wellhead or surface water intake, treatment plant, storage tank(s), pumps, distribution system, and offices). These are followed by more specific questions that look at individual system components in greater detail.			
QUESTION	ANSWER	COMMENT	ACTION NEEDED/TAKEN
Are facilities fenced, including well-houses and pump pits, and are gates locked where appropriate?	Yes No	Ideally, all facilities should have a security fence around the perimeter. The fence perimeter should be walked periodically to check for breaches and maintenance needs. All gates should be locked with chains and a tamper-proof padlock that at a minimum protects the shank. Other barriers such as concrete "jersey" barriers should be considered to guard certain critical components from accidental or intentional vehicle intrusion.	
Are your doors, windows, and other points of entry such as tank and roof hatches and vents kept closed and locked?	Yes No	Lock all building doors and windows, hatches and vents, gates, and other points of entry to prevent access by unauthorized personnel. Check locks regularly. Dead bolt locks and lock guards provide a high level of security for the cost. A daily check of critical system components enhances security and ensures that an unauthorized entry has not taken place. Doors and hinges to critical facilities should be constructed of heavy-duty reinforced material. Hinges on all outside doors should be located on the inside. To limit access to water systems, all windows should be locked and reinforced with wire mesh or iron bars, and bolted on the inside. Systems should ensure that this type of security meets with the requirements of any fire codes.	

		Alarms can also be installed on windows, doors, and other points of entry.	
Is there external lighting around the critical components of your water system?	Yes No	Adequate lighting of the exterior of water systems' critical components is a good deterrent to unauthorized access and may result in the detection or deterrence of trespassers. Motion detectors that activate switches that turn lights on or trigger alarms also enhance security.	
Are warning signs (tampering, unauthorized access, etc.) posted on all critical components of your water system? (For example, well houses and storage tanks.)	Yes No	Warning signs are an effective means to deter unauthorized access. "Warning – Tampering with this facility is a federal offense" should be posted on all water facilities. These are available from your state rural water association. "Authorized Personnel Only," "Unauthorized Access Prohibited," and "Employees Only" are examples of other signs that may be useful.	
Do you patrol and inspect your source intake, buildings, storage tanks, equipment, and other critical components?		Frequent and random patrolling of the water system by utility staff may discourage potential tampering. It may also help identify problems that may have arisen since the previous patrol. Consider asking your local law enforcement agencies to conduct patrols of your water system. Advise them of your critical components and explain why they are important.	
QUESTION	ANSWER	COMMENT	ACTION NEEDED/TAKEN
Is the area around the critical components of your water system free of objects that may be used for breaking and entering?	Yes No	When assessing the area around your water system's critical components, look for objects that could be used to gain entry (e.g., large rocks, cement blocks, pieces of wood, ladders, valve keys, and other tools).	
Are the entry points to your water system easily seen?	Yes No	You should clear fence lines of all vegetation. Overhanging or nearby trees may also provide easy access. Avoid landscaping that	

		will permit trespassers to hide or conduct unnoticed suspicious activities. Trim trees and shrubs to enhance the visibility of your water system's critical components. If possible, park vehicles and equipment in places where they do not block the view of your water system's critical components.	
Do you have an alarm system that will detect unauthorized entry or attempted entry at critical components?	Yes No	Consider installing an alarm system that notifies the proper authorities or your water system's designated contact for emergencies when there has been a breach of security. Inexpensive systems are available. An alarm system should be considered whenever possible for tanks, pump houses, and treatment facilities. You should also have an audible alarm at the site as a deterrent and to notify neighbors of a potential threat.	
Do you have a key control and accountability policy?	Yes No	Keep a record of locks and associated keys, and to whom the keys have been assigned. This record will facilitate lock replacement and key management (e.g., after employee turnover or loss of keys). Vehicle and building keys should be kept in a lockbox when not in use. You should have all keys stamped (engraved) "DO NOT DUPLICATE."	
Are entry codes and keys limited to water system personnel only?	Yes No	Suppliers and personnel from co-located organizations (e.g., organizations using your facility for telecommunications) should be denied access to codes and/or keys. Codes should be changed frequently if possible. Entry into any building should always be under the direct control of water system personnel.	
Do you have a neighborhood watch program for your water system?	Yes No	Watchful neighbors can be very helpful to a security program. Make sure they know whom to call in the event of an emergency or suspicious activity.	

QUESTION	ANSWER	COMMENT	ACTION NEEDED/TAKEN
Are your wellheads sealed properly?	Yes No	A properly sealed wellhead decreases the opportunity for the introduction of contaminants. If you are not sure whether your wellhead is properly sealed, contact your well drilling/maintenance company, your state drinking water primacy agency, your state rural water association, or other technical assistance providers.	
Are well vents and caps screened and securely attached?	Yes No	Properly installed vents and caps can help prevent the introduction of a contaminant into the water supply. Ensure that vents and caps serve their purpose, and cannot be easily breached or removed.	
Are observation/test and abandoned wells properly secured to prevent tampering?	Yes No	All observation/test and abandoned wells should be properly capped or secured to prevent the introduction of contaminants into the aquifer or water supply. Abandoned wells should be either removed or filled with concrete.	
Is your surface water source secured with fences or gates? Do water system personnel visit the source?	Yes No	Surface water supplies present the greatest challenge to secure. Often, they encompass large land areas. Where areas cannot be secured, steps should be taken to initiate or increase patrols by water utility personnel and law enforcement agents.	

Some small systems provide easy access to their water system for suppliers of equipment, chemicals, and other materials for the convenience of both parties. This practice should be discontinued.

Water Sources

In addition to the above general checklist for your entire water system (questions 1-13), you should give special attention to the following issues, presented in separate tables, related to various water system components. Your water sources (surface water intakes or wells) should be secured. Surface water supplies present the greatest challenge. Typically, they encompass large land areas. Where areas cannot be secured, steps should be taken to initiate or increase law enforcement patrols. Pay particular attention to surface water intakes. Ask the public to be vigilant and report suspicious activity.

Treatment Plant and Suppliers

QUESTION	ANSWER	COMMENT	ACTION NEEDED/TAKEN
Are deliveries of chemicals and other supplies made in the presence of water system personnel?	Yes No	Establish a policy that an authorized person, designated by the water system, must accompany all deliveries. Verify the credentials of all drivers. This prevents unauthorized personnel from having access to the water system.	
Are chemicals, particularly those that are potentially hazardous or flammable, properly stored in a secure area?	Yes No	All chemicals should be stored in an area designated for the for their storage only, and the area should be secure and access to the area restricted. Access to chemical storage should be available only to authorized employees. You should have tools and equipment on site (such as a fire extinguisher, dry-sweep, etc.) to take immediate actions when responding to an emergency.	
Have you discussed with your supplier(s) procedures to ensure the security of their products?	Yes No	Verify that your suppliers take precautions to ensure that their products are not contaminated. Chain of custody procedures for delivery of chemicals should be reviewed. You should inspect chemicals and other supplies at the time of delivery to verify they are sealed and in unopened containers. Match all delivered goods with purchase orders to ensure that they were, in fact, ordered by your water system. You should keep a log or journal of deliveries. It should include the driver's name (taken from the driver's photo I.D.), date, time, material delivered, and the supplier's name.	
Do you monitor raw and treated water so that you can detect changes in water quality?	Yes No	Monitoring of raw and treated water can establish a baseline that may allow you to know if there has been a contamination incident. Some parameters for raw water include pH, turbidity, total and fecal coliform, total organic carbon, specific conductivity, ultraviolet adsorption, color, and odor. Routine parameters for finished water and distribution systems include free and total chlorine residual, heterotrophic plate count	

		(HPC), total and fecal coliform, pH, specific conductivity, color, taste, odor, and system pressure. Chlorine demand patterns can help you identify potential problems with your water. A sudden change in demand may be a good indicator of contamination in your system. For those systems that use chlorine, absence of a chlorine residual may indicate possible contamination. Chlorine residuals provide protection against bacterial and viral contamination that may enter the water supply.	
Are tank ladders, access hatches, and entry points secured?	Yes No	The use of tamper-proof padlocks at entry points (hatches, vents, and ladder enclosures) will reduce the potential for of unauthorized entry. If you have towers, consider putting physical barriers on the legs to prevent unauthorized climbing.	
Are vents and overflow pipes properly protected with screens and/or grates?	Yes No	Air vents and overflow pipes are direct conduits to the finished water in storage facilities. Secure all vents and overflow pipes with heavy-duty screens and/or grates.	
Can you isolate the storage tank from the rest of the system?	Yes No	A water system should be able to take its storage tank(s) out of operation or drain its storage tank(s) if there is a contamination problem or structural damage. Install shut-off or bypass valves to allow you to isolate the storage tank in the case of a contamination problem or structural damage. Consider installing a sampling tap on the storage tank outlet to test water in the tank for possible contamination.	

Distribution
Hydrants are highly visible and convenient entry points into the distribution system. Maintaining and monitoring positive pressure in your system is important to provide fire protection and prevent introduction of contaminants.

QUESTION	ANSWER	COMMENT	ACTION NEEDED/TAKEN
Do you control the use of hydrants and valves?	Yes No	Your water system should have a policy that regulates the authorized use of hydrants for purposes other than fire protection. Require authorization and backflow devices if a hydrant is used for any purpose other than firefighting. Consider designating specific hydrants for use as filling station(s) with proper backflow prevention (e.g., to meet the needs of construction firms). Then, notify local law enforcement officials and the public that these are the only sites designated for this use. Flush hydrants should be kept locked to prevent contaminants from being introduced into the distribution system, and to prevent improper use.	
Does your system monitor for, and maintain, positive pressure?	Yes No	Positive pressure is essential for firefighting and for preventing backsiphonage that may contaminate finished water in the distribution system. Refer to your state primacy agency for minimum drinking water pressure requirements.	
Has your system implemented a backflow prevention program?	Yes No	In addition to maintaining positive pressure, backflow prevention programs provide an added margin of safety by helping to prevent the intentional introduction of contaminants. If you need information on backflow prevention programs, contact your state drinking water primacy agency.	
	Yes No		

Personnel You should add security procedures to your personnel policies.			
QUESTION	ANSWER	COMMENT	ACTION NEEDED/TAKEN
When hiring personnel, do you request that local police perform a criminal background check, and do you verify employment eligibility)?	Yes No	It is good practice to have all job candidates fill out an employment application. You should verify professional references. Background checks conducted during the hiring process may prevent potential employee-related security issues. If you use contract personnel, check on the personnel practices of all providers to ensure that their hiring practices are consistent with good security practices.	
Are your personnel issued photo-identification cards?	Yes No	For positive identification, all personnel should be issued water system photo-identification cards and be required to display them at all times. Photo identification will also facilitate identification of authorized water system personnel in the event of an emergency.	
When terminating employment, do you require employees to turn in photo IDs, keys, access codes, and other security-related items?	Yes No	Former or disgruntled employees have knowledge about the operation of your water system, and could have both the intent and physical capability to harm your system. Requiring employees who will no longer be working at your water system to turn in their IDs, keys, and access codes helps limit these types of security breaches.	
Do you use uniforms and vehicles with your water system name prominently displayed?	Yes No	Requiring personnel to wear uniforms, and requiring that all vehicles prominently display the water system name, helps inform the public when water system staff is working on the system. Any observed activity by personnel without uniforms should be regarded as suspicious. The public should be encouraged to report suspicious activity to law enforcement authorities.	

Have water system personnel been advised to report security vulnerability concerns and to report suspicious activity?	Yes No	Your personnel should be trained and knowledgeable about security issues at your facility, what to look for, and how to report any suspicious events or activity. Periodic meetings of authorized personnel should be held to discuss security issues.	
Do your personnel have a checklist to use for threats or suspicious calls or to report suspicious activity?	Yes No	To properly document suspicious or threatening phone calls or reports of suspicious activity, a simple checklist can be used to record and report all pertinent information. Calls should be reported immediately to appropriate law enforcement officials. Checklists should be available at every telephone. Sample checklists are included in Attachment 3. Also consider installing caller ID on your telephone system to keep a record of incoming calls.	

Information storage/computers/controls/maps			
QUESTION	ANSWER	COMMENT	ACTION NEEDED/TAKEN
Is computer access "password protected?" Is virus protection installed and software upgraded regularly and are your virus definitions updated at least daily? Do you have Internet firewall software installed on your computer? Do you have a plan to back up your computers?		All computer access should be password protected. Passwords should be changed every 90 days and (as needed) following employee turnover. When possible, each individual should have a unique password that they do not share with others. If you have internet access, a firewall protection program should be installed on your computer. Also consider contacting a virus protection company and subscribing to a virus update program to protect your records. Backing up computers regularly will help prevent the loss of data in the event that your computer is damaged or breaks. Backup copies of computer data should be made routinely and stored at a secure off-site location.	
Is there information on the Web that can be used to disrupt your system or contaminate your water?		Posting detailed information about your water system on a Web site may make the system more vulnerable to attack. Web sites should be examined to determine whether they contain critical information that should be removed. You should do a Web search (using a search engine such as Google, Yahoo!, or Lycos) using key words related to your water supply to find any published data on the Web that is easily accessible by someone who may want to damage your water supply.	
You should educate your customers about your system. You should encourage them to be alert and to report any suspicious activity to law enforcement authorities.			

Are maps, records, and other information stored in a secure location?		Records, maps, and other information should be stored in a secure location when not in use. Access should be limited to authorized personnel only. You should make back-up copies of all data and sensitive documents. These should be stored in a secure off-site location on a regular basis.	
Are copies of records, maps, and other sensitive information labeled confidential, and are all copies controlled and returned to the water system?		Sensitive documents (e.g., schematics, maps, and plans and specifications) distributed for construction projects or other uses should be recorded and recovered after use. You should discuss measures to safeguard your documents with bidders for new projects.	
Are vehicles locked and secured at all times?		Vehicles are essential to any water system. They typically contain maps and other information about the operation of the water system. Water system personnel should exercise caution to ensure that this information is secure. Water system vehicles should be locked when they are not in use or left unattended. Remove any critical information about the system before parking vehicles for the night. Vehicles also usually contain tools (e.g., valve wrenches) that could be used to access critical components of your water system. These tools should be secured and accounted for daily.	

Public Relations			
QUESTION	ANSWER	COMMENT	ACTION NEEDED/TAKEN
Do you have a program to educate and encourage the public to be vigilant and report suspicious activity to assist in the security protection the water system	Yes No	Advise your customers and the public that your system has increased preventive security measures to protect the water supply from vandalism. Ask for their help. Provide customers with your telephone number and the telephone number of the local law enforcement authority so that they can report suspicious activities. The telephone number can be made available through direct mail, billing inserts, notices on community bulletin boards, flyers, and consumer confidence reports.	
Does your water system have a procedure to deal with public information requests, and to restrict distribution of sensitive information?	Yes No	You should have a procedure for personnel to follow when you receive an inquiry about the water system or its operation from the press, customers, or the general public. Your personnel should be advised not to speak to the media on behalf of the water system. Only one person should be designated as the spokesperson for the water system. Only that person should respond to media inquiries. You should establish a process for responding to inquiries from your customers and the general public.	

Public Relations			
QUESTION	ANSWER	COMMENT	ACTION NEEDED/TAKEN
Do you have a procedure in place to receive notification of a suspected outbreak of a disease immediately after discovery by local health agencies?	Yes No	It is critical to be able to receive information about suspected problems with the water at any time and respond to them quickly. Procedures should be developed in advance with your state drinking water primacy agency, local health agencies, and your local emergency planning committee.	

Do you have a procedure in place to advise the community of contamination immediately after discovery?	Yes No	As soon as possible after a disease outbreak, you should notify testing personnel and your laboratory of the incident. In outbreaks caused by microbial contaminants, it is critical to discover the type of contaminant and its method of transport (water, food, etc.). Active testing of your water supply will enable your laboratory, working in conjunction with public health officials, to determine if there are any unique (and possibly lethal) disease organisms in your water supply. It is critical to be able to get the word out to your customers as soon as possible after discovering a health hazard in your water supply. In addition to your responsibility to protect public health, you must also comply with the requirements of the Public Notification Rule. Some simple methods include announcements via radio or television, door-to-door notification, a phone tree, and posting notices in public places. The announcement should include accepted uses for the water and advice on where to obtain safe drinking water. Call large facilities that have large populations of people who might be particularly threatened by the outbreak: hospitals, nursing homes, the school district, jails, large public buildings, and large companies. Enlist the support of local emergency response personnel to assist in the effort.	
Do you have a procedure in place to respond immediately to a customer complaint about a new taste, odor, color, or other physical change (oily, filmy, burns on contact with skin)?	Yes No	It is critical to be able to respond to and quickly identify potential water quality problems reported by customers. Procedures should be developed in advance to investigate and identify the cause of the problem, as well as to alert local health agencies, your state drinking water primacy agency, and your local emergency planning committee if you discover a problem.	

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Now that you have completed the

"Security Vulnerability Self-Assessment Guide for a Public Water

Systems," review your needed actions and then prioritize them based on the most likely threats. A Table to assist you in prioritizing actions is provided in

Attachment 1.

Attachment 1: Prioritization of Needed Actions

Once you have completed the "Security Vulnerability Self-Assessment Guide for Public Water Systems," review the actions you need to take to improve your system's security. Note the questions to which you answered "no" on this worksheet. You can use it to summarize the areas where your system has vulnerability concerns. It can also help you prioritize the actions you should take to protect your system from vulnerabilities. Make sure to prioritize your actions based on the most likely threats to your water system.

Question Number	Needed Actions	Scheduled Completion

Attachment 2: Emergency Contact List

We urge all public water systems to adopt an emergency response plan (ERP). Emergency plans are action steps to follow if a primary source of drinking water becomes contaminated or if the flow of water is disrupted. You can obtain sample ERPs from your state drinking water administrator, or from your state primacy agency.

This sample document is an "Emergency Contact List." It is an essential part of your ERP. It contains the names and telephone numbers of people you might need to call in the event of an emergency. This is a critical document to have at your disposal at all times. It gives you a quick reference to all names and telephone numbers that you need for support in the case of an emergency.

Filling out this Emergency Contact List reminds you to think about all of the people you might need to contact in an emergency. It also may encourage you to talk with these people about what you and they would do if an emergency were to occur.

Section 1. System Identification

System Name		
Town/City		
Telephone Numbers	System Telephone	Evening/Weekend Telephone
Other Contact Information		Email
Population Served and Number of Service Connections	People Served	Connections
System Owner (The owner must be listed as a person's name)		
Name, title, and telephone number of person responsible for maintaining this emergency contact list	Name and title	Telephone

Section 2. Local Notification List

ORGANIZATION	CONTACT NAME/TITLE	TELEPHONE DAY	TELEPHONE NIGHT	EMAIL
Fire Department				
Health Department				
National Intelligence				
Police Department				
Local Hospital				
Local Emergency Planning Committee				
Local Pharmacy				
Water System Operator				
Neighboring Water System Operator				
Other				

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Section 3. Communication and Outreach

Communications

Communications during an emergency poses some special problems. A standard response might be to call "911" for local fire and police departments. But what if you're emergency had disrupted telephone lines and over-loaded cell phone lines? Talk with your county emergency management agency about local emergency preparedness and solutions to these problems. Increasingly, state emergency agencies are establishing secure lines of communication with limited access. Learn how you can access those lines of communication if all others fail.

Outreach

Make arrangements for contacting institutions with large numbers of people, some of whom may be immuno-compromised:

If there is an incident of contamination in your water supply, you will need to notify the public and make public health recommendations (e.g., boil water, or use bottled water). To do this, you need a plan.

X How will you reach all customers in the first 24 hours of an emergency?
X Appoint a media spokesperson—a single person in your water system who will be authorized to
X make all public statements to the media.

Make arrangements for contacting institutions with large numbers of people, some of whom may be immuno-compromised:

- Nursing homes
- Hospitals
- Schools
- Prisons

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Attachment 3: Threat Identification Checklist

Water System Telephone Threat Identification Checklist

In the event your water system receives a threatening phone call, remain calm and try to keep the caller on the line. Use the following checklist to collect as much detail as possible about the nature of the threat and the description of the caller.

1. Types of Tampering/Threat:

☐ Contamination		☐ Threat to tamper
☐ Biological		☐ Bombs, explosives, etc.
☐ Chemical		☐ Other (explain)

2. Water System Identification:
Name:
Address:
Telephone:
PWS Owner or Manager's Name:

Alternate Water Source Available: Yes/No If yes, give name and location:

4. Location of Tampering:

–
–

☐ Distribution Line	☐ Water Storage Facilities	☐ Treatment Plant	☐ Raw Water Source
☐ Treatment Chemicals	☐ Other (explain):		

Contaminant Source and Quantity:

Date and Time of Tampering/Threat:

Caller's Name/Alias, Address, and Telephone Number:

Is the Caller (check all that apply):

☐ Male	☐ Female	☐ Foul	☐ Illiterate
☐ Well Spoken	☐ Irrational	☐ Incoherent	

9. Is the Caller's Voice (check all that apply):

☐ Soft	☐ Calm	☐ Angry	☐ Slow
☐ Rapid	☐ Slurred	☐ Loud	Laughing

☐ Crying	☐ Normal	☐ Deep	☐ Nasal
☐ Clear	☐ Lisping	☐ Stuttering	☐ Old
☐ High	☐ Cracking	☐ Excited	☐ Young

☐ Familiar (who did it sound like?)
☐ Accented (which nationality or region?)

Is the Connection Clear? (Could it have been a wireless or cell phone?)

Are There Background Noises?

☐	Street noises (what kind?)	
☐	Machinery (what type?)	
☐	Voices (describe)	
☐	Children (describe)	
☐	Animals (what kind?)	
☐	Computer Keyboard, Office	
☐	Motors (describe)	
☐	Music (what kind?)	
☐	Other	

Call Received By (Name, Address, and Telephone Number):

Date Call Received:

Time of Call:

14. Call Reported to: Date/Time

15. Action(s) Taken Following Receipt of Call:

Water System Report of Suspicious Activity

In the event personnel from your water system (or neighbors of your water system) observe suspicious activity, use the following checklist to collect as much detail about the nature of the activity.

Types of Suspicious Activity:	
Breach of security systems (e.g., lock cut, door forced open)	Changes in water quality noticed by customers (e.g. change in color, odor, taste) that were not planned or announced by the water system
Unauthorized personnel on water system property.	Other (explain)
Presence of personnel at the water system at unusual Hours	
Water System Identification:	
Name	
Address	
Telephone Numbers:	
PWS Owner or Manager's Name:	
Alternate Water Source Available: Yes/No	If yes, give name and location:
Location of the Suspicious Activity ☐ Distribution Line ☐ Treatment Plant ☐ Treatment Chemicals	☐ Water Storage ☐ Raw Water Sourc ☐ Other (explain)

If Breach of Security, What was the Nature of the Breach? ☐ Lock was cut or broken, permitting unauthorized entry. Specify location ☐ Lock was tampered with, but not sufficiently to allow unauthorized entry. Specify location ☐ Door, gate, window, or any other point of entry (vent, hatch, etc.) was open and unsecured Specify location ☐ Other Specify nature and location
Unauthorized personnel on site? Where were these people? Specify location What made them suspicious? ☐ Not wearing water system uniforms ☐ Something else? (Specify) What were they doing?
Please describe these personnel (height, weight, hair color, clothes, facial hair, any distinguishing marks):
Call Received By (Name, Address, and Telephone Number): Date Call Received: Time of Call:
9. Call Reported to: Date/Time:
10. Action(s) Taken Following Receipt of Call:

Disclaimer

This document contains information on how to plan for protection of the assets of your water system. The work necessarily addresses problems in a general nature. You should review local, state, and federal laws and regulations to see how they apply to your specific situation.

Knowledgeable professionals prepared this document using current information. The authors make no representation, expressed or implied, that this information is suitable for any specific situation. The authors have no obligation to update this work or to make notification of any changes in statutes, regulations, information, or programs described in this document. Publication of this document does not replace the duty of water systems to warn and properly train their employees and others concerning health and safety risks and necessary precautions at their water systems.

Neither the Association of State Drinking Water Administrators, the National Rural Water Association, the U. S. Environmental Protection Agency, or the Drinking Water Academy, nor its contractor, The Cadmus Group, Inc., assume any liability resulting from the use or reliance upon any information, guidance, suggestions, conclusions, or opinions contained in this document.

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Certificate of Completion

A final step in completing the "Security Vulnerability Drinking Water Systems" is to notify the State Ministry of Roads, Housing and Infrastructure that the fill in the following information and send a copy of this page to the Governor's office. You must maintain a copy of this page in your official records.

System Name: ____________________

Address: ____________________

Town: ____________________ State: ____________________

Phone : ____________________

Email: ____________________

Person Name: ____________________

Title: ____________________

Address: ____________________

Town: ____________________

Phone: ____________________

Email: ____________________ State: ____________________

I certify that the information in this vulnerability assessment has been completed to the best of my knowledge and that the appropriate parties have been notified of the assessment and recommended steps to be taken to enhance the security of the water system. Furthermore, a copy of the completed assessment will be retained at the pubic water system, in a secure location, for review by the State Department of Health when requested.

Designed by: ______________________________

(Please print/Type)

Signature: ____________________ Date: ____________________

VERY IMPORTANT!

Mail this completed page to: State Ministry of Public Health and Infrastructure
Rubkona, Unity State, South Sudan

Effective Response

The ability to respond rapidly and effectively in the event of an emergency is critical to the restoration of function and funds to any business. Standard operating procedures must be restored quickly to ensure the business can continue to provide vital services and meet customers' demands. Priority must be given to those operations critical to the restoration of safe water service to the public. The Emergency Response Plan should be considered to be a vital part of the annual Department of Health Capacity Assessment inspection and should be updated annually. Incomplete plans or ones that have not been annually updated should be noted as significant deficiencies for the system's Sanitary Survey. All Public Water Systems must complete an Emergency Response Plan.

The Emergency Response Plan allows the water system to address concerns about prevention, preparedness, response, and recovery in the event of an emergency. The plan asks system officials to focus on creating and updating an emergency contact list, emergency procedures, and a recovery plan. Employees should be thoroughly trained on the procedures in the system's plan, and should also be given specific assignments to focus on in the event of an emergency so that a goal of returning safe and secure water service to the customers can be realized.

Public Water System Emergency Response Plan
Template
(Revised 30/03/2021)

Provided by the State Ministry of Infrastructure, Housing and Roads, Unity State

Special thanks to

Community Resources Group, Inc.

for providing this document which

has been modified to meet the needs of

Mississippi's public water systems

Water System Emergency Response Plan

Section I.
General ERP Statement

Pursuant to guidance from U.S. EPA and in compliance with Section 1433 of the Safe Drinking Water Act and the Emergency Planning and Community Right-to-Know Act, ___________________________________ has adopted the following Emergency Response Plan to serve as a guide to the management and other staff in responding to an emergency event. Should such an event occur, board members, employees, and other agents of the system shall use this ERP as a guide and their best judgment in preparing an appropriate response. The water system ERP shall be reviewed by the board each year and updated as necessary.

Section II.
General Workplace Safety Policy Statements

1.01 General Policy Statement

Pursuant to Occupational Health and Safety Administration regulations and other federal and state laws, it is the policy of the water system to provide employees with safe and healthy working conditions. It is the policy of the water system that employees and other agents performing work for the system adhere to the following policy statements in an effort to minimize the chance of workplace accidents which can result in injuries or death to employees or others.

2.02 Reporting Workplace Hazards

The water system requires all employees to report existing and potential hazards as soon as practical to the Certified Operator. It is the responsibility of the water system board to take every reasonable measure to remove or warn employees about the reported hazards.

2.03 Contact List Posting

Copies of the water system ERP Contact List shall be posted at the water office as well as in every service truck or other vehicle owned or operated by the water system.

2.04 Safety Equipment Use

Individual safety equipment supplied by the system or safety components of equipment used by the employees of the water system including but not limited to seat belts, emergency flashing lights, hard hats, safety goggles, traffic cones or barricades, self-contained breathing apparatuses, safety harnesses, or other equipment shall be used accordingly. Alteration or removal of any equipment or vehicle's safety device components including but not limited to seat belts, emergency flashing lights, emergency engine kill switches, weight sensitive seat kill switches, or other components is strictly forbidden.

2.05 Notification of Injuries

Employees must inform the Certified Operator of any on-the-job injury or accident requiring first aid or medical attention, whether or not worktime is lost. The Certified Operator will in turn conduct an investigation of any job-related injury or illness requiring a doctor’s care. Injuries that require only first aid and result in no loss of production or worktime will be investigated by the Certified Operator who will in turn submit a written report to the board.

2.06 Confined Entry - Climbing Prohibition

Employees lacking proper training or OSHA certification are prohibited from entering a confined vessel including but not limited to ground storage water tanks, hydropneumatic water tanks, water standpipes, or elevated tanks. Employees are also prohibited from climbing water standpipes or elevated tanks without a safety line and harness and in the absence of another employee on the ground.

Section III.

General Emergency Response Procedures

3.01 General Emergency Procedures Statement

It is recommended that the water system employees adhere to the following steps in responding to all emergency event that threaten the system, its employees, its customers, and / or its ability to maintain pressure and to supply potable water in compliance of federal / state drinking water standards.

3.01.1 Identify the threat to the public, customers, employees, and / or other system assets.
3.01.2 Take appropriate actions to prevent injuries and / or the loss of life.
3.01.3 Take appropriate actions to prevent additional injuries and / or damage.
3.01.4 Complete repairs based on priority demand.
3.01.5 Return water system to normal operational levels.
3.01.6 Evaluate effectiveness of the ERP in providing guidance to this emergency event.
3.01.7 Revise the ERP as necessary to improve guidance for future events of this type.

Section IV.

Accident Procedures

4.01 Accidents Involving Employee

In the event of a workplace related accident causing injury to an employee of the water system, any nearby uninjured employee shall attempt to assess the severity of the injury and determine if an emergency response is necessary. If emergency aid is required, the uninjured employee shall contact the appropriate emergency response by dialing 911 and giving the dispatcher specific information related to the accident, location, and nature of the injured employee's injuries. As soon as possible, the Certified Operator should contact the water system's insurance carrier (if the system has workers compensation insurance).

4.02 Accidents Involving Others

In the event of an accident causing injury to someone other than an employee of the water system but involving an employee while on the job, the employee shall contact emergency response as soon as practical by dialing 911. The employee should give the dispatcher specific information related to the accident, location, and nature of the injuries involved. As soon as possible, the Certified Operator should contact the water system's insurance carrier and attorney. All employees shall refrain from making statements or admissions of wrong-doing without first consulting the water system's attorney.

Section V.

Natural Disasters

5.01 Natural Disasters

In the event of an impending weather related warning or advisory including a thunderstorm, tornado, hurricane, winter storm, flooding, or other natural disaster, the Certified Operator should ensure that the water system is adequately prepared by securing facilities, equipment, and ensuring reasonable protection for the system employees. If a sustained electrical outage is expected, the Certified Operator should coordinate efforts with the County/State Emergency Management Coordinator and the Mississippi Emergency Management Agency (MEMA) to obtain electrical generators necessary temporarily restore power to water wells, booster pumps, and treatment plants. As soon as possible after the immediate danger has ended, the Certified Operator should have the employees of the water system to conduct a damage assessment of the water system. If the damage has caused or will cause a water outage, steps should be taken to restore water pressure as soon as possible and to issue a boil water notice. Furthermore, the MEMA DR-1 Flash Report should be forwarded to the Rubkona County Emergency Management Agency within four hours of the event to ensure that the water system is eligible for federal / state disaster assistance.

Section VI.
External Emergencies
6.01 External Emergencies
In the event of an external emergency which threatens the water system, the Certified Operator and other system employees should ensure that the probability of damage and or contamination of the water system or injury to the employees of the water system is minimized. Such events including an accidental chemical release, nuclear or other radiological release, natural gas or petroleum leak or fire, wildfire, riots or strikes, an act of terrorism or other external emergencies have the possibility of threatening the property, employees, customers, and mission of the water system. In the event of such emergency, the Certified Operator should establish communication and with the County Emergency Management Coordinator and other emergency response agencies to aid in the development of a plan to mitigate any possible damage or threat to the water system.

Section VII.
Internal Emergencies
7.01 Internal Emergencies
In the event of an internal emergency which threatens the water system, the Certified Operator and other system employees should ensure that the probability of damage and or contamination of the water system, injury to employees, or injury to the public is minimized. Such events including an accidental chlorine release, fire, major water line break, or other internal emergencies have the possibility of threatening the property, employees, customers, and mission of the water system. In the event of such emergency, the Certified Operator should establish communication and with the County Emergency Management Coordinator and other emergency response agencies to aid in the development of a plan to mitigate any possible damage or threat to the water system, its employees, customers, or the public.

Section VIII.
Threats and Hoaxes
8.01 Threats and Hoaxes
With the receipt of a verbal, written, or rumored threat to the water system, the Certified Operator and other system employees should consider the threat to be real until proven otherwise. Such threats including but not limited to the use of firearms, explosives, weapons of mass destruction, other weapons, and the threat of contaminating the water supply should be taken seriously. Law enforcement officials should be notified of the threat as soon as possible and steps should be taken immediately to protect the water system, its employees, and its customers. If a threat related to introducing contaminants into the potable water supply, steps should be taken to immediately contact MDH Bureau of Public Water Supply and the County Emergency Management Agency (designated Homeland Defense State Coordinating Agency) in addition to shutting off the supply of water and issuing a “Do Not Drink” notice to the customers of the water system. A thorough inspection of the water system should be implemented as soon as possible in addition to obtaining water samples at the source, storage tanks, and distribution system.

Only after analytical tests have proven that no contaminants have been introduced into the water or under order from the MDH –Bureau of Public Water Supply, should the water system be re-pressurized and the "Do Not Drink" notice lifted.

Section IX.
Contamination and Waterborne Disease Outbreaks
9.01 Contamination and Waterborne Disease Outbreaks

The water operator shall have a minimum certificate qualification in water operations course in a reputable in Institution. Furthermore, if the free chlorine residual level drops below 0.5 mg/l, the Certified Operator and employees shall take steps to increase the residual including the flushing of lines and raising the chlorine dosage rate and if necessary shock chlorinating the water. However, if it is suspected that the water system has become contaminated because of increased aesthetic water quality complaints particularly related to unusual odor in the water or by reports of an increase in acute gastrointestinal illnesses or other suspicious illnesses of consumers of water supplied by the system, the Certified Operator shall contact the
MDH – Bureau of Public Water Supply as soon as possible. Increased water quality monitoring should be implemented and if necessary, a thorough inspection of the system's water tanks, backflow prevention devices, and other actions recommended by
MDH should be implemented. If it is suspected that the contamination is a result of intentional sabotage or an act of terrorism, the Certified Operator shall contact the Mississippi Emergency Management Agency as soon as possible.

Section X.
Water Outages
10.01 Water Outages

A minimum of 20 psi should be maintained throughout the distribution system at all times. Should a major line break, power outage, telemetry failure, or other unintentional or intentional event that results in a sustained pressure of less than this minimum threshold occur, the Certified Operator should coordinate with Bureau of Public Water Supply in the issuance of a voluntary Boil Water Notice. Furthermore, bacteriological samples should be taken from the effected areas of the system and if necessary, appropriate actions to increase the disinfectant level by adjusting the chlorine dosage rate or shock treatment should be completed. Only after samples have been analyzed and determined to be clear of total coliform should the Certified Operator lift the Boil Water Notice to the effected areas of the system.

Security Measures
11.01 Process-Oriented Security Measures

It is the policy of the water system that necessary measures are employed at all times to reduce the possibility of intentional damage to the water system's physical plant, office, vehicles and other equipment. All water well sites, tank sites, treatment plant sites are considered restricted areas. Only the payment window vestibule area and board room (only during board meetings) at the water office are not restricted areas. Only authorized employees of the water system may enter restricted areas unaccompanied. All other people are required to be accompanied by an authorized employee of the water system at all times while in restricted areas. Furthermore, all visitors to restricted areas shall be required to sign-in at the water office prior to be accompanied to a restricted area. All restricted areas shall be visibly marked "Restricted Area / Authorized Personnel Only" and shall be kept locked and secure at all times when an employee is not onsite. Other security measures shall also be followed to prevent the unauthorized use, theft, or damage to water system property. Employees shall remove keys from vehicles when not in use and lock doors to vehicles (and tool / supply storage boxes) at night and when attending meetings or training events.

Keys to other equipment shall be removed when not in use and additional measures employed to prevent the unauthorized use, theft, or damage. Computers shall be password protected and should be turned off at the close of each business day.

11.02 Security Barriers

Physical and passive security barriers shall be maintained to provide reasonable protection of the water system's assets. All wells, tanks, treatment plants, and pipe / maintenance yards shall be fenced at a minimum height of 72" and include either rolled barbed wire headers. Gates shall be kept operational and shall be locked with single locks only with only authorized system employees having keys. All doors to buildings, control panels, treatment plant rooms, chemical storage rooms / buildings, and electrical control boxes shall be locked at all times. Anti-climb barriers shall be installed on elevated tanks and stand pipes. Passive barriers including motion-activated exterior security lights shall be installed and maintained at the water office and the treatment plant. All facilities including wells, tanks, treatment plants, and the water office and other buildings shall have security night lights. Other passive barriers including keeping brush and vegetation off of or hanging over fences shall be implemented.

Section XII.

Recovery Plan

12.01 Recovery Plan

In the event of an emergency that causes catastrophic damage to the water system, the Certified Operator shall coordinate with the system's insurance carrier and if applicable with the County Emergency Management Coordinator in the development of a recovery plan to return the system to normal operations as soon as possible. The Certified Operator shall also be responsible for giving periodical updates to the board, to the news media, and to customers during the recovery phase of an emergency. Assistance from outside contractors as well as mutual aid providers shall be requested as necessary to expedite recovery operations.

Section XIII.

Emergency Response Training and Drilling

13.01 Contamination and Waterborne Disease Outbreaks

It is the policy of the water system that the management and other system employees have the knowledge and the skills necessary to effectively function during an emergency crisis. The Certified Operator shall ensure that other employees of the system have adequate training opportunities made available. Periodically, the Certified Operator should conduct practice exercises and mock emergency drills to ensure the proper response and readiness of system personnel in handling emergency situations. It is recommended that the Certified Operator involve other local / state agencies as well as neighboring water systems and mutual aid providers in the planning, coordination, and participation in these exercises.

Section XIV.

ERP Confidentiality

14.01 ERP Confidentiality

The water system Emergency Response Plan is a controlled document not intended for release to the general public. Every effort shall be made to keep the contents of this ERP confidential and prevent its intentional or unintentional release to others who may use it to identify weaknesses or procedural errors that can be exploited to cause harm to the water system. Release of this document is permitted to only authorize government agencies as required by law and to the County Emergency Management Coordinator.

Section XV.
Appendix Forms
15.01 Appendix Forms
The following Appendix Forms are an integral component of the water system Emergency Response Plan and shall be used in the execution of the aforementioned procedures. Furthermore, copies of all completed forms shall be kept on permanent file at the water office.
1. Emergency Response Plan Contact List
2. Water System Restricted Area Visitor Log
3. Policy Certification Form

____ Emergency Response Plan Contact List

1.0 Water System Contacts	Name	Title	Alternate
1.01 Water Office			
1.02 Board Members			
1.03 Employees			
1.04 Attorney			
1.05 Engineer			
1.06 Accountant/Finance manager			
2.0 Water System Contacts	Name	Title	Alternate
2.01 Law Enforcement			
2.02 Fire Department			
2.03 Emergency Medical Service			
2.04 County Emergency Management			
2.05 County Health Department			
2.06 Intellgence Department			

		Water System Restricted Area Visitor Log			
Date of Visit	Name of Visitor	Purpose of Visit	Time In	Time In	Name of Accompanying Authorized Employee
Page 1 of 30					

CERTIFICATION OF ADOPTION

I hereby certify that the above ____ Emergency Response Plan was adopted by a motion properly made, seconded, and approved by the water system board on the ________ day _______________A.D. with the effective date being ____________ day of __________________A.D. I further certify that the policy remains in force, has not been amended, or rescinded.

Certified Record of Vote: ________voting “Yes”, _________voting “No”, _________Abstaining or Absent.
Directors voting “Yes” Directors voting “No” Directors Absent or Abstaining

______________ ____
Name of Responsible Official (Please Print or Type)
____
____
Responsible Official Name / Signature Date

Communicating Your Message: The Importance of Public Relations

It is necessary that all public water systems communicate with their members. Not only do customers want to know what is occurring with their water systems, but it's also the law.

Public relations, or community relations, uses communication as a tool to link the water system to its customers. By establishing a community relations program, you can increase the public's awareness of the system and create a positive image. However, developing and maintaining a positive public image for the system takes time. You must remember that community relations is an ongoing process; it never stops. Once your system gains the support of the community, board members must work hard to maintain that support. Once you have the community's approval, the community will be more likely to support your system during new projects, rate hikes, and disasters. Also, negative news will not affect the water system as much if the community already has a favorable view toward the system. Your water system exists in order to provide a needed service to your community. In providing this service, your system must use public relations to:

- Build a relationship between the system and the community.
- Improve communications between system employees and customers.
- Strengthen the relationship between the system and the local government.
- Educate the community about the importance of water, water use, and water conservation.
- Minimize rumors and other negative news or information.
- Inform the public of any precautions that need to be taken.

You can judge the quality of your system's community relations program by answering the following questions.

Community Relations Assessment

1. How involved with the community is your water system?

not at all	somewhat	very

2. How often does your water system inform the community about board meetings?

never	sometimes	always

3. Does your water system keep the community informed on what it is doing?

never	sometimes	always

4. Does your water system have a designated spokesperson?

Yes	No

5. What type of communication does your water system use to get out its message? Check all that apply.

- [ ] newspaper
- [ ] Television
- [ ] radio
- [ ] Newsletter
- [ ] bill stuffer
- [ ] Letter
- [ ] informational fact sheet
- [ ] Brochure
- [ ] meeting
- [ ] None
- [ ] other

Gaining Community Support

A water system should strive to gain and maintain its community's confidence and support. To accomplish this goal, you need a communications strategy. You may ask, "Why bother with a communications plan?" The answer is simple: to make sure your communication activities help you reach your goals and objectives. Otherwise, you may be spending time and money doing things that don't help you get where you'd like to be going. When considering a public relations campaign to communicate your message and enhance your image in the community, think about answers to the following questions:

- What is public relations?
- What is the public?
- What audiences do you want to reach?
- What do you want to say?
- How do you send your message?
- When do you send your message?
- What are your local media?
- Who are your local media gatekeepers (people who control access)?
- Your water system should use the following steps to develop an effective public relations program:
- Clarify the mission
- Current situation analysis
- Goals and objectives
- Communications audit
- Communications resources
- Identify target audiences
- Strategies for reaching target audiences
- The communications plan
- Implementation

Clarify the Mission

Start the process by reviewing your water system's mission. Before any effective communications planning can take place, all board members and employees must have a clear understanding of your system's mission. If you don't know where the organization is headed, it is impossible to help it get there. If your system already has a mission statement, now is a good time to review it and revise it if necessary.

The following questions will help you develop a mission statement. It is vital that each board member consider the following questions before beginning the planning process:

1. Why does the water system exist?

2. What do you hope to accomplish with your organization?

3. If your water system stopped all activity tomorrow, what difference would it make? To whom?

4. After answering the above questions, develop a mission statement for your water system.
   Our mission statement:

Situation Analysis

Consider the direction your system is headed by analyzing current and anticipated concerns and opportunities.
The following questions are important to consider before planning an effective communications program. Make short notes to summarize the main points.

1. What are your water system's strengths and weaknesses?

2. How does your local political climate affect your system?

3. What are the major problems and opportunities affecting activities and the status of your water system?

4. What is the population served by your system?

5. How is it changing?

6. What are the social and economic conditions in your community?

7. How will support of your system change in the foreseeable future?

Determine the Image You Want To Project

Analyze the current situation and then think about your goals and objectives. Determine the image your system wants to project. You can later use that ideal as a yardstick once you solicit opinions on the system's perceived image.

When thinking about a desirable image, consider what the public wants from your water system. Then tell the stakeholders (all target audiences) what you are doing to accomplish these things.
For stakeholders to have confidence in your system, you must assure them that their water treatment meets or exceeds all standards, resulting in water that is safe and of a high quality. Stakeholders must be favorably impressed with the service the water system provides. Customers must view their charges as fair and accurate. They must believe the water system's employees are qualified, knowledgeable, competent, friendly, and polite. They must also know that the board of directors operates the water system in a professional manner. They must consider that the water system communicates well with them. Your system needs to have an excellent public image within the community in order to accomplish its goals. If the water system maintains a positive image, the community will support it when major improvements and purchases are needed. Customers will more likely understand that the changes are necessary to maintain high-quality water.

Goals and Objectives

When building the mission statement, situation analysis, and the image you want to project you should outline the major goals and the objectives for your system. Goals are general outcomes desired; they are "where you want to go." Objectives are specific means of achieving the goals; they are "how you will get to" your goals.

This is the time for the water system to decide the direction it will take. What does it want to accomplish? The water system must stay focused on its major goals such as raising awareness of the system, having an excellent image in the community, and providing excellent service.
Objectives are helpful for monitoring progress. If the water system has a clear idea of its game plan, it can look back later to see if it has been achieved. Objectives must be specific, achievable, and measurable. Make sure that your system does not set objectives that cannot be reached.

The board should include both short-term and long-term objectives. Short-term objectives can be accomplished relatively quickly, usually within 1 year. Long-term objectives generally take longer than 1 year to accomplish. You may need to develop many small "stepping stones" to aid in accomplishing your long-term objectives. Accomplishing these small stepping-stone objectives will help keep motivation high. For example, if your system wants to add a new storage tank, you may want to break that long-term objective into parts, such as getting bids one month and choosing suppliers another month. Small steps leading to a bigger goal may help the water system accomplish its purposes more easily.

List your ideas of goals and objectives in the space provided below. Remember to make objectives specific.

Goals	Objectives

Communications Audit

Take a look at what you currently are attempting to do in communicating the message of your system.

1. Briefly list the current communications activities supporting your water system.

2. How are these efforts being evaluated?

3. What evaluation techniques can be used in the future?

Communications Resources

Next, describe your current communication resources—who is communicating, what is your budget for communications, and how can you use local media. Consider the communications plan's position in the overall water system organization. Have a clear outline of any budget and personnel committed to communications. Although some water systems are large enough to have a team of public relations specialists to handle communications, many small, rural water systems do not have employees with backgrounds in public relations. Employees who were hired to handle operations probably do not have time to handle a community relations program. Decide on the best spokesperson for your water system. You do not want conflicting messages coming from more than one person. Whoever the water system's spokesperson is must possess excellent speaking and writing skills. The person must be friendly, visible within the community, and well-respected and well-liked. For credibility, the spokesperson must be knowledgeable, professional, and trustworthy—reflecting a positive image of the system. To a certain extent, the way the spokesperson is viewed by the community is how the community will view the water system.

If your system cannot hire a public relations professional, a volunteer (often a retired individual) may be used who has relevant experience with public relations. You may locate appropriate candidates through area civic groups and churches. If your water system is limited by the size of the population it serves, you could also check with a local community college or a high school. You may be able to get the free services of an outstanding student if you agree to provide a good reference for his or her skills to future employers. This will help the student build valuable job experience while the water system benefits from the student's skills. A board member may even be called upon to be the system's spokesperson. For anyone handling this important communications task, some training and supervision will probably be required. No matter who is responsible for public relations, it's a good idea for the water system to ask for samples of previous work. Remember that your water system's credibility and image are at stake. You don't want an unknowledgeable or untrained person developing and implementing the water system's communications plan. Resources include human resources, financial resources, physical resources, and media outlets. Reflect on the following questions in light of your current public relations efforts.

Human Resources

1. Who is currently handling the responsibilities for public relations? Briefly describe the communications responsibilities of each person involved with PR.

2. How are the priorities established?

3. What are the strengths and weaknesses of your communications efforts?

Financial Resources

1. What is the budget for a communications plan?
2. Are there any opportunities for other funds?

Physical Resources

1. What equipment is available to your organization?
2. What are the top priorities for proper equipment?

Media Outlets and Other Resources

Weekly newspapers

Daily newspapers

Radio stations

Television stations

Local schools

Local civic organizations

Identify a System Spokesperson

An imperative communications strategy that each water system should adopt is to designate a spokesperson for the system. While this spokesperson will not provide all communications for the system, he or she should provide a single, unified message in the event of disaster, major system events such as outages or major repairs/upgrades in which some customers will be without water, or rate/fee increases. Decide on the best spokesperson for your water system. You do not want conflicting messages coming from more than one person.

The spokesperson must possess excellent speaking and writing skills. The person must be friendly, visible within the community, and well respected and liked. For credibility, the spokesperson must be knowledgeable of the system and its operation, professional and trustworthy – thus reflecting a positive image of the system. To a certain extent, the way the spokesperson is viewed by the community influences how the community will view the water system.

Your board must be aware that anyone who handles this important facet of the system's operation must be required to undergo some training and be "supervised" by the board. Remember, no one from the outside will be able to understand the system's mission and goals without having it explained. Also, the message that the spokesperson is sharing is the board's message. For the board's message to be shared effectively and without distortion, the board must maintain an active role in making sure that the spokesperson is aware of the message that is to be distributed. You don't want an unknowledgeable and/or untrained person developing and implementing the water system's communications plan.

Identifying Target Audiences

Brainstorm about who your various target audiences, or stakeholders, are. It may be helpful to think of them in one of these categories: decision makers and influencers (health department and regulatory agencies; government officials), customers (water system users), internal (water system employees and board members), and others. Now think about why it is important to communicate with each of the target audiences you've identified and what you want to happen as a result of communicating with them. Your organization has many different potential audiences. Each group requires a slightly different communications approach and must be considered separately. Be specific. There is no such thing as the general public: To say you want to reach everyone is to admit you plan to reach no one. For communications to be effective, you must know whom you want to reach, what you want to say and accomplish, and what you can tell your audience is in it for them. After identifying the target audience, get a clear picture of why you want to communicate with this audience. Be very honest. This is only for your internal use. You may say things such as, "To get more money" or "To stop their attack on us." Next, determine the audience's present state of mind. "They don't even think about us." "They confuse us with other utilities." "They are angry about the issue we're dealing with." "They like our system and just need to be reminded to support us."

Assess the Water System's Current Image Among Stakeholders. To judge your target audiences' present state of mind and to determine how effective your current communications efforts have been, you must look at the system's current image among its stakeholders. How does the community view the water system? A water system's stakeholders must hold a favorable image or they will not support the system. To determine an accurate perception of the water system, you must obtain the views of all your target audiences. There are several methods a water system can use to learn its stakeholders' views, including informal personal interviews, telephone interviews or surveys, and written surveys.

Informal contacts. You can informally ask people what they think of the water system. Often customers as well as others will "open up" more in an informal situation when asked their opinions.

Surveys. You can learn the audiences' views of the water system through a customer survey. This survey may be conducted by telephone, or it may be distributed in written form by mail or picked up by customers in the water system office. If a water system designs its survey properly, it can be used for several years for budgeting, planning, and customer relations.

Even though a survey cannot tell a water system all the details that are needed, it can provide basic information on how the customers currently view it. Review the information after you gather and compile it. You should be able to get an idea of how the community feels about your water system. Telephone contacts can be made to determine the public's view of the water system. When using the phone to conduct an interview or a survey, remember to use telephone etiquette.

Look at the following sample survey. It may be used for telephone surveys or for written surveys.

Water System Survey

1. How would you describe your monthly bill charges?

low average high

2. How would you describe the accuracy of your water bills?

poor fair good very good excellent

3. How would you describe the ease of understanding your water bills?

poor fair good very good excellent

4. How would you describe the quality of your water?

poor fair good very good excellent

5. How would you describe the service of your water system?

poor fair good very good excellent

6. How well does your water system keep you informed on current news and activities pertaining to the system?

poor fair good very good excellent

7. How would you describe the image of your water system?

8. How would you improve your water system?

Determine Desired Results: The Message

Now, determine exactly what you want to be the result of your communications. This is critical to effectively analyze of the entire communications plan. If you don't have a clear picture of exactly where you want to go, you never will know when you have succeeded. State this outcome in definite, measurable terms, if possible.

Next, write the message you actually will try to convey to the audience. You may never really say these exact words to your audience, but until you know how to answer the audience's unvoiced question "What's in it for me?" you cannot prepare an effective communications plan.
Based on your understanding of the audience, its habits for receiving information, your objectives, and the level of commitment you want to get, select the form of communications best suited to your needs. Read the following explanation of an effective way to select a form of communications. Then complete the "Strategy for Reaching Target Audiences. By communicating with a target audience, you can

- inform people (create awareness or increase their level of awareness)
- influence their attitudes (reverse unfavorable
- attitudes or strengthen favorable attitudes)
- influence their behavior (reinforce or change their commitment to act)

Generally speaking, four forms of communications can be used:

- mass media (including news releases, TV, radio)
- targeted media (including direct mail, periodicals, newsletters)
- community and social gatherings (including public meetings and special events)
- one-on-one contact (including personal visits, personal phone calls)

Also, consider the role that technologies (such as teleconferencing, interactive video, CD-ROM, and computer networks) could play in your communications plan. When selecting the most resource-effective form of communication to use for a particular target audience, you need to consider its state of mind and what you want to achieve. For example, if you want to achieve awareness among large audiences, mass media is the best form of communication. On the other hand, if you want to achieve a commitment, the best form of communication is one-on-one contact. Some communication is through the written word, whereas some of it is through the spoken word. Whichever way information is presented, you should always choose words carefully.

Written Communications. The water system may use many forms of written communication to get its message to the community it serves. Listed next are some of the types:

Information Sheets. Basic information could include the history of the system, water sources, and the amount of water produced. Tips on water conservation and other topics would be of interest to many customers. The American Water Works Association provides many low-cost informational pieces ("bill stuffers") that could be included with water bills. Its address is included in the References section.

President's Letter. The president of the board may write a letter that includes the present status of the water system as well as future expectations. Major accomplishments can be listed as well. All that is required for this low-cost promotional item is letterhead and a message.

Brochures. Another way to spread the water system's message is through the use of brochures. A brochure can answer frequently asked questions. A brochure for a new-customer checklist could include the amount of the deposit and the requirements for proof of identification and proof of residence. Another brochure could be a water-quality report, which could include tests on the water and the results, as well as information on where the water comes from. Information on closing an account, such as how long it takes to get back the deposit and when the meter will be shut off, could be used in a brochure. A sample bill could be used in a brochure that informs customers how to read a bill and how the bill is generated.

Newsletters. A newsletter, with the water system logo, can be used to inform the community about the good work the water system is doing to provide safe and clean water. It could include water system news and community news, citing recent accomplishments of the water system and its employees.

Press Releases. A press release is a short news article about a particular newsworthy event. Information such as rate increases and interruption of service could be included. A press release should contain the following information: name of the water system, address, phone number, and contact person; release date; and critical event information, such as **what** the event is, **who** is involved with the event, **where** and **when** the event will be, and **how** the community can participate in the event.
Any further supporting information should also be included. The supporting information reinforces the critical information.

Consumer Confidence Reports. All public water systems, regardless of size, have to provide their customers with a consumer confidence report. A consumer confidence report should include information on the source of the water, a list of all contaminants that the water system tests for, a list of the contaminant levels found in the water, the violations of contaminant levels, the health concerns of the exceeded levels, and definitions of terms. A consumer confidence report can include information about improvements that have been made and future projects of the water system. A system can also tell its customers about its goals and can stress it is providing clean, safe water. Consumer confidence reports have unlimited possibilities for strengthening a system's community relations program. Though your number of complaints may increase due to some negative information being included in the consumer confidence report, your customers will also appreciate your honesty. Try to develop a report that has information the customers will be interested in. Several examples of these written materials can be found in the Appendix, the last part of this manual.

Spoken Communication. Spoken communication can be through informal contacts that are one-on-one, or they may be through formal presentations at public community meetings. Oral communication may also be over the telephone.

Presentations. Make sure your speech fits your audience. For example, if you are talking to customers, you probably would avoid technical terms they might not understand; however, if you're talking to a group of engineers, technical terms might be appropriate. If you are talking to customers in an informal setting, you could sit while speaking to them. If you are giving a formal presentation, on the other hand, you would stand when speaking to a group. Whenever you are communicating, remember that your appearance, hand gestures, eye contact, and facial expressions are all part of the message you are sending.

Telephone Contacts. Sometimes the first contact the water system will have with a customer is by telephone. The telephone is a useful tool that can improve the water system's public relations program. This first contact can form a lasting impression of the water system.
Using the following tips while making telephone contacts should help ensure a positive image of the water system:

- Answer the phone in a timely manner, usually within four rings.
- Identify yourself to callers.
- Use the caller's name. (Jot it down if you need to.)
- Listen closely to the other person. (You may be able to detect the caller's tone of voice.)
- Concentrate on the call. (Eliminate distractions; do not conduct side conversations.)
- Smile through the phone. (This technique projects a pleasant tone.)
- Ask permission before putting a person on hold. (Never keep someone on hold for extended periods; keep the caller informed on your progress.)
- Don't make the caller feel he or she has interrupted you.
- If you tell someone you will call back, make sure you do it.

Thank the caller.

Electronic Communication. Today's technologies provide for many new types of communication that are unique in themselves, but combine many of the attributes of one-on-one conversations, written communications and telephone communications. While some of these methods are currently fairly new and perhaps unfamiliar to many people, there are several that have been utilized in many situations and would be familiar to most water system customers.
E-mail. E-mail is a ubiquitous form of communication that is increasingly being used for mass notices. Effective e-mail systems can be free or can cost several hundred dollars. "Standard" messages are best

used for notices or warnings while "HTML" messages can be used for letters, features, highlights, and meeting agendas.
While there are e-mail accounts that are free and available to everyone, entity related domains are more professional (ex:Joe. smith@watersystem.org). Domains, obtained from internet service providers, are relatively inexpensive and provide the basis for websites and blogs. In order to be effective, customer e-mail addresses must be collected from the system's customers and every effort must be made to keep these e-mails confidential. Innovative tools that are based on e-mail include client groups and listserves. These tools can be used to maintain the recipient's confidentiality. If these types of tools are used, make sure that an easy method for customers to "unsubscribe" or not participate is provided.

Websites. Having a website provides a way for customers to obtain information and interact with the utility at all times. Anything and everything can and should be posted: bylaws, director/employee profiles, expansion/construction updates, payment methods, rates, as well as anything described in the Written Communications section above. Website programming can be moderately expensive; in most cases, you get what you pay for. There are some free hosting sites, but an entity-based domain is required for a professional appearance. Building a relationship with a skilled programmer is important.

Blogs. Blogs are much like websites, but they are much easier to program and fill with content; the premier blog service is blogspot.com. Usually blogs are maintained by someone who posts regular entries of text, web pages, and media related to its topic; many blogs provide commentary or news about a particular subject. There are ready-made templates available for blogs, but blogs can also be customized to some extent. All media can be posted including pictures, videos and text. Most blogs are interactive and allow viewers to post comments.
Blogs can be used to enhance communication in a corporation, and also, for marketing, branding, or public relations purposes. Blogs often feature advertisements to either financially benefit themselves or to promote their favorite causes. There are also fake blogs that companies create as a marketing tool to promote products.

Facebook. Facebook is a social network with 728 million daily users (as of 1/29/2014). Facebook incorporates many of the features of blog, a website, e-mail and Twitter and provides an "opt-in" method of gaining information. Content on Facebook must be posted in a professional manner; organizational pages should be used for organization businesses. The key to Facebook is to get other users to "like" your page which can be accomplished through the posting of relevant and valued material. In the same vein as having a single spokesperson for the water system, there should be one person or a small committee appointed to post content. Notices, updates, profiles, outages, etc., can all be useful in attracting followers. Facebook pages allow businesses and followers to post pictures and comments to share with the other people involved with a page. Starting with few followers can be discouraging. Constantly monitor followers' comments and likes to attract more people to your page. The learning curve for effectively using Facebook is fairly short, but would be beneficial if this a tool that the system is considering incorporating into its community relations/ communications plan

Twitter. Twitter is an information network designed to share short bits of information very quickly. Each short bit of information is provided in 140 character bursts called "tweets". Because of the short messages, the use of products are explained in ways that followers are more likely to read. Twitter allows companies to promote products on an individual level, and is a great way to share website postings, typically through a free website service called Tinyurl.com. Twitter is a good way to gather market intelligence and insights and build relationships with people who care about your company. Twitter allows entities to share photos, ask and answer questions, announce events and share general knowledge about operations, marketing and service activities. This interaction can create loyal connections between products and individuals and can also lead to larger advertising opportunities.

45% of businesses use Twitter as a form of intensive communication with their customers. Eighty-three percent of Twitter business users say they would recommend

Twitter to other small to medium sized businesses. **YouTube.** YouTube is a video posting website that hosts a variety of videos made by camcorders, flip cams, digital cameras, etc., and can be posted for general viewing. Appropriate videos could be of board meetings, construction/expansion projects, plant renovations or service and line expansions. Knowledge of rudimentary video editing software would be useful. Links to YouTube videos can be sent out through other social media or included on bills.

Communications Between Customers and the Water System. Customers are an important group to the water system because the water system cannot operate without them. Because customers are so important, your water system should keep its customers informed about changes that will affect them. The next section, Customer Service, lists changes that customers need to be informed about.

Treating new customers well will make a positive first impression. In providing exceptional service to new customers, the ground work is laid for a lasting relationship. Employees and board members of the water system should understand the message and the image the system wants to convey. Customers see employees on a day-to-day basis. Employees should dress professionally and abide by all safety regulations. Employees, as well as board members, should be knowledgeable about the water system and should be able to answer simple questions by people in the community.

Working With the Media. The media can be a powerful resource for a water system. Most people watch television, listen to radio, or read a newspaper. When using the media, make sure the story is interesting and has an effect on the community. The water system's spokesperson should build a strong relationship with TV and radio stations and with newspapers. A water system is only as good as the community sees it to be. To build rapport, the water system spokesperson and the media must trust and respect each other. Make sure the water system's spokesperson presents a professional image when being interviewed. In an interview, the spokesperson must be prepared; speak in everyday language, not use technical terms or jargon; and answer questions fully and truthfully. If the spokesperson does not know an answer, he or she should admit it but offer to find out the answer and follow up with the reporter. Never argue with a reporter for any reason.

Strategies for Reaching Target Audiences

Think about what is the best way to communicate with your target audiences—both in terms of the benefits you can stress and the forms of communication that will be most effective, given your resources.

The next four worksheets will help you prepare to develop the communications plan. List all the possible audiences within the four designated groups.

Strategies for Reaching Target Audiences Decision makers and those who influence decision makers (health department; government regulators or officials)	
Target audience (Specific groups you want to reach)	
Objectives (Why it is important to communicate with them?)	
Status (Audience's current state of mind)	
Intended outcome (Response you intend to elicit)	
Form of communications (Resource-effective media)	
Target audience (Specific groups you want to reach)	

Strategies for Reaching Target Audiences 2. Customers or users (those who benefit from your water system)	
Target audience (Specific groups you want to reach)	
Objectives (Why it is important to communicate with them?)	
Status (Audience's current state of mind)	
Intended outcome (Response you intend to elicit)	
Form of communications (Resource-effective media)	
Target audience (Specific groups you want to reach)	

Strategies for Reaching Target Audiences 3. Internal (water system board members, operator, engineer, manager, and other employees)	
Target audience (Specific groups you want to reach)	
Objectives (Why it is important to communicate with them?)	
Status (Audience's current state of mind)	
Status (Audience's current state of mind)	
Intended outcome (Response you intend to elicit)	
Form of communications (Resource-effective media)	
Target audience (Specific groups you want to reach)	

Strategies for Reaching Target Audiences 4. Others	
Target audience (Specific groups you want to reach)	
Objectives (Why it is important to communicate with them?)	
Status (Audience's current state of mind)	
Intended outcome (Response you intend to elicit)	
Form of communications (Resource-effective media)	
Target audience (Specific groups you want to reach)	

Implementation

Planning is no good without follow-through. In large organizations, a specific work group is designated to address the who, what, when, where, and how of the agreed-upon communications strategies. All water system employees will be affected by any organization-wide emphases. You should take into account your system's specific skills and resources, and then assign specific tasks. Establish priorities based on resources and plan evaluations.

Community Relations Review

1. List reasons why community relations is important to a water system.

2. What are the steps for developing an effective community relations program (communications plan)

3. List the characteristics that a water system's spokesperson should have.

4. List the resources that a water system could use to deliver its message.

5. List skills for using the telephone.

6. List the types of written communication a water system can use to deliver its message.

7. List the types of information that should be in a press release.

8. List some ways that a water system can get media coverage.

9. List the skills that should be used when being interviewed.

Please fill out the customer service assessment below. After completing the assessment, you will be able to judge the quality of your system's customer-service program.

Customer Service Assessment

1. Describe a typical customer of your water system.

2. How large is the area that your water system serves?
3. How many customers does your water system serve?

4. Does your system have a written policy that lists the steps a customer may take if he or she has a complaint?

   If so, what are the steps?
5. Who is responsible for handling customers at your water system?
6. What are some bad experiences you have had with customers?

The Importance of Customer Service

The most important people in the world to a water system board member are the water system customers. The primary reason a water system exists is to provide water service to its users, who in turn provide the income to the water system to cover the costs of delivering that water service.

Responding to Customers

Dissatisfied customers can hinder your water system. A survey completed by the Department of Consumer Affairs discovered that approximately 70 percent of customers will support you if you solve their problems to their satisfaction. In most instances, the customer only needs to be informed about the situation and told what you as a board member will do in order to solve the problem.

Word-of-Mouth Responses

Most information is spread by word of mouth. Statistically, customers who have had a bad experience and who remain dissatisfied with the water system will normally tell 11 other people. These 11 individuals will usually tell 5 more people.

As you can see, a snowball effect can occur from just one dissatisfied customer. This one bad experience can result in about 67 people talking negatively about your water system. Pleasant experiences do not have the same effect. Only about half as many customers tell others about their good experiences. People take good service for granted. Customers expect consistent, excellent service. In general, a very good experience will lead a customer to spread the information about your service to approximately five others. These five individuals then tell at least two more.

As you can see, your water system must strive to maintain excellent customer service, because a few bad experiences can hinder growth. Customers with bad experiences will not support your system. A water system that provides excellent customer service will maintain a high image because of excellent word-of-mouth comments from customers. How you handle disgruntled customers tests your customer service expertise.

Skills for Building Good Customer Relationships

As a board member, you set an example for your water system to follow. To be an effective board member you need skills to develop a good customer-service relationship with your water system users. These skills include the following:

- Possessing a positive, caring attitude
- Communicating effectively
- Satisfying customers
- Following up on problems

Positive Attitude. As a board member, customer service begins with you. Employees in the water system follow your lead about customer service. Water system users look to you when they have questions or problems. It is impossible to eliminate all problems with water system users, but try to keep your approach positive. A positive attitude must be maintained to show customers that you care. If you have the attitude that customer service skills are needed only when dealing with difficult customers and complaints, you will not be effective. Water system customers may contact you for reasons other than to complain. They may want information about the water system, or they may want to give you suggestions. Someone may even call to thank you for excellent service.

Effective Communication. The second skill that you need to possess for maintaining excellent customer service is effective communication. Remember that your job as a board member is to serve the water users in your district. In order for you to communicate well, you must learn to listen; good communication begins with listening. You must be willing to listen with an open mind to complaints as well as to questions and suggestions. Communication is a two-way process between you and the water system users. You communicate with your customers through your communications strategy plan (see previous section). Maintaining regular contact with water system users through “bill stuffers,” newsletters, and press releases builds support with the community for your water system.

Customer Satisfaction. The third skill needed to maintain exceptional customer service is the ability to satisfy the customers. Because you are a board member, water system users look to you to help them solve their problems. You must be able to do the “right things right the first time.” Most customers will forgive and forget if you take care of their problems quickly. Customers become irritable when their problems take a long time to be resolved.

From time to time, you will encounter dissatisfied, even irate, customers. Some customers complain only about serious problems, whereas other customers complain about even minor misunderstandings. If you are a new board member, you also may inherit negative attitudes from some customers. Never let a customer think you are unconcerned with his or her problem or deny that a problem exists. If you do, the situation will only worsen. If a customer thinks he or she has a problem with the water system, then you have a problem. If a customer becomes irate, remain calm and let him or her cool down. The customer’s anger and frustration probably has built up, making the problem seem worse than it may actually be. If you can eliminate the anger, a customer’s complaint usually becomes merely a request. As a board member, try to help customers remain calm so you can find a satisfactory solution. Cool heads usually prevail over ill-tempered ones.

Timely Follow-Up Response. You must be able to follow up with the customer after he or she initially contacts you with a problem. Your response shows the customer that you care and that you want to make sure he or she is satisfied. The customer must feel that customer satisfaction is one of your top priorities.

After the first meeting, send a letter that outlines the details of the agreed-upon solution. Then follow through on what was promised. After about a week, call to see if the customer is satisfied with the results. Also, reassure him or her that you appreciate his or her business and patience. Mention that you are available whenever problems or questions arise. Always strive to deliver fast, dependable service; if you cannot deliver timely service, let the customers know why you cannot. Emergency situations do arise that prevent prompt attention to problems, but customers are usually understanding if they are told the truth so they know what to expect. For customers who make unrealistic requests, offer alternative solutions. If the solution cannot be handled in a timely manner, at least keep the customer informed on your progress. Always be honest with customers. Never make promises you cannot keep. Broken promises only create more problems.

Applying the Golden Rule. Customer service skills are easy to master if you put yourself in the place of the customer. Keep this in mind: How do I like being treated? Almost everyone likes to be treated as though he or she is the most important person in the world.

Valuing Your Customers

Use the following principles when dealing with your customers:

- Make customers feel welcome in the water system office, at board meetings, and at other water system functions.
- Make your customers feel important and let them know you respect them.
- Give consideration to customers' ideas and suggestions.
- Listen carefully to customers' problems to understand their points of view.
- Don't let anything interfere with your serving your customers.
- Ask nonthreatening and non-defensive questions about their problems.
- Give your customers the individual and undivided attention they deserve.
- Don't take it personally when customers are unhappy. They are attacking the quality of the water system's service, not you.
- Be a partner with customers in solving their problems.
- Get to know customers by their names.
- Ask what would satisfy them in solving their problems.
- Correct their problems as quickly as possible.
- Apologize to customers for their inconvenience.
- Reassure customers by letting them know you are dedicated to customer service.
- Thank customers for their input.

Situations for Using Customer Service Skills

Water systems should inform their users when the water service may be changed or affected. Explain that the reason for the changes is to improve the overall quality of the current system. Customer service skills benefit a water board member when dealing with the following situations:

- Unhappy customers
- Interruption of water service
- Repairs to the water system
- Changes in taste and pressure
- Rate increases
- Unusual findings from testing
- Collection of water bills

- Water rate disputes
- Water leaks
- New projects

Precautionary Measures. Take precautionary measures to help prevent future conflicts. The following are some preventive measures to ensure quality service for water system users and prevent misunderstandings:

- Provide users with a rate/price list and a schedule of billing dates, late charges, and cutoffs. Include connection and reconnection fees.
- Provide users with costs and income estimates used in setting water rates.
- Establish a convenient location for payments.
- Attend training for board members and employees on dealing with displeased or unhappy customers.
- Inform customers of procedures used to meet legal requirements for providing safe water.
- Have written policies available to customers for the priority of water system jobs and repairs.
- Provide customers with the procedures for filing complaints and the names and phone numbers of contacts.
- Establish open communication with water system users.

Customer Service Review

1. Why is customer service so important?

2. What are some situations you may encounter that require customer-service skills?

3. What are the skills a board member needs in order to provide excellent customer service?

4. List techniques to use in dealing with unhappy customers.

5. List precautionary measures that a water system can use to avoid conflicts with customers.

Section x: A Snapshot Of Operation And Maintenance A Water Utility – From Board Management Point of View

Operation

Objective

The objective of the operational organization is to ensure the provisions of a continued and satisfactory service to the user of the water or sanitation system at minimum cost.

Staffing

Staffing Norms

The Design of both processes and plant must be related to the level of Local staff capability if service is to be satisfactory. Depending on the water supply, the staffing is divided into management, which provide directions and control, the operators provide product quality and matching rate of working to requirement. Maintenance workers will be concerned with the replacement of worn or defective items so as to ensure continuous serviceability. These duties may overlap in the interests of economy.

Composition and duties of staff

The managerial staff of a utility is likely to include engineers (civil, mechanical and electrical) and chemists, supported by engineering and Laboratory Technicians and Technical Assistants, Accounting, Clerical and Secretarial staff. Staff numbers and tasks will depend upon the system size and its complexity.

Staff motivation

Job enrichment aims at increasing the levels of all satisfiers and removing any reason for discontent with the levels of the dissatisfied. The effective operation depends upon trained, interested and motivated staff and it must be a primary task of management to create and maintain such staff.

Records

Records may relate to permanent construction, to operation or to maintenance and repair. Records of permanent construction show what has been done and where it is located. They are used to locate the components of the system on the ground, to aid understanding of the Design and hence how the system is intended to operate, and to facilitate alteration or extension of the system. Operational records may provide guidance for the operation of the system, so they will very often incorporate records of permanent construction or record operational performance to aid future design and to serve administrative purposes. Records of maintenance and repair serve to allow critical evaluation of performance, and to facilitate planned maintenance.

Records of Permanent Construction.

The easy and economic operation of a scheme is particularly dependent upon an understanding of the layout and ready location of the component parts by persons having varying degrees of familiarity with it. The basic requirement therefore is a series of drawings showing increasing degrees of detail starting with a layout of the whole scheme and ending with intricate details of components.

Records Required for Operation and Maintenance

Additional drawings are likely to be required for operation, some only modifications of those already mentioned, these will include plans which show water meter areas. Zoning may be altered over the years so zones should not be permanently depicted on the basic records except by erasable lines.
Organization division for which branch offices are responsible will also be shown on plans.
As-built drawings and others will be incorporated in plant operating manuals wherever this assists the operator. Card files, notebooks, or drawings may be used for other records relating to the distribution system. Cards can also be usefully employed as part of the plant maintenance programme. For example, there should be records on every item of mechanical and electrical.

System curves for pipelines and performances curves for pumps should be included in operating manual. Treatment works, pump stations and similar installations must provide operating records for control, costing and future design. The attendant, who should record the results of routine checks at prescribed intervals, will log basic data. The superintendent will add other information and general comments. At waterworks, reports of this type are likely to show daily figures for the following:-

- Raw water intake
- Pure water output
- Peak day output for period of report.
- Clarifiers scoured: fine since last scour
- Filters back: washed time since last wash
- Water losses
- Chemical usage: Type of chemical
  Mass used
  Dosage added to raw water
  Deliveries
  Residual stock
- Mechanical/electrical plant (for each unit)
  Hour meter readings, hours run
  Power/fuel used
  Fuel stocks remaining
  Service done
  Maintenance done or needed
- Distribution reservoir level
- Raw water storage level
- General comments on materials received or removed, equipment (breakdowns, down time), expenditure and staff.
- The results of works laboratory testing.

The operational report from the sewage treatment works will relate to the type of treatment. For pond treatment, the operating report is unlikely to cover more than daily inflow, color of ponds, maintenance work done, and general remarks. Where treatment is provided by settlement and biological filter, daily records should cover:-

- Inflow – average, peak rate
- Screenings volume
- Volume
- Raw sludge volume

Updating Records

Special arrangement is necessary to ensure effective and continuous updating and reissue. The appropriate processes must be incorporated in the administrative system and time and staff must be provided for the work.

Treatment works – Operational Procedures

The operator at a water or wastewater treatment plant will be concerned with:-

- Distributing inflow among the various units to suit their ratings,
- Preparing and adding chemicals at certain stages in proportions selected to provide an outgoing flow of the correct quality at least overall cost.
- Periodic attention to treatment units, e.g. clarifier scour, water filter backwash or cleaning and removal of vegetable growths.
- Operation and adjustment of a variety of mechanical equipment e.g. screens, mixers, stirrers, chemical dosing equipment, compressors, pump sets, aerators and conveyors.
- Quality control of the effluent leaving the plant.
- Disposal of plant wastes (e.g., filter wash water) by methods environmentally acceptable.
- Minor maintenance procedures
- General cleanliness and appearance of plant and surrounds and
- Record keeping

The waterworks superintendent in particular will be concerned to evaluate demand for an operating period immediately ahead, generally the next day and with matching to it the output of treated water from the plant as efficiently as this can be done. To assess demand we need to know the quantity of water supplied by his works during the previous day, and the distribution reservoirs. Then applying factors to allow for the weather, the day of week and so on, he will formulate his forecast.

Public Relations

As a corollary, the utility should have defined procedures for dealing with complaints, which should be tactfully received and investigated. A utility should have a public relation officer who records complaints and channels them to appropriate person for action simultaneously serves as a record. When appropriate action has been taken, the complaint is advised. Even where he is unreasonable, every attempt should be made to satisfy the complainant.

Laboratories

Objective:

The Laboratory has two chief objectives, firstly, that the result of treatment is a water or wastewater, which complies with prescribed standards and secondly that treatment is efficient.

Sampling:

To ensure the integrity of samples, they should be taken by persons disinterested in the results. Satisfactory results are obtained by engaging both operational and laboratory staff in sampling in a random manner.

MAINTENANCE

Purpose

Maintenance is a key element in the efficient operation of water supply system and hence the necessity of a good preventive and correction or breakdown maintenance program. Preventive maintenance is planned or scheduled maintenance, performed to eliminate or minimize breakdown or corrective maintenance and to extend the useful life of a water supply system. Breakdown or corrective maintenance refers to unplanned or unscheduled maintenance or repair caused by failure and requires immediate action.

Maintenance Programs

Key features of maintenance programs should include:

- Responsibility for maintenance clearly defined and vested in competent personnel.
- Management should state its maintenance objectives and make its position clear with proper support, morally and financially.
- Proper tools, parts, instruments and maintenance facilities must be provided.
- Preventive maintenance must be planned for scheduled and accomplished.
- An adequate system of written records and reports must be used and readily available to control and monitor the program.

Maintenance Systems

The creation of an efficient maintenance service will be facilitated if:-

Management states its maintenance policy, objective and attitude clearly,
Responsibilities are clearly defined and are vested in competent persons
Adequate equipment and materials are scheduled, provided, and themselves maintained, and
Records and reports facilitate control.

Types of Maintenance

There are 3 classes of maintenance viz: -

i. Operational, maintenance, carried out on a day to day basis by the operator and including cleaning minor adjustment, and lubricating
ii. Corrective or breakdown undertaken only after fault or breakdown,
iii. Planned or preventive maintenance. Regular maintenance and parts replacement in accordance with a programme based on calendar time or condition monitoring has superseded operating hours, which seeks to do the work just in time to avert breakdown or serious deterioration in performance.

Preventive (Planned) Maintenance

The intention behind a planned programme is to eliminate breakdown, thus ensuring performance at an acceptable level of efficiency without failure.

- Helps to assure continuous supply of water
- Can be scheduled at times of the year when customer service is not affected or when its adverse effects are minimized.
- The frequency of a planned maintenance program will vary from one utility to another and even among smaller types of equipment. Each equipment item must be studied individually, as similar pieces of equipment may have different maintenance requirements because of location and service.

Table 22: Recommended Summary of Inspection, Test and Maintenance Frequencies

S/NO	Inspection, Test or maintenance performance		Frequency
A	S/NO	Underground water system	
	1	Visual inspection for leaks	Daily
	2	Flushing	
		• Recommended	Semi-annually
		• Minimum	Annually
	3	Inspect/operate non-cutical valves (< 250 mm)	Annually
	4	Inspect/operate large valves (>250mm) cuticle valves or valves with closed gearboxes.	Semi-annually
	5	Fire hydrant inspection	
		• Recommended	Semi-annually
		• Minimum	Annually
	6	Listening survey for leaks	Every 2-3 years
	7	Complete leak detection survey including flow measurements, 24-hour consumption and trunk main gauging.	Every 5 years.
	8	Fire flow tests	Annually
	9	Loss of head tests	Every 5 years
	10	Pressure testing of pipes	
		• Recommended	Every 10 years
		• Minimum	Every 15-20 years
	11	Meter accuracy test	
		>150 mm	Annually
		75 – 150	Every 2 years
		25 – 75	Every 5 years
		< 25mm	Every 10 years
	12	Inspection/testing of backflow parameters (min)	Annually
B		Water plant	
	1	Housekeeping – General condition and appearance of buildings, grounds and equipment.	Daily
	2	Valve inspection/ operation	Semi annually

	3	Water storage tanks	
		• Exterior visual observations	Weekly
		• Check water levels	Weekly
		• Inspect general condition	Annually
		• Complete inspection including tank drainage and checking interior condition and for sedimentation build-up.	
		○ <5,000M^3	Every 5 years
		○ 5000-50,000M^3	Every 10 years.
		○ Over 50,1000M^3	Every 20 years.
	4	Pumps	
		Check operation of routinely operating pumps	Daily
		Check operation of standby operation pumps	Weekly
		Check operation of standby generation equipment	Weekly
		Pump effectiveness and performance testing	Annually
C		Water Quality	
	1	Chlorine residual	Daily
	2	Turbidity	
		• Surface water	Daily
	3	Bacteriological	Monthly
	4	Primary drinking water standards to KBS Standards	
		Surface water	Annually
	5	Radionuclides	Annually
	6	Trilialomethanes	Annually

NOTES

1. Table is presented as a guide which should be modified based on site specific conditions
2. Table does not include a complete schedule of all types of equipment considered to be part of the water plant. Manufacturer's recommendation should be consulted before establishing preventive maintenance schedules on any specific equipment type.
3. Water quality frequency testing would be recommended according to the requirements of the state in which the utility is located. The testing listed is considered the minimum to be accomplished and should be supplemented by other tests needed to monitor and control specific water quality problems in a particular system.
4. Frequency and number of samples of C5 and C6 could be reduced pending at least one year's satisfactory results, but would be subject to the specific requirements of the National Standards.

Other Assets

The principle of planned maintenance, though most significant for mechanical and electrical equipment, should be applied in principle to every part of the system.

Organizing for Breakdown and Emergency

Any utility providing services to the public should prepare itself to deal with breakdowns and emergencies of varying severity. If a local emergency system is adopted, a member of staff should be made responsible for the area in which he resides, and with tools and transport readily available, he should quickly go to the scene of any problem and attend to it or summon assistance.

Purchases

The system of stock control should produce the information needed for the timing of purchases and should record the consumption upon which the buyers depend for fixing the size of any order.

PART II: WATER TREATMENT OPERATORS TRAINING

General Objective Of Transmission System

The overall objective of a transmission system is to deliver raw water from the source to the treatment plants and transmit treated water from treatment plants to the storage reservoirs for onward supply into distribution networks. Transmission of raw water can be either by canals or by pipes whereas transmission of treated water is by pipes only. Transmission through pipes can be either by gravity flow or by pumping.

The objective of O&M of transmission system is to achieve optimum utilization of the installed capacity of the transmission system with minimum transmission losses and at minimum cost. To attain this objective the agency has to evolve operation procedures to ensure that the system can operate satisfactorily, function efficiently and continuously, and last as long as possible at lowest cost.

Routine and emergency operating procedures should be in writing and clear to all operators with the authority to act in emergencies. Further specific operational procedures are required for inspecting, monitoring, testing, repairing and disinfecting the system as well as for locating the buried pipes and valves. System records and maps should be updated and have sufficient details of the system facilities.

NORMAL CONDTIONS

Routine Conditions

Normally the operations involve transmission of required water within the available head or within the pumping head. Operation of valves at reservoirs from which transmission channels/ mains start and operation of pumps (in case of pumping mains) from which the transmission mains start are the routine operations. Operation of chlorinators where installed are also included in the routine operations.

Record of Flow, Water Levels and Pressures

a) Gravity Channels and pipes

A record is kept at the transmitting and receiving reservoirs about the valve operations, water levels and flows. Flow meters are installed at start and end points of transmission channels/pipes for monitoring the flows. Water levels in the reservoirs from which the channels/pipes transmit water and water levels in the receiving reservoirs are measured either by visible gauges or by automatic instruments.

b) Pumping transmission mains

Water levels in the sumps from which the water is being pumped are measured. Critical points are selected in the transmission system for monitoring of pressures by installation of pressure recorders and gauges. In the pumping systems, whenever water pressures in the pumping station drops below the designed system pressure, the operators are alerted to search for possible leaks in the pumping system. Similarly at the receiving end, if the required water levels are not building up at the storage reservoir, it indicates that the required quantity is either not pumped or there may be leakages enroute. At times whenever the maximum levels in the receiving reservoirs are reached the pumps will have to be stopped or the outlet valves of the reservoir have to be opened.

c) Continuity

Operators are required to check that the transmission of water takes place continuously and as per the requirement. Normally, the flow meter readings, water levels in reservoir and pressures in transmission mains are recorded and transmitted to the control room. The operators have to ensure the accuracy of the measuring instruments for flows, pressures and levels so as to perform the operations properly. Analysis of the records will enable the agency to evaluate how well the transmission system is working.

Transmission Through Open Canals Or Open Channels

Introduction

Open channels and Canals are exposed watercourses for transmission of water from one specific point to another. Whereas 'Open Channel' is a general name for such a watercourse, a 'Canal' normally forms a part of canal network taken off from a river, a dam or a reservoir. Following discussion relates to a canal. The criteria for design, operation, and maintenance for open channels are identical to those of a canal.
The canals are meant primarily for irrigation purposes.

The canal water is, however, liberally made available for drinking water supply schemes. While designing new canal projects the requirement for drinking purposes is pre-determined and necessary provision made in the design of the canal projects.

Under special circumstances, however, a specific canal may be constructed exclusively for a drinking water supply project. There are, however, a large number of small water channels taken off from the main canal system and are meant exclusively for the drinking water supply schemes.

MAPS

Survey maps may be procured or prepared for the entire existing and proposed canal network, which could be the probable source of raw water for drinking water supply projects. These maps shall show the contours, spot levels and important land features for the whole area where the water supply schemes are to be implemented or augmented.
Alignment of all main canals, branches, distributaries and smaller major and minor channels shall be marked on the maps. The old maps shall be updated from time to time particularly when an important project is to be undertaken.

Following information shall be obtained for all important points along the alignment from where the connections are likely to be taken.

i. Natural surface level,
ii. Full supply levels,
iii. Bed levels,
iv. Free board,
v. Water surface slope,
vi. Bed width, side slopes, velocity,
vii. Subsoil water levels,
viii. Hydraulic data of outlets, regulators, bridges, drainage crossings, off take channels.

WATER DISTRIBUTION PRACTICES

The canals may run continuously or on rotational basis, depending on the availability of water and demand. Depending on the closure period of a canal, adequate storage of raw water has to be created at the site of the waterworks to endure uninterrupted water supply. Such storage is in the form of open square or rectangular tanks whose side slopes and bed are properly lined. Surfaces of such storage tanks are identical to those of the canals with a difference that the canal surfaces are exposed to flowing water whereas, the water in the storage tanks is comparative static.

OPERATION

The key objective of proper operation and maintenance of the canal system is to ensure uninterrupted, assured, authorized water supply from head to tail of a canal distribution system, ensure efficient conveyance of water, saving seepage losses en-route, at economical maintenance cost. Hence well planned and executed programme of operation, maintenance and repair of canal system, timely and methodically, is very important.

The availability of canal water is far below the requirements except during the active raining months. In order to overcome this problem arising due to less availability of canal water as compared with the overall requirement the entire canal network is divided into different groups which are run strictly according to the sanctioned/notified rotational programme. Each feeding channel has a full supply turn followed by a closure turn. No supply can be allowed to go out of turn.

RECORD KEEPING

An accurate and systematic record of the performance of a canal should be maintained by periodic observations of roughness coefficient, evaporation and seepage losses, life and behavior of the lining adopted, surge wage heights and performance of any special design features like pressure release systems, provision of humps or regulators etc.

MAINTENANCE OF UNLINED CANALS

Some of the most desirable requirements are:

- A clean bed.
- Straight clean slopes.
- Uniform berm widths.
- Uniform regular top width.

Bed and Berms

The beds and berms should be correctly aligned. These should be scraped, where necessary and especially in tail reaches. The canal should be straightened. The kinks and irregularities should be removed and curves should be eased off where scouring or silting takes place. Clearing operation should be started from downstream to upstream.

Bed

All grass should be scraped and weeds removed from the silted bed wherever they are found to exist since their presence induces silt deposits. All accumulation or deposits or mounds of silt should be removed.
Beds should be levelled and their gradient regularized. The canals that carry silt-free water from the reservoirs generally get infested with aquatic weed growth which reduces their capacity and impairs proper functioning. Such canals should be kept clear of aquatic weeds.

Berms

Berms should be kept straight by trimming projections after aligning them correctly.

Site Clearance

Silt ejectors/desilting basins, wherever provided should be operated regularly to prevent accumulation of silt. Longitudinal sections of the silted bed of canals should be taken during closure immediately after monsoons and the gradient at which silt should be removed should be ascertained.

Bridges and Siphons

When a canal is running brushwood that collects at bridges, siphons and falls should be removed away from the banks, dried and burnt. When trees fall into a canal they should be removed at once. Silt and rubbish should be cleared from under the bridges.

Scouring

In case of excessive scouring at any point adequate measures should be taken to stop these.

Flow and gauges

To have effective control in regulation, it is desirable to observe discharge at conspicuous places. Gauges should be installed at the head and tail of all the channels and at important points in between. Their readings should be observed and recorded daily.

Banks

i. The banks should be brought up and maintained to full section. All holes should be traced out and fully opened up. The fallen or loose lumps of earth should be removed. Filling and repairing should be properly done. Both edges of the bank especially Thinner ones should be neatly aligned parallel to the canal. Both inner and outer slopes and toes of the banks should be free from irregularities. The top of both the banks should be kept smooth and free from holes.
ii. Side slopes are usually kept 1:1 in cutting and 1.5:1 in filling. If the soil is comparatively sandy gentler slopes say 1.5:1 in cutting and 2:1 may be provided.
iii. Following precautions may be taken to ensure stability of the Embankments and to maintain their slopes.
    - Adequate compaction to avoid settling on saturation,
    - Prevention of cracks due to settling of fills,
    - Prevention of seepage,
    - Protection from burrowing animals.

No silt should be normally permitted to take place in a lined canal. Sometimes the canal may have to be run at less than the designed full supply demands on account of fluctuating water demands. Such condition may cause deposition of silt over the bed owing to low velocities of flow Consequently discharge carrying capacity is adversely affected. The silt deposition in lined canals can be minimized by judicious operation of gates of cross regulators, silt ejectors/desilting basins, wherever provided.

Inspection of Lining

During the canal closure period the lining, its auxiliaries and special design features should be carefully inspected. Following points should be noted:

i. Whether any cavities or pockets have been formed behind the lining.
ii. Development of any cracks or displacement or damage to the lining.
iii. Whether the filter material in the joints of the lining is sound, intact and leak proof and any weed growth in the joints has taken place.
iv. Whether any pressure release arrangements and humps or regulators function effectively.
v. Whether pipes and openings provided in the crest of the falls are choked.

vi. Silt deposits and weed growth.
vii. Full supply water level, gauges, bench marks etc.

Lining: Defects and their repairs

i. **Defects**

Defects ranging from small settlement cracks to excessive heaving displacement and sinking of the lining may be due to following reasons:

- Cuts in soft fine ground soils especially when lining was laid on the soil without any special preparation of the subgrade.
- High water table situated considerably above the canal bed, especially in fine grained soils, where weep holes or other simple drainage devices are not very effective.
- Freshly laid embankments.
- High continuous spoil banks, left too near the canal excavation without sufficiently wide berms and adequate arrangement for draining the rain water away from the canal and similar situations permitting surface drainage to enter behind the lining.
- Cavities behind the lining caused due to sucking out action on subgrade material by oscillating waves or fluctuating supplies of water of the canal through cracks, open joints and holes in lining.

ii. **Remedies**

- Pockets or any activities detected behind the lining should be carefully packed with sand or other suitable material. During such operations, however, care should be taken to ensure that the lining does not get damaged or displaced.
- Damaged or displaced portions of lining should be removed and replaced by fresh lining of a quality comparable to the original lining. The subgrade should be thoroughly compacted and prepared before laying the fresh lining. The cracks (other than hair cracks) should be filled so as to ensure water-tightness of the lining. A more effective sealing of the cracks may be obtained by cutting a V-groove along the face of the cracks before filling with sealing compound. Dumping powered clay upstream of the cracks may seal minor cracks on the lining.
- The damaged or displaced portions of the joint filter should be carefully removed. The joint should be cleaned of dirt weed etc., before filling in fresh filter material.
- The choked pressure release pipes should be cleaned by intermittent application of air and water by rodding. Defective flap valves or other parts should be repaired or replaced. The humps or regulators should be well maintained and repaired.
- All drainage and pressure release pipes and openings should be cleaned of any dirt, debris etc. and water accumulating upstream of the fall, if any, should be drained.
- In pervious linings, such as boulder lining, any portion in which excessive settlement has taken place, should be repaired by dismantling, making up the subgrade and relaying the lining.
- The lining should be protected from ingress of rain water behind the lining.

Reaches with high subsoil water level

The subsoil water level should be observed carefully and regularly during and after rainy season besides routine observations from time to time. In case of rise, the adequacy of pressure release systems or other remedial measures like humps, regulators etc. provided for the safety of the lining should be reviewed and further measures adopted.

Seepage through embankments

Seepage through embankments, if any, should be observed at reasonable intervals of time.
Observations of seepage flow should be made and abnormal increase in the seepage rate and soil particles should be reviewed with caution, its possible causes investigated and remedial measures taken.

Silt Clearance

If any silt deposition is detected during inspection, steps should be taken to investigate causes thereof and to take remedial measures for the same. Only in exceptional circumstances it may be necessary to excavate the silt and remove it. If any silting tendency is noticed in the form of reduction of discharge carrying capacity, cross-sections of the lined canal should be taken at frequent intervals to determine the extent of silting and to see if the silt deposited during rains can be flushed out during non-monsoon periods when the water is silt free. Where silt clearance is unavoidable, it should be done carefully by manual labour to prevent damage to the lining.

Weed removal

Aquatic weed growth, if observed below the supply level should be removed. Land weed growing over the free board should also be controlled.

Canals, Banks and Bamps

The canal banks should be inspected for the seepage conditions at the outer slope and for some distance beyond the toe, especially in high fill reaches. The roads and ramps should be properly maintained.

Transmission Through Pipes Problems In Transmission Mains

Leakage

Water is often wasted through leaking pipes, joints, valves and fittings of the transmission system either due to bad quality of materials used, poor workmanship, and corrosion, age of the installations or through vandalism. This leads to reduced supply and loss of pressure. Review of flow meter data will indicate possible leakages. The leakages can be either visible or invisible. In the case of invisible leaks sections of pipeline can be isolated and search carried out for location of leaks.

Leakage through appurtenances

Most common leaks are through the glands of sluice valves. Leaks also occur through expansion joints where the bolts have become loose and gland packing is not in position. Leaks through air valves occur due to improperly seated ball either due to the damage of the gasket or due to abrasion of the ball, through the gland of the isolating sluice valve or through the small orifice.

Air Entrainment

Air in a rising main in free form will collect at the top of pipeline and then run up to higher points. Here it will either escape through air valves or will form an air pocket. With more accumulation of air the size of air pocket will rise. The cross sectional area of the pipe will diminish and the velocity of water will increase. The formation of air pocket will result in an increase of head loss. Other problems associated with air entrainment are: surging, corrosion, reduced pump efficiency and malfunctioning of valves or vibrations. In rare cases bursting of pipes also is likely to occur due to air entrainment.

Water Hammer
The pressure rise due to water hammer may have sufficient magnitude to rupture the transmission pipe or damage the valves fixed on the pipeline. Water hammer in water supply systems occurs due to rapid closure of valves and sudden shut off or unexpected failure of power supply to the pumps.

Age of the System
With age there is considerable reduction in carrying capacity of the pipelines particularly unlined CI, MS and GI pipes resulting in corroded pipes and leaks and hence in reduced quantity and pressures.

Lack of Records
Maps showing the actual alignment of transmission mains are not readily available. The location of pipes and the valves on the ground becomes difficult in the absence of system maps. Some minimum information about the location of pipes and valves and size of pipes and valves and the direction of opening of valves etc. is required, to operate and maintain the system efficiently.

Operational Schedule
Mapping and Inventory Pipes and fittings in the Water Supply Systems
Availability of updated transmission system maps with location of valves, flow meters and pressure gauges is the first requirement for preparation of operation schedule. The agency should set up routine procedures for preparing and updating the maps and inventory of pipes, valves and tappings if any on the transmission mains. The maps shall be exchanged with other public utilities and also contain information about the location of other utility services like electricity, communications etc. with reference to the alignment of transmission.

Valve location maps, apart from indicating location of valves, also show the direction to open the valve, number of turns to open, make of valve and date of fixing of valve. At times plan and profile drawings are also available which show the depth of pipe, pipe location vertically and horizontally and distance from reference point. Hydraulic gradient lines are also to be marked to indicate the pressures in the transmission system. They can be used for identifying high pressure or problem areas with low pressures.

The activities involved in mapping are:
- Establishment of consultative process with management of other utility services like electricity, communications etc.
- Definition of maps such as layout, scale, representation of pipes, valves, trappings/ connections etc.
- Establishment of procedures for storage and retrieval and updating of maps and inventory information including intersections.
- Setting up procedures for collecting map information in the field including verification in the field for compliance of the as built drawings with design.

Field Survey: Existing maps are used or conventional survey is carried out for preparation and up-dation of maps. As an alternative to traditional survey and map preparation, total station method is gaining popularity. Total station instruments can be used for survey and mapping of pipelines where data is not readily available.

Normal Operation of the Water Supply System
The efficiency and effectiveness of a water supply transmission system depends on the operating personnel's knowledge of the variables that affect the continuity, reliability, and quantity of water transmitted. The operational staff should be able to carry out changes in the hydraulic status of the system

as required depending on those variables promptly and effectively. Routine operations shall be specified which are activities for adjusting the valves and operation of pumps to match the prevailing conditions (flows, pressures, levels and operation of pumps).

Valve and pump operations will have to be controlled as per a schedule. The schedule shall contain operations for operating the transmission system. It should contain procedures to obtain, process, and analyse the variables related to water flows, pressures and levels as well as the consequences of manipulating control devices, such as operation of valves and/or pumps so that the hydraulic status of the system can match the required capacity of the system for transmission of water. When operators change their shifts information on valve closure and opening must be exchanged.

Operations in abnormal conditions

Operations other than routine viz. during breakdowns and emergencies have to be specified to be carried out in specific circumstances when normal conditions change i.e., when flows, pressures and levels and operation of pumps change.

Evaluation of Hydraulic Conditions

A continuous evaluation of the hydraulic conditions of the water supply system can be done by the O&M personnel after obtaining the data on water volumes in the reservoirs, flow meter readings from and into the reservoirs connected to a transmission system and compared with the expected performance. This evaluation shall lead to identification of operational problems and/or system faults. Depending on the type of problems actions have to be initiated to ensure that the system functions as per the requirement.

System Pressures

Maintenance of a continuous positive pressures in the mains at the time of transmission of water is required. Locations along the transmission mains which show low pressures have to be promptly investigated if necessary by measuring pressures with pressure gauges. Low pressures may be due to:

i. purposefully or accidentally a line valve is left closed or partly closed or blockage may occur due to any material causing loss of pressure,
ii. high velocities in small pipelines,
iii. low water levels in service reservoir (SR) feeding into the transmission main,
iv. failure of pumps either due to power failure or mechanical failure feeding the transmission system.

Simulation of Transmission Network

Operations have to be planned for specific circumstances such as failure at source, failure of pumps, leakages or bursts. Criteria have to be determined on the basis of analysis of the effects of particular operations on the hydraulic configuration of the water supply transmission system. These effects can be seen in simulated operating conditions. Mathematical simulation models can be developed from basic data on the network such as length, size, flow, characteristics of pumps, valves, reservoir levels etc. This approach can be very useful for analysing the effects of variables on large and complex water supply transmission systems.

Sampling for quality of water

The agency operating the water supply system is charged with the primary responsibility of ensuring that the water supplied to the consumer is of an appropriate quality. To achieve this objective it is necessary that the physical, chemical and bacteriological tests are carried out for the water samples collected at frequent intervals. The minimum number of samples to be collected from a water supply system should be as prescribed in the Chapter 15 of the Manual on Water Supply & Treatment. Samples should be taken at different points of the transmission system on each occasion to enable overall assessment. In the event of epidemic or danger of pollution more frequent sampling may be required especially for bacteriological quality.

System Surveillance

Surveillance of Transmission system is done

- To detect and correct sanitary hazards.
- To detect and correct any deterioration of the transmission system facilities.
- To detect encroachment of transmission system facilities by other utilities such as sewer and storm water lines, power cables, telecom cables etc. and
- To detect and correct damages to the system facilities by vandalism.

These checks are done routinely. In addition checks are done under special circumstances for assessing damage of the transmission system after flooding along the alignment following a heavy storm. All these checks are also done for above ground water facilities such as valves and valve chambers or exposed pipelines. Any activity or situation that might endanger the water facility or water quality shall be investigated and corrective action is to be taken. Surveillance shall also include looking for unauthorised construction activity on or near the utility's pipelines which may pose a physical threat to the mains. Any digging or excavation or blasting near the mains shall be closely supervised by the utility staff. Surveillance of Valve chambers and valves of the transmission system shall be done as noted in para 4.3.3.

MAINTENANCE SCHEDULE

A maintenance schedule is required to be prepared to improve the level of maintenance of water Transmission system through improved co-ordination and planning of administrative and field work and through the use of adequate techniques, equipment and materials for field maintenance. The schedule has to be flexible so that it can achieve team action with the available vehicles and tools. Co-ordination of activities is required for spares and fittings, quality control of materials used and services rendered. Training of maintenance staff shall, apart from the technical skills, include training to achieve better public relations with consumers.

Activities in maintenance Schedule

Following activities are to be included in the schedule:

i. Develop and conduct a surveillance programme for leaks in pipelines, pipe joints and valves,
ii. Develop and conduct a water quality surveillance programme,
iii. Develop and conduct a programme for locating and repairing leaks including rectifying cross connections if any, arrange for flushing, cleaning and disinfecting the mains,
iv. Establish procedures for setting up maintenance schedules and obtain and process the information provided by the public and the maintenance teams about the pipeline leaks,
v. Establish repair procedures for standard services and with provision for continuous training of the team members,
vi. Procure appropriate machinery, equipment and tools for repair of leaks and replacement of pipes and valves,
vii. Allocate suitable transport, tools and equipment to each maintenance team,
viii. Establish time, labour and material requirement and output expected, time required and other standards for each maintenance task, and
ix. Arrange for monitoring the productivity of each team.

Preventive Maintenance schedule

A preventive maintenance schedule has to be prepared for:

i. Maintenance of the pipelines with particulars of the tasks to be undertaken, works not completed, works completed,
ii. Servicing of valves, expansion joints etc.
iii. Maintenance of valve chambers,
iv. Maintenance of record of tools, materials, labour, and
v. Costs required to carry out each task.

a) Servicing of Valves

Seating of Valves which are subject to operations several times is likely to become leaky or pass the flow downstream even after closing tight. Periodical servicing will be required for valves, expansion joints, flow meters and pressure gauges. Corrosion of valves is the main problem in some areas and can cause failure of bonnet and gland bolts. Leaks from spindle rods occur and bonnet separates from the body. Stainless steel bolts can be used for replacement and the valve can be wrapped in polyethylene wrap to prevent corrosion.

b) Manufacturers' Catalogues

The manufacturer's catalogues may be referred and comprehensive servicing procedures should be prepared for the periodical servicing. These procedures shall contain manufacturer's name, address telephone number etc. and also the technical information furnished by the manufacturers of the equipment used in the transmission system such as sluice valves, BF valves, air valves, pressure gauges, flow meters, etc. The test certificates, inspection reports and warranty certificates of these equipment shall also be kept along with the manual.

c) List of Spares

A list of spares required for the transmission system shall be prepared and the spares shall be procured and kept for use. The list of probable spares to be kept in stock may include the following:

Spare check nuts and spindle rods and assorted bolts; nuts and washers for the flanged joints, gaskets for flanged joints for all sizes of sluice valves installed in the transmission system, spare manhole covers and consumables like the gland rope, grease, cotton waste, jointing material like rubber gaskets, spun yarn, pig lead and lead wool.

d) List of Tools

The necessary tools equipment to properly repair and correct both the routine problems and for facilitating repairs and replacements in a Transmission system have to be identified and provided to the maintenance staff. Some of the tools for the maintenance work in a Transmission system : Key rods for operation of all sluice valves, hooks for lifting manhole covers, pipe wrench of appropriate sizes (200, 300 or 450 mm) DE spanner set, ring spanner set, screw drivers, pliers, hammers, chisels, caulking tools for lead and spun yarn, ladles and pans for melting and pouring lead joints, excavation tools such as crow bars, spades, iron baskets, buckets and de-watering pumps. In case of large diameter transmission system excavators, cranes, diesel welding sets, welding electrodes, gas cutting accessories and gas cylinders will also be required.

e) Maintenance of Chambers for appurtenances

Valve chambers shall be checked to ensure that they are not damaged, nor filled up with earth or buried in pavement. Cover of valve chambers are stolen or broken up by vandalism or accidentally leading to damage to the valve itself or will lead to accidental fall into the open valve chamber; such situations have to be corrected on priority. Road improvement works require constant attention of water utility staff since the valves may be lost or at times the valve chambers in the roads have to be reconstructed to match the renewed road surface.

Valve Chambers on cross country pipelines are likely to be tampered to collect water and are likely to be affected by floods and agricultural and industrial activities. Leakages at such places will affect the water quality by cross connections and hence these leaks require to be attended on priority.

Maintenance Of Pipelines

Main breaks

Pipeline bursts/main breaks can occur at any time and the utility shall have a plan for attending to such events. This plan must be written down, disseminated to all concerned and the agency must always be in readiness to implement the plan immediately after the pipe break is reported. After a pipe break is located, determine which valve is to be closed to isolate the section where the break has occurred. Some important consumers may be on the transmission system and having an industrial process dependent on water supply which cannot be shut down as fast as the water supply lines are cut off and should be notified about the break. These consumers have to be informed about the probable interruption in water supply and also the estimated time of resumption of water supply.

After the closure of the valve the dewatering/mud pumps are used to drain the pipe break points. The sides of trenches have to be properly protected before the workers enter the pit.
The damaged pipe is removed, and the accumulated silt is removed from inside the pipe and the damaged pipe is replaced and the line is disinfected before bringing into use. A report shall be prepared following every pipe break about the cause of such break, the resources required for rectification and the time and cost required for repairing etc. so that the agency can follow up with measures for avoiding such breaks and also modify their plan to address such breaks in future.

Deterioration of Pipes

Pipes deteriorate on the inside because of water corrosion and erosion and on the outside because of corrosion from aggressive soil and water/moisture. Depending upon the material of the pipes these are subject to some deterioration, loss of water carrying capacity, leaks, corrosion and pitting, tuberculation, deposition of sediment and slime growth. Preventive maintenance of transmission system assures the twin objectives of preserving the bacteriological quality of water carried in the transmission mains and providing conditions for adequate flow through the pipelines. Incidentally this will prolong the effective life of the pipeline and restore its carrying capacity. Some of the main functions in the management of preventive aspects in the maintenance of pipelines are assessment, detection and prevention of wastage of water from pipelines through leaks, maintaining the capacity of pipelines, cleaning of pipelines and relining. The topic of assessment of leaks is dealt in detail in the Chapter 15 on Water Audit and Leakage Control in this manual.

Flushing of Pipelines

Flushing is done to clean the transmission lines by removing impurities or sediment that may be present in the pipe; this is particularly essential in the case of transmission lines carrying raw water. Routine flushing of raw water pipelines is often necessary. It is advisable that a programme for flushing is prepared and followed so that water mains are flushed before the water quality deteriorates and consumers start complaining. Since flushing is not the only solution to the water quality problems of a transmission system, proper operation of treatment process and cleaning of service reservoirs supplying water to the transmission system shall also be planned along with the flushing of distribution system. Flushing is usually done in low water demand, when the weather is favourable. Prior planning and good publicity with public will allow the flushing to proceed quickly and without confusion.

Flushing and Cleaning of Pipelines

Mechanical cleaning devices such as swabs and pigs are some times used if flushing does not improve the water quality. Scrapers or brushes are used in pipelines with hardened scales or extensive tuberculation. Sometimes scrapers and brushes are used before taking up lining works. The topics of cleaning of pipelines including cleaning and swabbing are dealt in Chapter 10 of Manual on Water Supply & Treatment.

Cement and Mortar Lining

The present trend is to use cement mortar lined DI pipes or MS pipes so that they will not lose their carrying capacity with use and age. Still many new pipelines are proposed with unlined metal pipes and there are several existing pipelines with bare metal surface such as CI or MS. With passage of time these pipelines deteriorate and require rehabilitation. Cement mortar lining is done which stifles corrosion through its ability to develop high alkalinity. *Insitu* cement mortar lining of existing metal water mains has been beneficial where:

i. Pipe carrying capacity has reduced due to tuberculation,
ii. Water quality is affected due to release of corrosion products from the pipes to the water, and
iii. Leaks occur through joints and pipe walls.

Leakage Control

Leakage of water in the transmission system occurs by way of leakage from pipes, joints & fittings, reservoirs & overflows of reservoirs & sumps. The objective of leakage control programme is to reduce to a minimum the time that elapses between the occurrence of a leak and its repair. The volume of water lost through each leak should be reduced by taking whatever action is technically and economically feasible to ensure that the leak is repaired as quickly as possible. To achieve this, the agency shall prescribe procedures for identifying, reporting, repairing and accounting for all visible leaks. It will be beneficial for the agency if the procedures involve the conscious and active participation of the population served by the agency apart from its own staff.

Procedures for reporting visible leaks

Utility has to **e**stablish procedures whereby the population residing along the transmission mains can notify the visible leaks to the agency. The agency staff can also report visible leaks found by them while carrying out other works on the water supply system. Utility has to establish procedures for prompt repair of leaks and for attending efficiently and accurately to the leaks. Critical areas where leaks often occur have to be identified and appropriate corrective measures have to be implemented.

Procedures for detecting invisible visible leaks

In the case of transmission mains the leaks become visible due to the high pressures. However if it is necessary to identify the invisible leaks procedures have to be established for detecting and locating non visible leaks. Selection and procurement of equipment for detection and location of leaks must take into account the cost effectiveness and the financial capability of the agency. Description of equipment for leak detection and location and the methodology are described is given in the Chapter 15 of this manual. Management has to process the data and evaluate the work on detection and location of leaks and for dissemination of the results and initiate actions to control the overall problem of water loss.

Chlorine Residual Testing

A minimum free chlorine residual of about 0.2 mg/l at the receiving reservoir of a transmission system is often maintained to ensure that contamination is destroyed by the chlorine. Hence absence of residual chlorine could indicate potential presence of heavy contamination in the transmission system. If routine checks of the incoming water at the end of the transmission system are revealing, required chlorine residuals and any sudden absence of residual chlorine should alert the operating staff to take up prompt investigations.

Immediate steps to be taken are:

i. Re-testing of residual chlorine,
ii. Checking chlorination equipment at the start of the transmission system,
iii. Searching for source of contamination along the transmission system which has caused the increased chlorine demand,
iv. Immediate rectification of source of contamination.

Cross Connections

Contaminated water through cross connections of water supply lines with sewers and drains is a problem prevailing widely. Regular survey along the alignment of transmission system has to be undertaken to identify potential areas likely to be affected by cross connections and back-flow. All field personnel should be constantly alert for situations where cross connections are likely to exist. Densely populated areas and slums without sanitation facilities located along the transmission lines are some of the locations prone for cross connections.

Telemetry and SCADA System

Manual Monitoring

Normally the Managers of O&M of water utilities monitor levels in service reservoirs fed by the transmission system and also monitor the flow meter readings of upstream and downstream reservoirs connected by a transmission system. The pressures of the pipeline at salient points are also monitored. Data on operation of pumps such as hours of pumping and failure of pumps and on water quality by measuring residual chlorine is also monitored. The manager usually uses the telephone line or wireless unit to gather the data, analyses the same and uses his discretion gained with experience and takes decisions to ensure that the system is operating with required efficiency. Manual collection of data and analysis may not be helpful in large undertakings if water utilities have to aim at enhanced customer service by improving water quality and service level with reduced costs. These days acquisition of such data by Telemetry and SCADA is being adopted. This Topic is discussed in Chapter 12 on Distribution system of this manual.

RECORDS AND REPORTS

Record System

i. A record system has to be developed which should be realistic and applicable to the operating problems involved in the Transmission system. Management must be clear as to why the data/ information are collected, as to who will review the data and who will respond to the results of review. The most efficient way to keep records is to plan what data is essential and then prepare the formats followed by guidelines, fill the data, frequency and to send the record to for review and report. Sample records to be maintained are given below for guidance.
ii. Updated transmission system map with alignment plan and longitudinal section of the pipeline showing the invert levels and hydraulic grade lines of the pipelines and location of appurtenances, flow meters and pressure gauges,

iii. Record of flow meter readings at upstream and downstream ends of the transmission system,
iv. Record of water levels of the reservoirs at both upstream and downstream ends of the transmission system,
v. Pressure readings of the transmission system pipelines,
vi. Review of record of pressures and flows,
vii. Identify the persistent low pressures in the transmission system,
viii. Record on age of pipes/quality of pipes,
ix. Identify pipelines to be replaced,
x. Presence of corrosive water in the system,
xi. Identify the source of leaks,
xii. Identify the persistent leak points,
xiii. Status of bulk meters – functional
xiv. Identify the residual chlorine levels at the receiving and transmitting ends of the transmission system,
xv. Identify the bacteriological quality of the water sampled from the reservoirs linked to the transmission system,
xvi. Identify reasons for residual chlorine being absent/where bacteriological samples are unwholesome,
xvii. Record on when the pipeline leaks were repaired or pipes changed and the cost of materials and labour cost thereof,
xviii. Record on when the gland ropes of the valves distribution system were changed and the cost of materials and labour cost thereof,
xix. Record on when the spares of the valves were changed and the cost of materials and labour cost thereof,
xx. Record on when the expansion joints were serviced and the cost of materials and labour spent for repairing the same,
xxi. Record on when the manholes on the valve chambers were changed and the cost of materials and labour cost thereof,
xxii. Record on man-hours spent on routine operations in the transmission system in the previous year and the cost thereof,
xxiii. Record on total cost of repairs and replacements in previous year along with break up of material cost and labour cost with amount spent on outside agencies for repairs and replacements,
xxiv. Record on when the exposed piping was last painted and the cost of materials and labour cost thereof.

Reports

With the accumulation of all essential data a report can be prepared evaluating the O&M of the facility. The report can identify the deficiencies in the system and its appurtenances and then plan future repairs to the transmission system, valves and other equipment or for replacement of defective valves or other equipment.

Checks on The Transmission

A programme has to be prepared for each zone of the transmission system which shall contain procedures for routine tasks, checks and inspections at intervals viz. Daily, weekly, quarterly semi-annually or annually. This plan shall fix responsibility, timing for action, ways and means of completing the action as to when and who should take the action and the need to take these actions. Simple checklists for use by the managerial staff can be prepared to ensure that the O&M staff have completed the tasks assigned to them.

Table 23: Checklist for Pipe Repair

S/No.	Checks required/Undertaken	Status	Suggested frequency of reporting
1	Check whether the operation of the valves is smooth without any abrupt stoppage during closure		
2	Check whether closure of the valves results in the complete stoppage of flow or if any of flow passes the valve (passing the valve)		
2	Check for status of scouring and then proper clossure of washout valves		
4	Check for leaks through pipes		
5	Check for leaks through valves, expansion joints and pipes and jointing materials		
6	Check for leaks at the appurtenances including expansion joints		
7	Check for any signs of corrosion in pipelines		
8	Check for the status of Manhole Covers over the chamber covers; are they corroded		
9	Inspect any possibilities of pollution of the transmission systems		
10	Check status of outfall drain for scour valves and chances of contamination of scours		
11	Assess the need for painting of the pipework		
12	Check for the availability of spares for valves, expansion joints and pipes and jointing materials		
13	Carry out review of pressures		
14	Carry out review of flows		
15	Check age of pipes/ C-values of pipes		
16	Check for corrosive water		
17	Study inflows and outflows into reservoirs linked to the transmission system		
18	Identify source of leakage		
19	Metering		
	Status of bulk metering		
	Review facilities for repair of meters		
21	Availability of updated system map		

Introduction

Water to be supplied for public use must be potable i.e., satisfactory for drinking purposes from the standpoint of its chemical, physical and biological characteristics. Drinking water should, preferably, be obtained from a source free from pollution. The raw water normally available from surface water sources is, however, not directly suitable for drinking purposes. The objective of water treatment is to produce safe and potable drinking water.

Some of the common treatment processes used in the past include Plain sedimentation,
Slow Sand filtration, Rapid Sand filtration with Coagulation-flocculation units as essential pretreatment units. Pressure filters and Diatomaceous filters have been used though very rarely. Roughing filters are used, under certain circumstances, as pretreatment units for the conventional filters. The treatment processes may need pretreatment like pre-chlorination and aeration prior to conventional treatment. The pretreatment processes comprising of Coagulation and Flocculation have been discussed under the main title of Rapid Sand filters in para 5.4 of this chapter. Detailed discussion on all such aspects as well as recommended unit operations, is given in the Manual on Water Supply and Treatment (1999 Edition) Ministry of Urban Development. Figure 5.1 shows typical flow patterns of a Conventional Treatment Plant.

Filtration Plants

Slow-Sand Filter Plants

It may include Plain Sedimentation basins followed by the conventional Filter-Plant.

Rapid-Sand Filter Plants

It can be briefly divided into two main components:

1. The Pretreatment Works
   These include the (1) Coagulation- Flocculation Units with adequate chemical dosing and rapid mixing facilities, and (2) Sedimentation Units to handle the effluent from the Coagulation-flocculation units.
2. Filter units.

Other Categories

There are a number of other categories of filtration plants but not of common use. Of these to reduce load on the treatment plants. Small streams of water in the catchment areas may carry large particles and floating matter. Introduction of the roughing filters will ensure entrapping of such undesirable material prior to the storage structures of the treatment units.

Slow-Sand Filter Plants

Process

Slow Sand filtration was the first type of porous media filtration used in water treatment. This process is known for its simplicity and efficiency. During the initial operational period of slow sand filters, the separation of organic matter and other solids generates a layer of biological matter on the surface of the filter media.

Filter Controls

The pipe work, valves and devices used to regulate the operation of a filter should be properly planned. Adequate means must be available to:

- Deliver raw water into the supernatant reservoir,
- Remove scum and floating matter,
- Drain off supernatant water prior to filter cleaning,
- Lower water level in the bed,
- Control the rate of filtration and adjust it as bed resistance increases,
- Ensure that negative pressures cannot occur within the bed (the weir is the device usually used for this purpose),
- Convey filtered water to the filter water tank,
- Run filtered water to waste or to the inlet side of other filters during the ripening process,
- Fill sand bed from below with filtered water (from other filters) after cleaning.

Operation

The operation of the filter is determined by the filtration rate, which is controlled at the effluent outlet. Inflow, which may be by gravity from a constant level reservoir, or by a pump, is adjusted so that the head of water in the supernatant reservoir remains constant at all times. Excessive raw water delivery will cause overflow through the scum outlets, while a reduction in the rate of inflow will cause the level in the supernatant water reservoir to drop; either condition should alert the operator to a defect in the mechanism controlling the supply of raw water.

The filtration rate is controlled by a single regulating valve on the effluent delivery. At the beginning of the filter run this will be partially closed, the additional resistance thereby provided being equal to that which will later build up within the filter bed. Day by day as the run continues this valve must be checked and opened fractionally to compensate for the choking of the filter and to maintain a constant filtration rate. In the early part of the filter run the daily build-up of resistance will be almost imperceptible, calling for very little valve adjustment, but towards the end of the filter run the resistance will increase more rapidly, necessitating a more positive opening of the valve and signalling the impending need for filter cleaning. To enable the operator to regulate the valve precisely it is necessary to have some form of measuring device on the effluent outlet.

Control Of Algal Growth

Excessive algal growth may cause trouble in the operation of open filters. Pretreatment by microstrainers is one method of removing the algae contained in the raw water. For more details please refer to para 5.8 of this chapter.

Dissolved Oxygen

If the dissolved oxygen content of the raw water drops below the potential oxygen demand, anaerobic conditions may develop within the bed. To some extent a reasonable growth of algae in the supernatant reservoir oxygenates the supernatant water. Where the composition of raw water or climate does not favour the growth of algae, or where chemical dosing or some other device has been used to remove or exclude them, it may be necessary to use other expedients to increase the dissolved oxygen content, such as aeration of the incoming raw water.

Ventilators are provided as an integral part of the filter bed. It should be ensured that these function properly.

Water Quality

Samples of raw and treated water will be taken at regular intervals for analysis. In a large waterworks with its own laboratory, sampling will almost certainly be carried out daily, since the effluent analysis constitutes the only certain check that the filter is operating satisfactorily and the raw water analysis provides what is possibly the only indication of a change in quality that might adversely affect the efficiency of treatment. In case of small plants with no laboratory facilities, an attempt should be made to conduct sampling on regular basis. Field testing equipment may be used to measure water quality. For more details please refer to Chapter 9 of this manual.

Filter Cleaning

While the filter is in operation, a stage comes when the bed resistance increases so much that the regulating valve has to be fully opened and it is the right time to plan the cleaning of the filter bed since any further resistance is bound to reduce the filtration rate. Resistance accelerates rapidly as the time for cleaning approaches. Indicators may be installed showing the inlet and outlet heads, from which the head loss can be regularly checked; this gives a clear picture of the progress of choking and the imminence of the end of the run. Without any measurement of the head loss the only true indicator of build up of resistance is the degree of opening of the regulating valve, though the experienced operator may be able to recognize preliminary visual warnings in the condition of the filter bed surface. A slight deterioration in the effluent quality may be a reason for the need for cleaning.

To clean a filter bed, the raw water inlet valve is first closed, allowing the filter to discharge to the clear water well as long as possible (usually overnight). As the head in the supernatant reservoir drops, the rate of filtration rapidly decreases, and although the water above the bed would continue to fall until level with the weir outlet, it would take a very long time to do so.

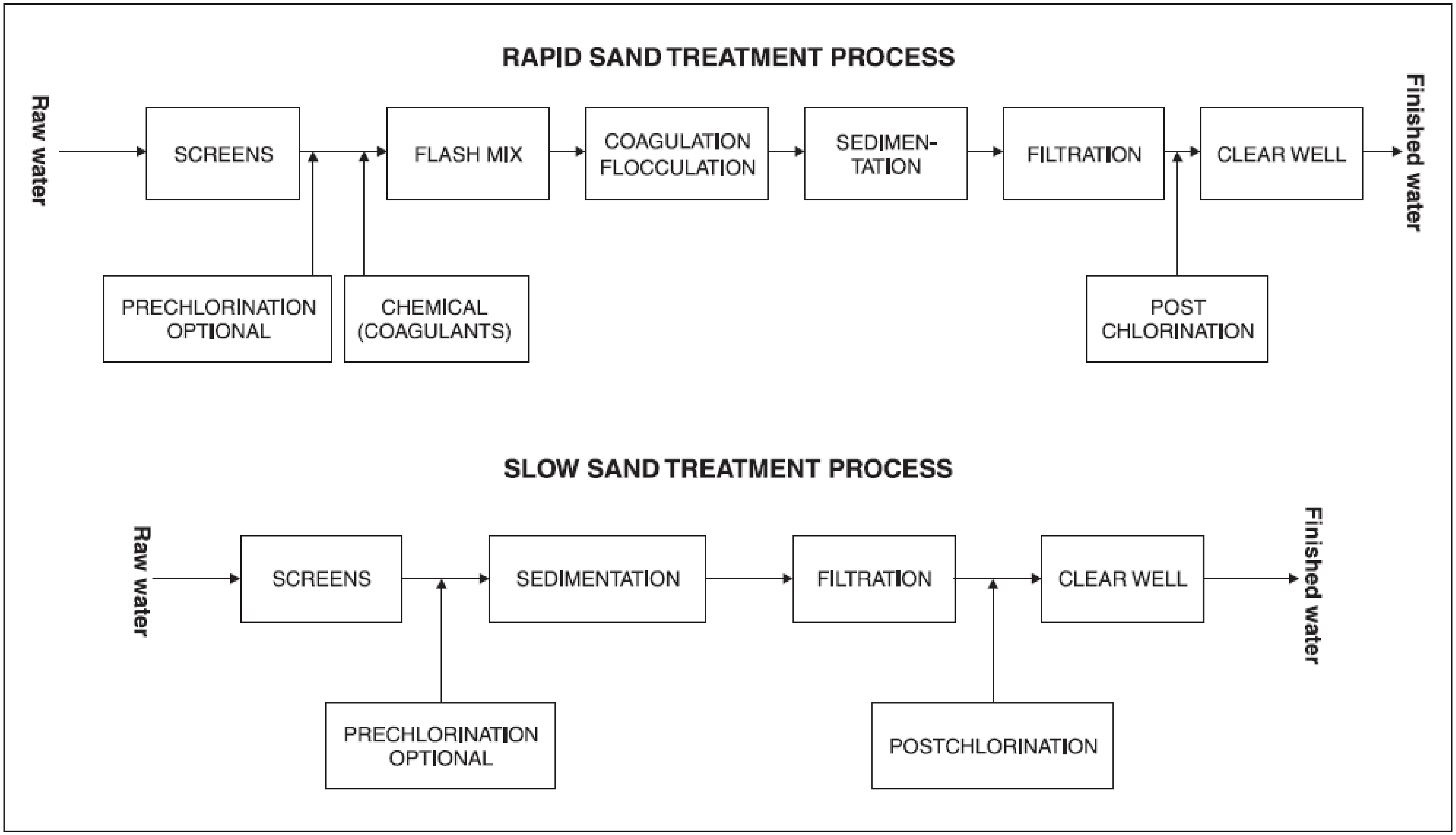


Figure 1: Conventional Filtration Processes

Consequently, after a few hours, the effluent delivery to the clear water well is closed, and the supernatant water outlet is run to waste through the drain valve provided.
When the supernatant water has been drained off (leaving the water level at the surface of the bed) it is necessary to lower the water within the bed still further, until it is some
100 mm or more below the surface .This is done by opening the waste valve on the effluent outlet pipe. As soon as the *Schmutzdecke* is dry enough to handle, cleaning should start. If the filter bed is left too long at this stage it is likely to attract scavenging birds that will not only pollute the filter surface but also disturb the sand to a greater depth than will be removed by scraping.

The cleaning of the bed may be carried out by hand or with mechanical equipment. Working as rapidly as possible, they should strip off the *Schmutzdecke* and the surface sand adhering to it, stack it into ridges or heaps, and then remove the waste material by barrow, hand cart, basket, conveyor belt or other device.

After removal of the scrapings the bed should be smoothed to level surface. The quicker the filter bed is cleaned the less will be the disturbance of the bacteria and shorter the period of re-ripening. Provided they have not been completely dried out, the microorganisms immediately below the surface will quickly recover from having been drained and will adjust themselves to their position relative to the new bed level. In this event a day or two will be sufficient for re-ripening.

Before the filter box is refilled, the exposed walls of the supernatant water reservoir should be well swabbed down to discourage the growth of adhering slimes and algae, and the height of the supernatant water drain and of the outlet weir must be adjusted to suit the new bed level. The water level in the bed is then raised by charging from below with treated water from the clear water well or from one of the other filters. As soon as the level has risen sufficiently above the bed surface to provide a cushion, the raw water inlet is gradually turned on. The effluent is run to waste until analysis shows that it satisfies the normal quality standards. The regulating valves on the effluent line will be substantially closed to compensate for the reduced resistance of the cleaned bed, and the filter will then be ready to start a new run.

During the cleaning operations precautions must be taken to minimize the chances of pollution of the filter bed surface by the labourers themselves. Such measures as the provision of boots that can be disinfected in a tray of bleaching solution should be taken. Hygienic personal behaviour must be rigidly imposed, and no labourers with symptoms that might be attributable to water borne or parasitic diseases should be permitted to come into direct or indirect contact with the filter medium.

RESANDING

After several years' operation and, say, twenty or thirty scrapings the depth of filtering material will have dropped to its minimum designed level (usually 0.5 to 0.8 m above the supporting gravel, according to the grain size of the medium). In the original construction, a marker, such as a concrete block or a step in the filter box wall, is sometimes set in the structure to serve as an indication that this level has been reached and that resanding has become due.

During the long period of the filter use/run some of the raw water impurities and some products of biochemical degradation will have been carried into the sand-bed to a depth of some 0.3 to 0.5 m according to the grain size of the sand. To prevent cumulative fouling and increased resistance this depth of sand should be removed before resanding takes place, but it is neither necessary nor desirable that it should be discarded. Instead it is moved to one side, the new sand is added, and the old sand replaced on the top of the new, thus retaining much of the active material to enable the resanded filter to become operational with the minimum re-ripening.

This process (of replacing old sand on the top of the new) known as "throwing over" is carried out in strips. Excavation is carried out on each strip in turn, making sure that it is not dug so deeply as to disturb the supporting gravel layers below. The removed material from the first strip is stacked to one side in a long ridge, the excavated trench is filled with new sand, and the adjacent strip is excavated, throwing the removed material from the second trench to cover the new sand in the first. The operation is illustrated in Fig. 5.2. When the whole of the bed has been resanded, the material in the ridge from the first trench is used to cover the new sand in the last strip.

In areas where sand is expensive or difficult to obtain, the surface scrapings may be washed, stored and used for resanding at some future date. These scrapings must be washed as soon as they are taken from the filter, otherwise, being full of organic matter, the material will continue to consume oxygen, quickly become anaerobic, and putrefy, yielding taste and odour producing substances that are virtually impossible to remove during any washing process.

Sand Washing Machines should be provided for the bigger plants. Wherever provided, these should be operated regularly to prevent accumulation of sand and also to keep the machine in working condition.

RECORD KEEPING

The following are the basic records that must be maintained:

1. The date of each cleaning (commencement)
2. The date and hour of return to full service (end of re-ripening period)
3. Raw and filtered water levels (measured each day at the same hour) and daily loss of head.
4. The filtration rate, the hourly variations, if any.
5. The quality of raw water in physical terms (turbidity, colour) and bacteriological terms (total bacterial count, E.Coli.) determined by samples taken each day at the same hour.
6. The same quality factors of the filtered water.
7. Any incidents occurring e.g. plankton development, rising *Schmutzdecke*, and unusual weather conditions.

Augmentation Of The Capacity Of An Existing Plant

Some of the existing slow sand filtration plants need augmentation. There is a tendency to abandon the old plants and substitute the same with Rapid sand Filtration plants. It is suggested that wherever possible the old Slow sand Filtration plants may be retained on account of the following reasons:

i. Slow sand filter is less likely to go wrong under inexperienced operation.
ii. It does not require skilled attendance.
iii. Head consumed is less.
iv. It provides greater reliability of the removal of bacteria.
v. Operating costs may be less.

It is, however, adapted to waters low in colour, turbidity and bacterial count. Under such circumstances, provision of a roughing filter as a pretreatment unit gives good results.

RESANDING OF A SLOW SAND FILTER

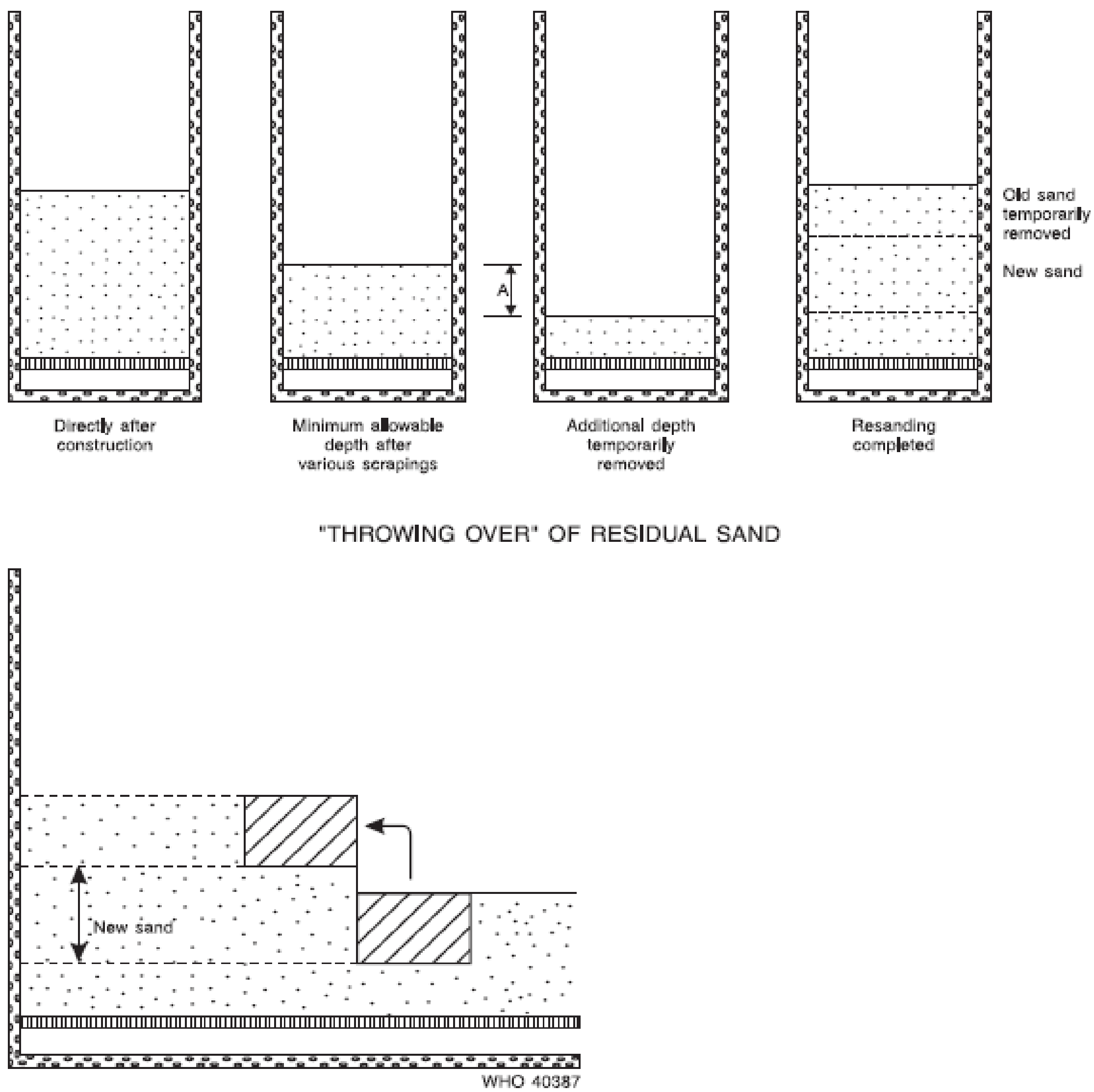


Figure 2: Resanding of slow sand filters

Rapid Sand Filtration Plants

The pretreatment units which form essential parts of a Rapid sand filtration unit include (a) Coagulation and flocculation with rapid mixing facilities and (b) Sedimentation units.

Coagulation And Flocculation

Purpose

The purpose of coagulation and flocculation is to remove particulate impurities, especially non-settleable solids (particularly colloids) and colour from the water being treated. Non-settleable particles in water are removed by the use of coagulating chemicals.

Chemical Coagulants commonly used in a Water Treatment Plant

Table 24: chemical coagulants

Name	Formulae	Coagulant Primary/Aid
Ferric Alum	$Fe_2(SO4)_3.24H_2O$	Primary
Poly alluminium chloride	$\{Al(OH)_{2.7}Cl_{3.3})\}_{15}$	Primary
Ferric Chloride	$FeCl_3.6H_2O$	Primary
Calcium Hydroxide	$Ca(OH)_2$	Primary/Aid
Calcium oxide	CaO	PrimaryAid

The most commonly used coagulant is ferric alum. However, Poly Aluminium Chloride (PAC) is also used as a coagulant. The advantages of PAC are i) it gets properly dispersed, ii) it does not have any insoluble residue, iii) it does not affect the settling tanks, iv) it is more effective than alum v) it requires less space (may be about 50%). The disadvantage of PAC is that it is less effective in removal of colour.

Selection of Coagulants

Coagulation is a physical and chemical reaction occurring between the alkalinity of the water and the coagulant added to the water, which results in the formation of insoluble flocs. The most important consideration is the selection of the proper type and amount of coagulant chemical to be added to the water to be treated.

Overdosing as well as underdosing of coagulants may lead to reduced solids removal efficiency. This condition may be corrected by carefully performing Jar tests and verifying process performance after making any change in the process of the coagulation process.

Jar Test

The jar test has been and is still the most widely used method employed to evaluate the coagulation process and to aid the plant operator in optimizing the coagulation, flocculation and clarification processes. From the turbidity values of the settled water, settling velocity distribution curves can be drawn. These curves have been found to correlate well with the plant operating data and yield useful information in evaluating pretreatment, such as optimizing of velocity gradient and agitation and flocculation, pH, coagulation dosage and coagulant solution strength. Such curves cannot be generalized and are relevant to the plant for which the data have been collected through the Jar tests.

Typical Jar test Data sheet is given in Table 5.2.

In addition, the turbidity, colour and alkalinity of the raw and treated water should be measured for evaluation of the treatment.

Date & Time	Flocculation period with RPM	Settling Period	Jar No.	pH	Turbidity	Colour	Alkalinity $CaCO_3$	Time for 1st flocc. formation	Remarks

Mixing

The main requirement of the mix is that all the coagulant be rapidly mixed with all the water instantly so as to achieve complete homogenization of a coagulant chemical in the stream to be treated. The reason is that the chemical reaction is extremely rapid, practically instantaneous, especially in waters with high alkalinity. Since this is not physically possible although desirable, it is important to approximate as nearly as possible to instant and complete dispersion.

To accomplish the mixing of the chemicals with the water to be treated, several methods can be used.

- Hydraulic mixing
- Mechanical mixing
- Diffusers and grid system
- Pumped blenders.

Mixing of the chemical coagulant can be satisfactorily accomplished in a special coagulant tank with mixing devices. Mixing may also occur in the influent channel or a pipeline to the flocculation basin if the flow velocity is high enough to produce the necessary turbulence. The shape of the basin is part of the flash mix design.

Flocculation basin Operation

The objective of a flocculation basin is to produce a settled water of low turbidity which in turn will allow reasonably long filter runs. Following points should be considered during the operation of the flocculation basins.

Short Circuiting

An important factor that determines the functioning of a flocculator is the short circuiting. In such a basin, against a predetermined 30 minutes agitation, a large portion may get only 10 minutes while another sizeable amount may get 60 minutes. Under such circumstances very inferior settled water is produced.

Short circuiting in flocculation basins is characterized by currents which move rapidly through and continue into the settling tanks .The floc removal problem is compounded then with flocculation which is incomplete and currents introduced into the settling process which further inhibit removal. Properly operated entrance, curtain baffles and exit weirs and launders can significantly improve settling.

The flocculators may be circular, square or rectangular. The best flocculation is usually achieved in a compartmentalized basin. The compartments (most often three) are separated by baffles to prevent short circuiting of the water being treated. The turbulence can be reduced gradually by reducing the speed of the mixers in each succeeding tank or by reducing the surface area of the paddles. This is called tapered-energy mixing. The reason for reducing the speed of the stirrers is to prevent breaking apart the larger floc particles, which have already formed. If the floc is broken up nothing is accomplished and the filter gets overloaded.

Dosing of the coagulant at a spot of maximum turbulence

Rapid mix of coagulant at a spot of maximum turbulence, followed by tapered flocculation in three compartmentalized units allows a maximum of mixing, (reduced short circuiting) followed by a period of agglomeration intended to build larger fast settling floc particles. The velocity gradient is gradually reduced from the first to the third unit. The concepts of velocity gradient and tapered flocculation have been discussed in the Manual of Water supply and Treatment (1999 edition).

Interaction with Sedimentation and Filtration

The processes of coagulation and flocculation are required to precondition or prepare nonsettleable particles present in the raw water for removal by sedimentation and filtration. Small particles (particularly colloids), without proper coagulation and flocculation are too light to settle out and will not be large enough to be trapped during filtration process.

Since the purpose of coagulation – flocculation is to produce particle removal, the effectiveness of the sedimentation and filtration processes, as well as overall performance, depends upon successful coagulation - flocculation.

Flocculation-Coagulation process Actions

Typical jobs performed by an operator in the normal operation of the coagulation flocculation process include the following:

- Monitor process performance.
- Evaluate water quality conditions (raw and treated water).
- Check and adjust process controls and equipment, and
- Visually inspect facilities.

Fig. 1 shows the overall plan view of the coagulation-flocculation process of a typical plant.

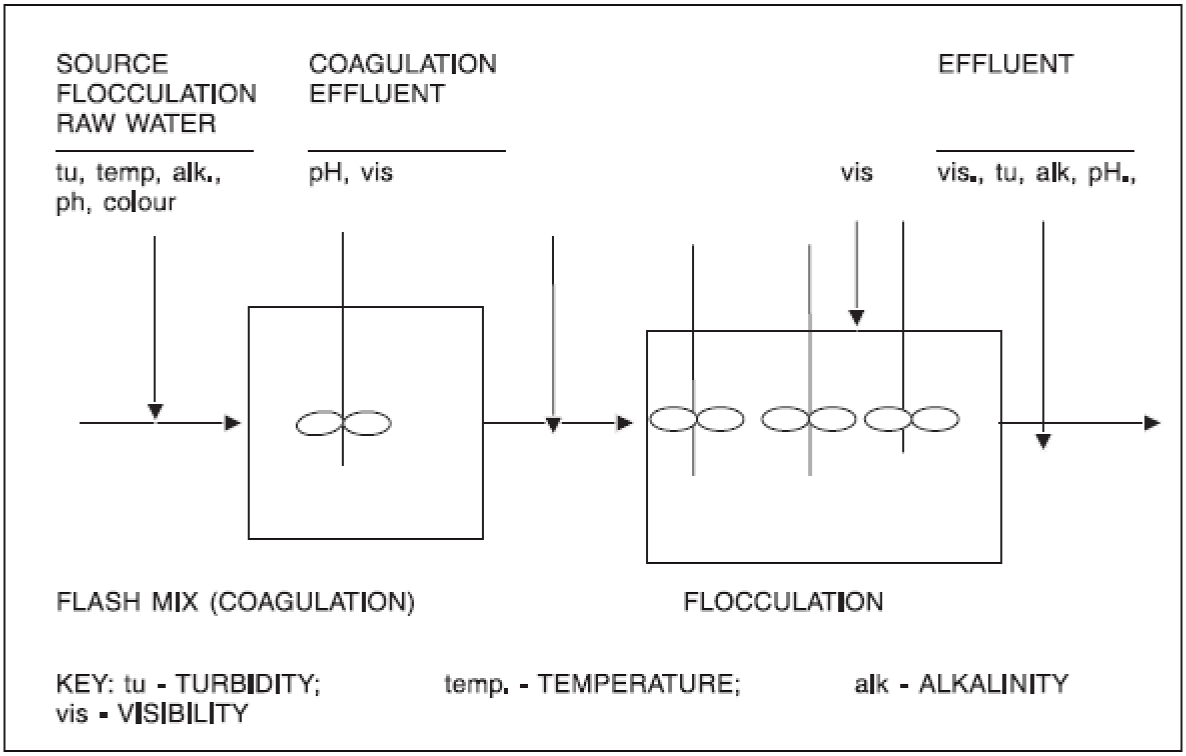


Figure 3: Coagulation-Flocculation Process Monitoring Guidelines

Examination of the floc

Examine the water samples at several points enroute the flow line of the water. Look at the clarity of the water between the flocs and study the shape and size of the floc.

- Observe the floc as it enters the flocculation basins. The floc should be small and well dispersed throughout the flow.
- Tiny alum floc may be an indication that the chemical dose is too low. A 'popcorn flake' is a desirable floc. If the water has a milky appearance or a bluish tint, the alum dose is probably too high.
- As the floc moves through the flocculation basins the size of the floc should be increasing. If the size of the floc increases and then later starts to break up, the mixing intensity of the downstream flocculator may be too high. Try reducing the speed of these flocculators or increasing the coagulant dosage.
- Examine the settlement of the floc in the sedimentation basin. If a lot of floc is observed flowing over the laundering weirs the floc is too light for the detention time. By increasing the chemical dose or adding a coagulant aid such as a polymer, a heavier, larger floc may be produced. The appearance of the fine floc particles washing over, the effluent weir could be an indication of too much alum and the dose should be reduced. For precise evaluation you should make only one change at a time and evaluate the results.

Table 25 is a summary of coagulation-flocculation process problems; how to identify the causes of these problems and also how to go to correct the problems.

Record Keeping

Records of the following items should be maintained:

- Source water quality (pH, turbidity, temperature, alkalinity, chlorine demand and colour.
- Process water quality (pH, turbidity, and alkalinity).

- Process production inventories (chemicals used, chemical feed rates, amount of water processed, and amount of chemicals in storage).
- Process equipment performance (types of equipment in operation, maintenance procedures performed, equipment calibration and adjustments).
- A plot of key process variables should be maintained. A plot of source water turbidity vs. coagulant dosage should be maintained. If other process variables such as alkalinity or pH vary significantly, these should also be plotted.

Table 25: Coagulation-Flocculation Process Trouble-Shooting

Source water quality	Operator actions	Possible process changes
Turbidity Temperature	1. Perform the necessary analysis to determine the changes 2. Evaluate the overall process performance 3. Perform Jar tests 4. Make appropriate process changes (see right hand column possible process changes) 5. Increase frequency or process monitoring	1. Adjust coagulant dosage 2. Adjust flush mixer/flocculator mixing intensity. 3. Add coagulant aid oor filter aid 4. Adjust alkalinity or or pH 5. Change Coagulants
Coagulation Process Effluent Quality Changes	**Operator Actions**	**Possible Process Changes**
Turbidty Alkanity pH	1. Evaluate Source water quality 2. Perform Jar test 3. Verify process performance a) Coagulant feed rates b) Flash mixer operation 4. Make appropriate process changes	1. Adjust coagulant dosage 2. Adjust flush mixer intensity(if possible) 3. Adjust alkalinity or 4. pH Change Coagulants
Coagulation Process Effluent Quality Changes	**Operator Actions**	**Possible Process Changes**
Floc formation	1. Observe floc formation in basin: a) Dispersion; b) Size; and c) Floc Strength (break-p) 2. Evaluate overall process performance 3. Perform Ja Tests a) Evaluate floc size, settling rate and strength b) Evaluate quality of the supernatant; clarity (turbidty), pH and colour 4. Make appropriate process changes	1. Adjust coagulant dosage 2. Adjust flush mixer/flocculator intensity(if possible) 3. Add coagulant aid 4. Adjust alkalinity; or 5. Change Coagulant(s)

Note that all major problems should be reported to authorities

Safety considerations

In the coagulation-flocculation processes, the operator will be exposed to a number of hazards such as:

- Electrical equipment,
- Rotating mechanical equipment,
- Water treatment chemicals,
- Laboratory reagents (chemicals),
- Slippery surfaces caused by certain chemicals
- Flooding.
- Confined spaces and underground structures such as valve or pump vaults (toxic and explosives gases, insufficient oxygen).

Strict and constant attention must be given to safety procedures. The operator must be familiar with general first aid practices such as mouth-to-mouth resuscitation, treatment of common physical injuries, and first aid for chemical exposure (chlorine).

Start-up and shut-down procedures

a) Conditions requiring Implementation of Startup and Shutdown Procedures

This is not a routine operating procedure in most of the plants. These procedures generally happen when the plant is shut down for maintenance. In some rare instances, shut down may be required due to a major equipment failure.

b) Startup Procedures

1. Check the condition of all mechanical equipment for proper lubrication and operational status.
2. Make sure all chemical feeders are ready. There should be plenty of chemicals available in the tanks and ready to be fed to the raw water.
3. Collect a sample of raw water and immediately run a jar test using fresh chemicals from the supply of chemicals to the feeders.
4. Determine the settings for the chemical feeders and set the feed rates on the equipment.
5. Open the inlet gate or valve to start the raw water flowing.
6. Immediately start the selected chemical feed systems. Open valves to start feeding coagulant chemicals and dilution make-up water.
   Start chemical feeders.
7. Turn on the flash mixer at the appropriate time. You may have to wait until the tank or channel is full before turning on the flash mixer. Follow the manufacturer's instructions.
8. Start the sample pumps as soon as there is water at each sampling location. Allow sufficient flushing time before collecting any samples.
9. Start the flocculators as soon as the first basin is full of water.
10. Inspect mixing chamber and flocculation basin. Observe formation of floc and make necessary changes.
11. Remove any debris floating on the water surface.
12. Perform water quality analysis and make process adjustments as necessary.
13. Calibrate chemical feeders.

Note: Do not allow any untreated water to flow through the plant.

c) Shut down Procedures

1. Close raw water gate to flash-mix chamber or channel.
2. Shut down the chemical feed systems.
   Turn off chemical feeders.
   Shut off appropriate valves.

Flush or clean chemical feed lines if necessary.

3. Shut down flash mixer and flocculators as water leaves each process.
4. Shut down sample pumps before water leaves sampling location.
5. Waste any water that has not been properly treated.
6. Lock out and tag appropriate electrical switches.
7. Dewater basins if necessary. Waste any water that has not been properly treated.

Note : Do not dewater below-ground basins without checking groundwater levels.

Close basin isolation gates or install stop-logs.
Open basin drain valves
Be careful that the basin may float or collapse depending on ground water, soil or other conditions.
Good records of actions taken during start/shutdown operations will assist the operator in conducting future shutdowns.

Laboratory tests

Process control water quality indicators of importance in the operation of flocculation process include turbidity, alkalinity, chlorine demand, colour, pH, temperature, odour and appearance.

Sedimentation

Sedimentation Basins

The Basin can be divided into four zones.

1) Inlet zone
2) Settling zone
3) Sludge zone
4) Outlet zone

Basin Types

The basins may be of the following types:

- Rectangular basins.
- Circular and square basins.
- High Rate Settlers (Tube Settlers).
- Solid Contact Units (Up-flow solid-contact clarification and up-flow sludge blanket clarification).

Sludge Handling

(a) Sludge characteristics

Water treatment sludges are typically alum sludges, with solid concentrations varying from 0.25 to 10% when removed from a basin. In gravity flow sludge removal systems, the solid concentration should be limited to about 3%. If the sludges are to be pumped, solids concentrations as high as 10% can be readily transported.
In horizontal flow sedimentation basins preceded by coagulation and flocculation, over 50% of the floc will settle out in the first third of the basin length. Operationally, this must be considered when establishing the frequency of the operation of sludge removal equipment.

(b) Sludge Removal Systems

Sludge which accumulates on the bottom of the sedimentation basins must be removed periodically for the following reasons:

i. To prevent interference with the settling process (such as resuspension of solids due to scouring).

ii. To prevent the sludge from becoming septic or providing an environment for the growth of microorganisms that create taste and odour problems.
iii. To prevent excessive reduction in the cross sectional area of the basin (reduction of detention time).

In large-scale plants, sludge is normally removed on an intermittent basis with the aid of mechanical sludge removal equipment. However, in smaller plants with low solid loading, manual sludge removal may be more cost effective.

In manually cleaned basins, the sludge is allowed to accumulate until it reduces settled water quality. High levels of sludge reduce the detention time and floc carries over to the filters.
The basin is then dewatered (drained), most of the sludge is removed by stationary or portable pumps, and the remaining sludge is removed with squeegees and hoses. Basin floors are usually sloped towards a drain to help sludge removal. The frequency of shutdown for cleaning will vary from several months to a year or more, depending on source water quality (amount of suspended matter in the water).
In larger plants, a variety of mechanical devices can be used to remove sludge including:

- Mechanical rakes.
- Drag-chain and flights.
- Travelling bridge.

Circular or square basins are usually equipped with rotating sludge rakes. Basin floors are sloped towards the centre and the sludge rakes progressively push the sludge toward a centre outlet. In rectangular basins, the simplest sludge removal mechanism is the chain and flight system.

Interaction with other Treatment processes
The purpose of sedimentation process is to remove suspended particles so as to reduce load on Filters. If adequate detention time and basin surface area are provided in the sedimentation basins, solids removal efficiencies greater than 95% can be achieved. However, high sedimentation basin removal efficiencies may not always be the most cost effective way to remove suspended solids.

In low turbidity source waters (less than about 10 NTU) effective coagulation, flocculation and filtration may produce satisfactory filtered water without the need for sedimentation. In this case, coagulation-flocculation process is operated to produce a highly filterable pinpoint, which does not readily settle due to its small size; instead the pinpoint is removed by the filters.

There is, however, a practical limitation in applying this concept to higher turbidity conditions. If the filters become overloaded with suspended solids, they will quickly clog and need frequent back washing. This can limit plant production and cause degradation in filtered water quality.

Thus the sedimentation process should be operated from the standpoint of overall plant efficiency. If the source water turbidity is only 3 mg/l, and the jar tests indicate that 0.5 mg/l of coagulant is the most effective dosage, then you cannot expect the sedimentation process to remove a significant fraction of the suspended solids. On the other hand, source water turbidities in excess of 50 mg/l will probably require a high coagulant dosage for efficient solids removal. In this case, the majority of the suspended particles and alum floc should be removed in the sedimentation basin.

Operating procedures

From a water quality standpoint, filter effluent turbidity is a good indication of overall process performance. However one must monitor the performance of each of the individual water treatment processes, including sedimentation, in order to anticipate quality or performance changes. Normal operating conditions are considered to be conditions within the operating ranges of your plant, while abnormal conditions are unusual or difficult to handle conditions.

In normal operation of the sedimentation process one must monitor.

- Turbidity of the water entering and leaving the sedimentation basin and temperature of the entering water. Turbidity of the entering water indicates the floc or solids loading on the sedimentation process. Turbidity of the water leaving the basin reveals the effectiveness or efficiency of the sedimentation process. Low levels of turbidity are desirable to minimize the floc loading on the filter.
- Temperature of the water entering the sedimentation basin is important. As the water becomes colder, the particles will settle more slowly. To compensate for this change, you should perform jar tests and adjust the coagulant dosage to produce a heavier and thus a settling floc. Another possibility is to enforce longer detention times when water demand decreases.
- Visual checks of the sedimentation process should include observation of floc settling characteristics, distribution of floc at the basin inlet and clarity of settled water spilling over the launder weirs. An uneven distribution of floc, or poorly settling floc may indicate that a raw water quality change has occurred or that the operational problems may develop.

Process Actions

In rectangular and circular sedimentation basins, it is generally possible to make a judgment about the performance of the sedimentation process by observing how far the flocs are visible beyond the basin inlet. When sedimentation is working well, the floc will only be visible for short distance. When the sedimentation is poor, the floc will be visible for a long distance beyond the inlet.

In up-flow or solid-contact clarifiers, the depth of the sludge blanket and the density of the blanket are useful monitoring tools. If the sludge blanket is of normal density (measured as milligrams of solids per litre of water) but is very close to the surface, more sludge should be wasted. If the blanket is of unusually light density, the coagulation-flocculation process (chemical dosage) must be adjusted to improve performance.

With any of the sedimentation processes, it is useful to observe the quality of the effluent as it passes over the launder weir. Flocs coming over at the ends of the basin are indicative of density currents, short circuiting, sludge blankets that are too deep or high flows. The clarity of the effluent is also a reliable indicator of coagulation-flocculation efficiency.

Process equipment should be checked regularly to assure adequate performance. Proper operation of sludge removal equipment should be verified each time the equipment is operated, since sludge removal discharge piping systems are subject to clogging. Free flowing sludge can be readily observed if sight glasses are incorporated in the sludge discharge piping.

Record Keeping

Maintain daily operations log of process performance and water quality characteristics and keep the following records:

1. Influent and effluent turbidity and influent temperature.
2. Process production inventory (amount of water processed and volume of sludge produced).
3. Process equipment performance (type of equipment in operation, maintenance procedures performed and equipment calibration).

Otherwise, the outlet of the sludge line should be observed during sludge pumping. Frequent clogging of sludge pipe requires increasing frequency of sludge removal equipment and this can be diagnosed by performing sludge solids volume analysis in the laboratory.

A summary of routine sedimentation process actions is given in Table 22

Table 26: gives a summary of sedimentation process problems and remedial measures.

Monitor Process Performance and Evaluate Water Quality Conditions	Location	Frequency	Possible Operator Actions
Turbidty Temperature	Influent/Effluent Influent	At least once every 8 hours shift Occasionally	1. Increase sampling frequency water quality is variable 2. Perform Jar test 3. Make necessary process changes a) Change coagulant dossage b) Adjust flash mixer/floculator mixing intensity c) Change coagulant
Make Visual Observations			Possible Operator Actions
Floc settling characteristics Floc distribution Turbidity(clarity) of settled water	First half of basin inlet Launders of settled water conduit	At least once per 8-hour shift At least once per 8-hour shift At least once per 8-hour shift Note: Depends on the size of plant	Perform Jar tests. Make necessary process changes a) Change coagulant dosage. b) Adjust flash mixer/floculator mixing intensity c) Chanage frequency of sludge removal d) Change coagulant
Check sludge removal Equipment			Possible operator actions
Noise, vibration, Leakage, Overheating	Various	Once per 8-hour shift	1. Correct minor problems 2. Notify others of major problems
Operate sludge removal Equipment			Possible operator actions
Perform normal operation sequence	Sed. basins	Depends on process conditions (may vary	Change frequency of operations: If sludge is too watery, decrease frequency of operation and/or pumping rate

Observe conditions of sludge being removed		from once per day to several days or more)	If sludge is too dense, bulks or clogs discharge lines, increase frequency of operations, and/or pumping rate
Inspect facilities			Possible operator actions
Check Sedimentation Basins Observe Launder waters over basin weirs Observe basin surface water Check for algae build up on basin walls and launders	Various Various Various Various	Once per 8-hour shift Once per 8-hour shift Once per 8-hour shift Occasionally	Report abnormal conditions Make flow changes or adjust launder weirs Remove debris from basin water surface

Notes: All major problems should reported to competent authorities and should be duly followed up.

Start up and Shut Down Procedure

In the event of requirement for shut down or start up of processes on account of maintenance or a major equipment failure, proper procedures must be followed as per recommendations of the manufacturer of the plant and equipment. The procedures, in general, are given below:

a) Start up Procedure

1. Check operational status and mode of operation of equipment and physical facilities.
   Check that basin valves are closed.
   Check that basin isolation gates are closed.
   Check that launder weir plates are set at equal elevations.
   Check to ensure that all trash, debris and tools have been removed from basin.
2. Test sludge removal equipment.
   Check that mechanical equipment is properly lubricated and ready for operation.
   Observe operation of sludge removal equipment.
3. Fill sedimentation basin with water.
   Observe proper depth of water in basin.
   Remove floating debris from basin water surface.
4. Start sample pumps.
5. Perform water quality analyses.
6. Operate sludge removal equipment. Be sure that all valves are in the proper position.

b) Shut Down Procedures

1. Stop flow to sedimentation basin. Install basin isolation gates.
2. Turn off sample pump.
3. Turn off sludge removal equipment.
   Shut off mechanical equipment and disconnect where appropriate.
   Check that valves are in proper position.
4. Lock out electrical switches and equipment.
5. Dewater basin if necessary.
   Be sure that the water table is not high enough to float the empty basin.
   Open basin drain valves.
6. Grease and lubricate all gears, sprockets and mechanical moving parts which have been submerged immediately following dewatering to avoid seize up.

a) Equipment

Types of support equipment – Operation and Maintenance

The operator will need to be thoroughly familiar with the operation and maintenance instructions for each specific equipment.

- Flow meters and gauges.
- Valves.
- Control Systems.
- Water Quality monitors such as turbiditimeters.
- Sludge removal equipment.
- Sludge pumps.
- Sump pumps.

b) Equipment Operation

1. Check the following:
2. Proper lubrication and operational status of each unit.
3. Excessive noise and vibration, overheating and leakage.
4. Pumps suction and discharge pressure.

a) Safety Considerations *Electrical Equipment*

1. Avoid electric shock.
2. Avoid grounding yourself in water or on pipes.
3. Ground all electric tools.
4. Use a lock out and tag system for electric equipment or electrically driven mechanical equipment.

b) Mechanical Equipment

1. Keep protective guards on rotating equipment
2. Do not wear loose clothing around rotating equipment.
3. Keep hands out of valves, pumps and other equipment.
4. Clean up all lubricant and sludge spills.

c) Open Surface water – filled structures

1. Use safety devices such as hand rails and ladders
2. Close all openings.
3. Know the location of all life preservers.

Valve and Pump Vaults, Sumps

1. Be sure all underground or confined structures are free of hazardous atmosphere (toxic or explosive gases, lack of oxygen).
2. Work only in well ventilated structures.
3. Take proper steps against flooding.
4. For more details please refer to Chapter 19 - Safety Practices.

Preventive maintenance

Such programmes are designed to assure the continued satisfactory operation of treatment plant by reducing the frequency of breakdown failures. Typical functions include.

1. Keeping electric motors free of dirt and moisture.
2. Assuring good ventilation.

3. Checking pumps and motors for leaks, unusual noise and vibrations, overheating or signs of wear.
4. Maintaining proper lubrication and oil levels.
5. Inspecting alignment of shafts and couplings.
6. Checking bearings for overheating and proper lubrication.
7. Checking for proper valve operation.
8. Checking for free flow of sludge in sludge removal collection and discharge systems.
9. Good House Keeping.

FILTRATION (RAPID SAND FILTERS)

Interaction with Other Treatment Processes

The purpose of filtration is the removal of particulate impurities and floc from the water being treated. In this regard, the filtration process is the final step in the solids removal process which usually includes the pretreatment processes of coagulation, flocculation and sedimentation.

The degree of treatment applied prior to filtration depends on the quality of water.

Operation

Filter Operation: A filter is usually operated until just before clogging or breakthrough occurs or a specified time period has passed (generally 24 hours).

Backwashing: After a filter clogs or breakthrough occurs or a specified time has passed, the filtration process is stopped and the filter is taken out of service for cleaning or backwashing.

Surface Wash: In order to produce optimum cleaning of the filter media during backwashing and to prevent mud balls, surface wash (supplemental scouring) is usually required. Surface wash systems provide additional scrubbing action to remove attached floc and other suspended solids from the filter media.

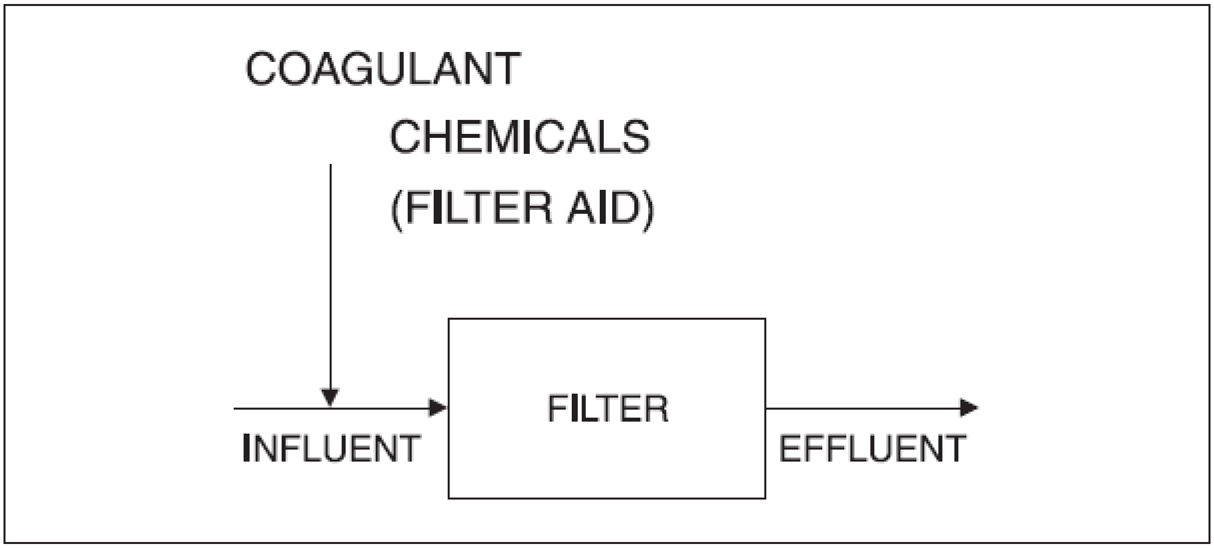


FIG. 5.4 IN LINE FILTRATION

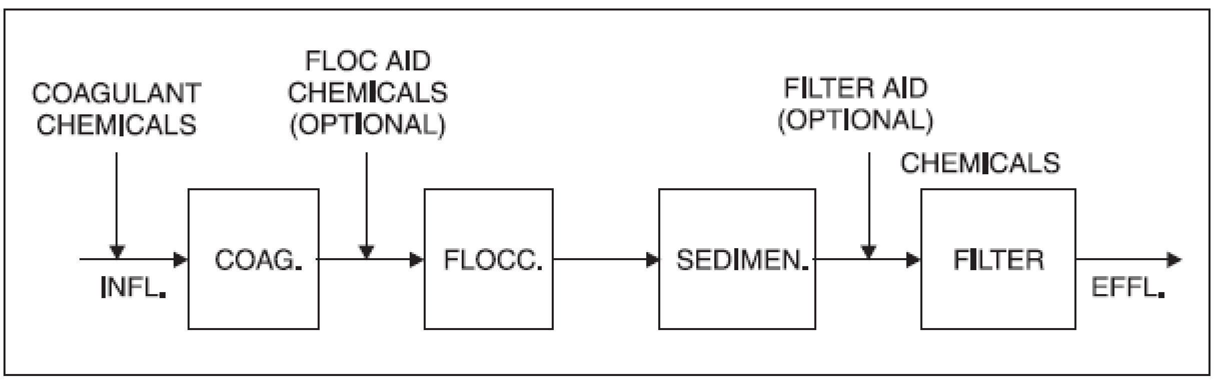


Figure 4: Conventional Filtration

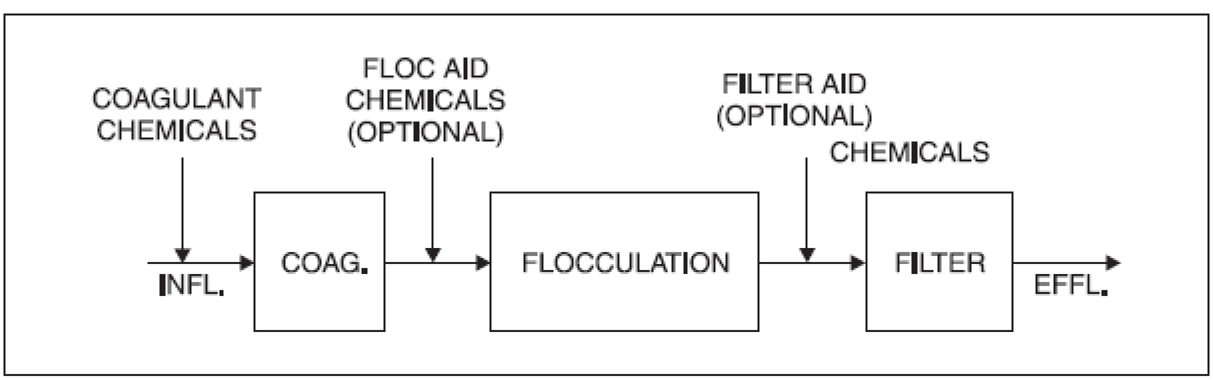


Figure 5: Direct Filtration

OPEARTION PROCEEDURES

(a) The indicators of Normal Operating Conditions

The filter influent and effluent turbidities should be closely watched with a turbidimeter.

Filter Influent turbidity levels (settled turbidity) can be checked on a periodic basis at the filter or from the laboratory sample tap. However, the filter effluent turbidity is best monitored and recorded on a continuous basis by an on-line turbiditimeter.

(b) Process Actions

Follow the steps as indicated below:

Monitor process performance.

Evaluate turbidity and make appropriate process changes.

Check and adjust process equipment (change chemical feed rates).

Backwash filters.

Evaluate filter media condition (media loss, mud balls, cracking).

Visually inspect facilities.

(c) Important process activities and Precautions.

1. Monitoring process performance is an ongoing activity. You should look for and attempt to anticipate any treatment process changes or other problems that might affect filtered water quality, such as a chemical feed system failure.
2. Measurement of head loss built up (Fig.5.7) in the filter media will give you a good indication of how well the solids removal process is performing. The total designedhead loss from the filter influent to the effluent in a gravity filter is usually about 3 meters. At the beginning of the filtration cycle the actual measured head loss due to clean media and other hydraulic losses is about 0.9m. This would permit an additional head loss of about 2.1m due to solid accumulation in the filter.
3. The rate of head loss build up is an important indication of process performance. Sudden increase in head loss might be an indication of surface sealing of the filter media (lack of depth penetration). Early detection of this condition may permit you to make appropriate process changes such as adjustment of chemical filter aid feed rate or adjustment of filtration rate.
4. Monitoring of filter turbidity on a continuous basis with an on-line turbiditimeter is highly recommended. This will provide you with continuous feed back on the performance of the filtration process. In most instances it is desirable to cut off (terminate) filter at a predetermined effluent turbidity level. Preset the filter cutoff control at a point where you experience and tests show that breakthrough will soon occur.
5. In the normal operation of the filter process, it is best to calculate when the filter cycle will be completed on the basis of the following guidelines:

    Head loss.
    Effluent turbidity level.
    Elapsed run time.

    A predetermined value is established for each guideline as a cut off point for filter operation. When any of these levels is reached, the filter is removed from service and backwashed.
6. At least once a year one must examine the filter media and evaluate its overall condition. Measure the filter media thickness for an indication of media loss during the backwashing process. Measure mud ball accumulation in the filter media to evaluate the effectiveness of the overall backwashing operation.
7. Routinely observe the backwash process to qualitatively assess process performance. Watch for media boils (uneven flow distribution) during backwashing, media carry over into the wash water trough, and clarity of the waste wash-water near the end of the backwash cycle.

8. Upon completion of the backwash cycle, observe the condition of the media surface and check for filter sidewall or media surface cracks. You should routinely inspect physical facilities and equipment as part of good housekeeping and maintenance practice. Correct or report the abnormal equipment conditions to the appropriate maintenance personnel.
9. Never bump up a filter to avoid backwashing. Bumping is the act of opening the backwash valve during the course of a filter run to dislodge the trapped solids and increase the length of filter run. This is not a good practice.

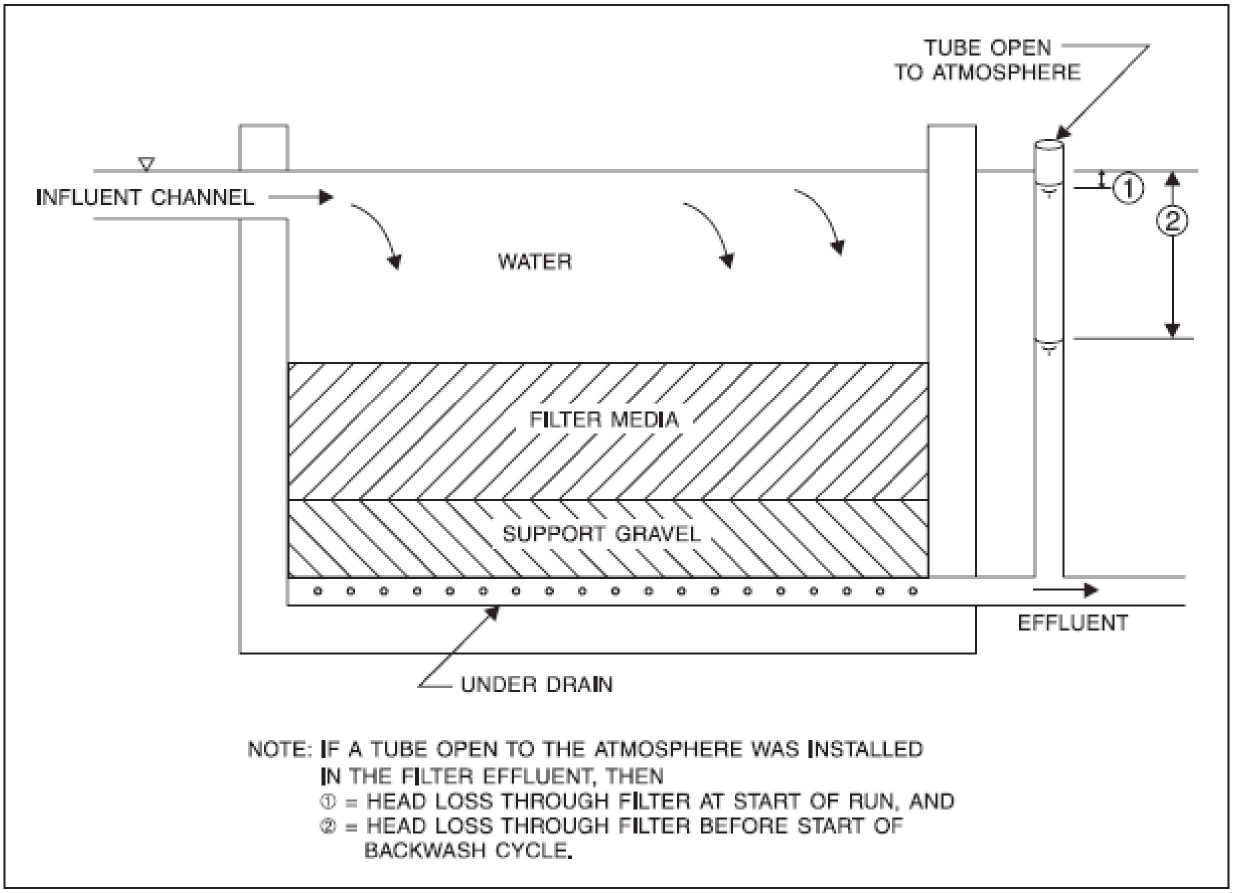


Figure 6: Measurement Of Head loss

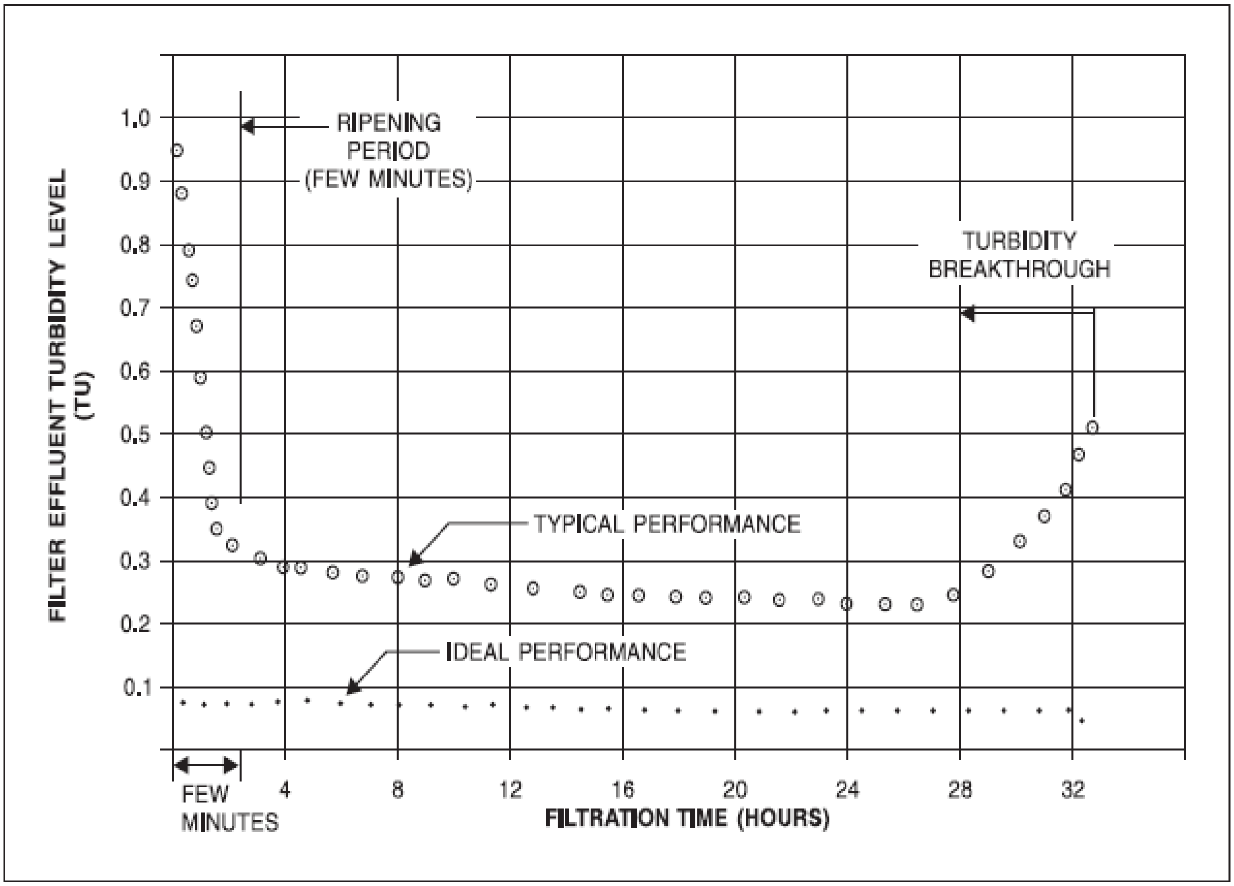


Figure 7: Typical Filter Effluent Turbidity Data

Shortened filter runs can occur because of air bound filters. Air binding will occur more frequently when large head losses are allowed to develop in the filter. Precautions should be taken to minimize air binding to avoid damage to the filter media.
A summary of routine filtration process action is given in Table 27.
Table 5.7 gives Filtration process trouble shooting problems.

RECORD KEEPING

Maintain a daily operations log of process performance data and water quality characteristics.
Accurate recording of the following items should be maintained.

1. Process water quality (turbidity and colour).
2. Process operation (filters in service, filtration rates, loss of head, length of filter runs, and frequency of backwash, backwash rates, and UFRV-unit filter run volume).
3. Process water production (water processed, amount of backwash water used, and chemicals used).
4. Percentage of water production used to backwash filters.
5. Process equipment performance (types of equipment in operation, equipment adjustments, maintenance procedures performed, and equipment calibration).

A typical daily operating record for a water treatment plant is shown in Table 28.

Table 27: Summary Of Routine Process Action

Monitor Process Performance and Evaluate Water Quality Conditions	Location	Frequency	Possible Operator Actions
Turbidity Colour Headloss	Influent/Effluent Influent/Effluent	At least once in 8 hours shift At least once in 8 hours shift At least two time in 8 hours shift	1. Increase sampling frequency water quality is variable 2. Perform Jar test 3. Make necessary process changes : a) Adjust coagulant dossage b) Adjust flash mixer/floculator mixing intensity c) Change filtration rate d) Change wash filter e) Change coagulant f) Change Chlorine dossage
Operate Filters and Backwash			
Put Filter into service Change filtration rate Remove filter from service Backwash filter Change back-wash rate	Filter module	Depends on process conditions	See Operation procedures
Check Filter Media Condition			
Media depth evaluation Media cleanliness Cracks or shrinkage	Filter Module	At least monthly	1. Replace lost filter media 2. Change back-wash procedure 3. Change chemical coagulants
Make visual observations of backwash operations			
Check for media boils and media expansion Check for carry-over into washwater trough. Observe clarity of wastewater	Filter Module	At least once per day or whenever back-washing occurs	Change back-wash rate Change back-wash cycle time Adjust surface wash-rate or cycle time Inspect filter media and support gravel for disturbance.
Check filtration process and backwash Equipment condition			
Noise, Vibration, Overheating	Various	Once in 8 hours shift	Correct minor problems
Inspect Facilities			
Check physical facilities and algae on sidewalls and troughs	Various	Once a day	Remove debris from filter media surface Adjust chlorine dosage to control algae

Notes: All major problems should reported to competent authorities and should be duly followed up.

Table 28: Table 26 Filtration Process Trouble Shooting

Source water quality changes	Operator Actions	Possible Process Changes

Turbidty Temperature Alkanity pH Colour Chorine Demand	1. Perform the necessary analysis to determine the extent of change. 2. Assess the overall process performance 3. Perform Jar tests 4. Make appropriate process changes 5. Increasing frequency of process monitoring 6. Verify response to process changes (be sure to allow for sufficient time for change to take effect) 7. Add lime or caustic soda f alkanity is low	1. Adjust coagulant dosage 2. Adjust flash mixer-flocculator mixing intensity. 3. Change frequency of sludge removal (Increase or decrease) 4. Adjust backwash cycle (Rate, Duration) 5. Change filtration rate (Add or delete filters) 6. Start filter change feed 7. Change coagulant
Sedimentation Process Effluent Quality Changes		
Head-Loss increase short filter runs media surface sealing mudballs. Filter cracks, shrinkage Filter not clean Media boils Media Loss Excessive head loss	1. Assess overall process performance 2. Perform Jar test 3. Make appropriate process changes	1. Adjust coagulant dosage 2. Adjust flash mixer/flocculator Mixing Media intensity 3. Change frequency of sludge removal 4. Adjust backwash cycle (rate, duration) 5. Manually remove mud-balls 6. Decrease filtration rate (add more filters) 7. Decrease or terminate filter-aid 8. Replenish lost media 9. Clear under-drains openings of the media, corrosion or chemicals deposits, check head loss 10. Change coagulant
Filter Effluent Quality Changes		
Turbidty breakthrough Colour pH Chlorine	1. Assess overall process performance 2. Perform Jar test 3. Verify process performance: a) Coagulation and flocculation b) Sedimentation Process c) Filtration process 4. Make appropriate process changes	1. Adjust coagulant dosage 2. Adjust flash mixer/flocculator Mixing Media intensity 3. Change frequency of sludge removal 4. Start filter aid feed 5. Change coagulant 6. Decrease filtration rate (add more filters) 7. Change chlorine dosage

Notes: All major problems should reported to competent authorities and should be duly followed up.

Table 29: Filter Daily Operating Record

	START TIME		HOURS OPERATED			WASH		PHYSICAL CONDITION OF FILTERS
	START	STOP	Today	Prev.	Total	MIN.	MIN. GAL	
1.								

2.								
3.								
4.								
5.								
6.								
7.								
No. of filters washed			Average Filter rate					
Average rub hours			Average Hourly rae					
Total wash water			Total Water filered					
Percent of water filtered			Total					
Average time of wash in him			No of filters operating					
			Shift					
			Operator					

Start up and Shutdown procedures

a) Routine Procedure

Most plants keep all filters on line except for backwash and in service except for maintenance.

Filters are routinely taken off line for backwashing when the media becomes clogged with particulates, turbidity breakthrough occurs or demands for water are reduced.

b) Implementation of Startup and Shutdown Procedures

1. Filter checkout procedures

- Check operational status of filter.
- Be sure that the filter media and wash water troughs are clean of all debris such as leaves, twigs, and tools.
- Check and be sure that all access covers and walkway gratings are in place.
- Make sure that the process monitoring equipment such as head loss and turbidity systems are operational.
- Check the source of backwash to ensure that it is ready to go.

2. Backwash Procedure

   i. Filters should be washed before placing them into service.
   The surface wash system should be activated just before the backwash cycle starts to aid in removing and breaking up solids on the filter media and to prevent the development of mud balls. The surface wash system should be stopped before completion of the backwash cycle to permit proper settling of the filter media.

A filter wash should begin slowly for about one minute to permit purging (removing) of an entrapped air from the filter media, and also to provide uniform expansion of the filter bed. After this period the full backwash rate can be applied.

Sufficient time should be allowed for cleaning of the filter media. Usually when the backwash water coming up through the filter becomes clear, the media is washed. This generally takes from 3 to 8 minutes. If flooding of wash water troughs or carryover of filter media is a problem, the backwash rate must be reduced.

ii. Procedure for backwashing a filter is as follows: (Fig. 7).

Log length of filter run since last backwash.
Close filter influent valve (V-1).
Open drain valve (V-4).
Close filter effluent valve (V-5).
Start surface wash system (Open V-2).
Slowly start backwash system (Open V3).
Observe filter during washing process.
When wash water from filter becomes clear (filter media is clean), close surface wash system Valve (V 2).
Slowly turn off backwash system (close V-3).
Close drain valve (V-4).
Log length of wash and the quantity of water used to clean filter.

c) Filter Startup Procedures

Start filter
Slowly open influent valve.
When proper elevation of water is reached on top of filter, filter effluent valve should be gradually opened. This effluent control valve should be adjusted itself to maintain a constant level of water over the filter media.
Waste some of the initial filtered water if such a provision exists.
Perform turbidity analysis of filtered water and make process adjustments as necessary.

d) Filter Shutdown Procedures

Remove filter from service by closing influent valve and closing effluent valve
Backwash filter.
If filter is to be out of service for a prolonged period, drain water from filter to avoid algal growth.
Note status of filter in operations log.

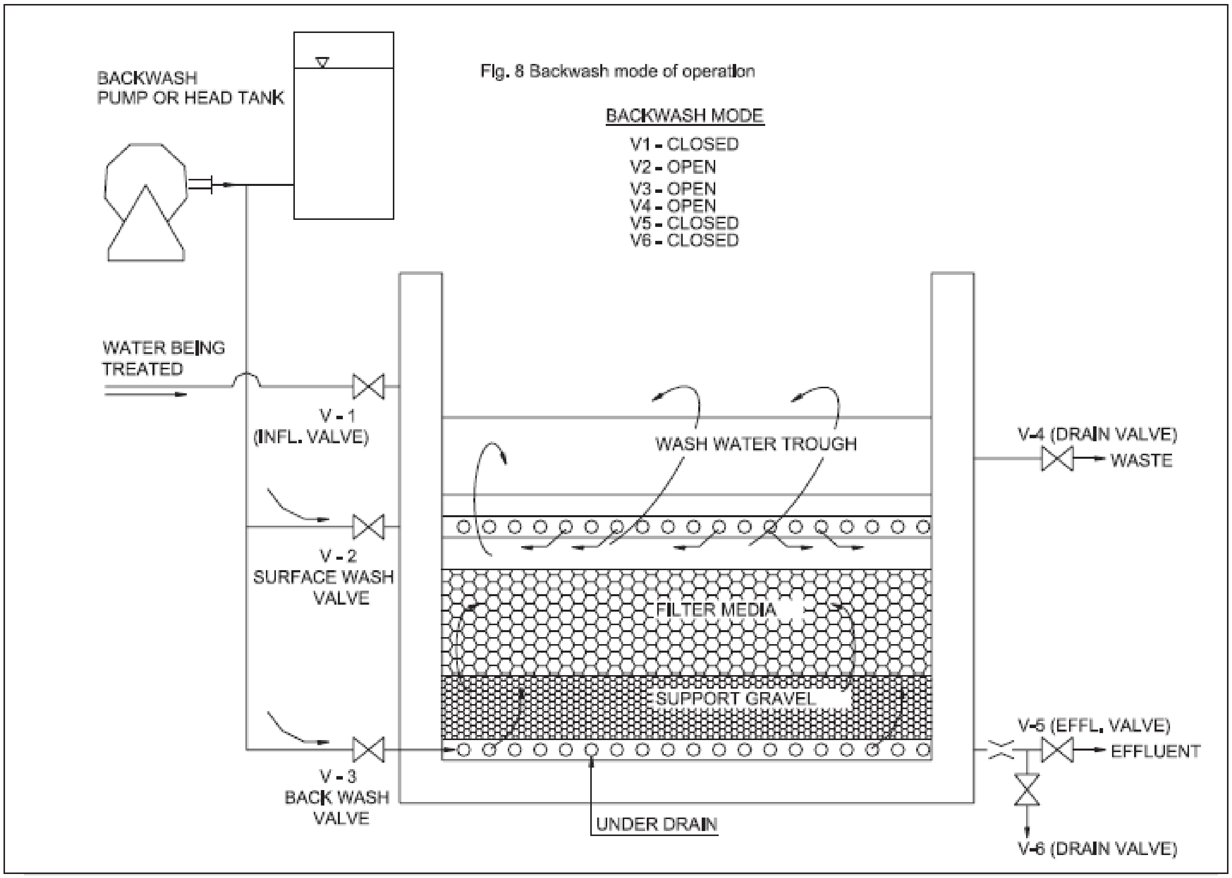


Figure 8: Backwash Operation

Support Equipment

The operator must be familiar with the operation and maintenance instructions for each specific equipment item or control system.

a) Types of Equipment

1. Filter Control Valves.
2. Backwash and surface wash pumps.
3. Flow meter and level/pressure gauges.
4. Water quality monitors such as turbiditimeters.
5. Process monitors (head loss and water level).
6. Mechanical and electrical filter control systems.

b) Equipment Operation

Before starting a piece of mechanical equipment, such as a backwash pump, be sure that the unit has been serviced on schedule and its operational status is known.

After startup, always check for excessive noise and vibrations, overheating, and leakage (water, lubricants). When in doubt about the performance of a piece of equipment, refer to manufacturer's instructions.

Periodic calibration and maintenance of the equipment is necessary.

Preventive Maintenance Procedures

Preventive maintenance programmes are to assure the continued satisfactory operation of treatment plant facilities by reducing the frequency of breakdown failures.

Routine maintenance functions include:

- Keeping electric motors free of dirt, moisture and pests (rodents and birds).
- Assuming good ventilation (air circulation) in equipment work areas.
- Checking pumps and motors for leaks, unusual noise and vibrations or overheating.
- Maintaining proper lubrication and oil levels.
- Inspecting for alignment of shafts and couplings.
- Checking bearings for overheating and proper lubrication.
- Checking the proper valve operation (leakage or jamming).
- Checking automatic control systems for proper operation.
- Checking air/vacuum relief systems for proper functioning, dirt and moisture.
- Verifying correct operation of filters and backwashing cycles by observation.
- Inspecting filter media condition (look for algae and mudballs and examine gravel and media for proper gradation).
- Inspecting filter underdrain system (be sure that the underdrain openings are not becoming clogged due to media, corrosion or chemical deposits).

Safety Considerations

a) Electrical Equipment

1. Avoid electric shock (use preventive gloves).
2. Avoid grounding yourself in water or on pipes.
3. Ground all electric tools.
4. Lock out and tag electrical switches and panels when servicing equipment.

b) Mechanical Equipment

1. Use protective guards on rotating equipment.
2. Don't wear loose clothing around rotating equipment.
3. Keep hands out of energized valves, pumps and other pieces of equipment.
4. Clean up all lubricant and chemical spills (slippery surfaces cause bad falls).

c) Open – Surface Filters

1. Use safety devices such as handrails and ladders.
2. Close all openings and replace safety gratings when finished working.
3. Know the location of all life preservers and other safety devices.

d) Valve and Pump Vaults, Sumps, Filter galleries

1. Be sure that all underground or confined structures are free of hazardous atmospheres (toxic or explosive gases, lack of oxygen) by checking with gas detectors.
   Only work in well ventilated structures (use air circulation fans).
2. For more details please refer to Chapter 19 - 'Safety Practices'

augmentation Of Rapid Sand Filtration Plants

Augmentation of an existing Rapid Sand Filtration Plant can be carried out by converting the conventional filtration process to Variable Declining Rate Filtration with dual media filter units. The filter unit will, however, require additional depth. Special precautions are required to strictly adopt the specifications of the two filter media as regards effective size and specific gravity. During operation a special watch has to be kept to avoid intermixing of the two media.

PRESSURE FILTERS

INTRODUTION

Pressure Filters are Rapid Sand Filters placed in a closed water-tank. The water passes through the sand and emerges from the filter under a pressure greater than atmosphere. Pressure filters are used primarily in small plants and in industries where the raw water is received, and the filtered water is discharged, under pressure. The use of pressure filters for public water supplies is unusual because of cost, inefficiency of filtration and the relative poor quality of results obtained.

OPERATION

The filter is operated similar to a gravity- type filter except that the coagulated water is applied directly to the filter without mixing, flocculation, or conditioning. Automatic filters are available in which the valves are manipulated automatically to backwash at a predetermined time or head loss. It is to be noted that the head loss through the filter is approximately the same as through a gravity filter. The term “pressure filter” does not imply that water is pumped through the filter under a high pressure loss.

The coagulant, normally, is applied under pressure in the influent line to the filter, the influent water dissolving the alum as it enters the filter.

Following drawbacks have been noticed in the working of the Pressure filters. Efforts should be made during their maintenance to avoid the same.

- There is no scope for proper formation of the flocs, the entrapment of the unsettleable and colloidal particles and independent settlement of the settleable solids.
- The filter media becomes mixed up due to the water pressure. Cracks develop within the filter sand media and serious piping develops within the entire media.
- Due to intermixing of the media the under-drainage system gets damaged.
- The behaviour of the filter operation cannot be examined properly.

Roughing Filters

These filters are used to remove solid matters which would, otherwise, impair the operation of the conventional filters.

These may be of Horizontal flow or Vertical flow. When used as pretreatment units in slow sand filter, the plant can handle raw water of higher turbidity, colour and bacterial count.

When installed in a catchment area it reduces the load on the conventional plant by arresting courser impurities and floating matter.

CHECKLIST

Water Treatment Plant Information, Operation, Maintenance, Records etc.

Plant Information

Source

Surface i. River ii. Reservoir iii. Dam iv. Lake v. Canal.

Ground i. Well ii. Tubewell iii. Infiltration well/gallery

Intake

i. Location. ii. Pollution Source iii. Gates and Valves iv. Structural details.

Treatment Processes

1. Screens.
2. Storage tanks/Pre-settling tanks.
3. Pre-disinfection/Pre-chlorination.
4. Aeration.
5. Coagulation and Flocculation.
   a) Mixing tank or Mixing channel,
   b) Chemicals: lime, alum, or others
   Conventional or tapered flocculation.
   Independent tank or in the form of a clarifier.
6. Sedimentation.
   Tanks (circular or rectangular)
   If circular, as independent tanks or as clariflocculators with or without Scrapers.
   Other important features.
7. Filters
   Slow, Rapid or Others.
   Filter box
   Filter media
   Desludging.
   Backwashing with water only or both with and air.

8. Clear Water Tanks.

a) Capacity ii) Number iii) Size

OPERATION, MEINTENANCE, RECORDS E.T.C.

Flow

Measurements: i. Raw ii. Settled iii. Filtered iv. Chlorinated.

Flow Meters

i. Calibration and accuracy of equipment.
ii. Charts and pen recorder.
iii. Servicing of equipment.
iv. Cleaning of sump, water channel etc.

Chemical Feeding

i. Dosing at a point of maximum turbulence
ii. Jar test apparatus - ascertaining coagulant dosing.
iii. Cleaning V-notches, weirs and floor.
iv. Mixer painting.
v. Painting alum tank.
vi. Spares for rapid mix

Flocculator

i. Observing floc formation.
ii. Checking speeds of paddles.
iii. Checking short circuiting.
iv. Sludge collection, if any, and to take remedial measures to stop it.
v. Lubrication of mechanical devices.
vi. Dosing lines
vii. Valves and pipes.

Settling Basins

i. Examination of floc:
   observing floc formation efficiency
   floc distribution
   clarity of settled water.
ii. Checking short circuiting.
iii. Scrapers and squeezers.
iv. Outlet weir adjustment, biological growth.
v. Sludge lines and telescopic sludge devices if any.
   density of sludge
   accumulation of sludge
   bleeding of sludge
   sludge disposal
vi. Measuring turbidity at the end.
vii. Watching efficiency of various components.
viii. Overhauling all equipment.
ix. Painting.
x. Rail tracks.
xi. Reduction gear box.

Filters

i. Checking turbidity at start and end
ii. Adequate depth of water
iii. Rate of filtration
iv. Head loss at different important stages
v. Negative head
vi. Filter run
      Filter media surface cracks.
      mud balls
      slime growth
      intermixing of media
      uplifting of under drain nozzles.
      filter media carry over.
vii. Backwashing
      time and quantity of water used in backwashing.
      uniform washing of filter media.
      thickness of filter media before and after washing.
viii. Water quantity
      received; wasted; consumed for backwashing; produced

ix. Operation of Valves.
x. Performance of blowers.
xi. Status of functioning of Instruments
xii. Corrosion of Underwater equipment.

Records

a) Coagulation and Flocculation

1. Source water quality (pH, turbidity, temperature, alkalinity, chlorine demand and colour).
2. Process water quality (pH, turbidity, and alkalinity).
3. Process production inventories (chemicals used, chemical feed rates, amount of water processed, and amount of chemicals in storage).
4. Process equipment performance (types of equipment in operation, maintenance procedures performed, equipment calibration and adjustments).

b) Sedimentation

1. Influent and effluent turbidity and influent temperature.
2. Process production inventory (amount of water processed and volume of sludge produced.)
3. Process equipment performance (type of equipment in operation, maintenance procedures performed and equipment calibration).

c) Filtration

1. Process water quality (turbidity and colour).
2. Process operation (filters in service, filtration rates, loss of head, length of filter runs, frequency of backwash, backwash rates, and UFRV).
3. Process water production (water processed, amount of backwash water used, and chemicals used).
4. Percentage of water production used to backwash filters.
5. Process equipment performance (types of equipment in operation, equipment adjustments, maintenance procedures performed, and equipment calibration).

ALGAL CONTROL

Note: Only a brief description of removal of algae is being given in order to help the operator to understand and take effective steps in operating and maintaining such plant processes. For more details a reference may be made to the Manual of Water Supply and Treatment (Chapter 9).

INTRODUCTION

Algae are unicellular or multicellular chlorophyll bearing plants without any true root, stem or leaves. They may be microscopic unicellular colonial or dense mat forming filamentous forms commonly inhabiting surface waters. Their growth is influenced by a number of factors, such as mineral nutrients, availability of sunlight, temperature and type of reservoir. During certain climatic conditions there is an algal bloom which creates acute problems for treatment and production of potable water.

The algae encountered in water purification plants are Diatoms, Green Algae, Blue Green Algae and Algal Flagellates. Algae may be seen floating (plankton) in the form of blooms.

PROBLEMS CAUSED BY ALGAE

1. Many species of algae produce objectionable taste and odour due to characteristic oil secretions (Table 5.9). These also impart colour ranging from yellow-green to green, blue-green, red or brown.
2. Profuse growth of algae interferes with chemical treatment of raw water by changing water pH and its hardness.
3. Some algae act as inhibitors in process of coagulation carried out for water purification.
4. Some algae clog filters and reduce filter run.
5. Some algae produce toxins and their growth in drinking water reservoirs is harmful for humans and livestock.
6. Some algae provide shelter to a large number of bacteria, some of which may be pathogenic.
7. Some algae corrode metal tanks, forming pits in their walls.
8. Algae may also cause complete disintegration of concrete in contact with them.
9. Prolific growth of algae increases organic content of water, which is an important factor for the development of other organisms.

REMEDIAL MEASURES

Preventive Measures

Preventive measures can be taken to a limited extent by making environmental conditions unfavourable.

Control Measures

Adequate records of number, kind and location of algae becomes handy for algal growth control.
Algicide dose used should be harmless to humans, have no effect on water quality, should be inexpensive and easy to apply. The most commonly used *algaecides* are copper Sulphate and chlorine.

COPPER SULPHATE TREATMENT

Toxicity and Dosage

Copper Sulphate is toxic to many algae at comparatively low concentration, which is normally non-lethal to fishes and is relatively inexpensive.

Dosage of copper sulphate lethal for algae is expressed in terms of concentration of $CuSO_4.5H_2O$ in mg./l. The quantity of copper sulphate required has to be calculated on the basis of the type of algae present, period of its multiplication and volume of reservoir. Temperature, alkalinity and carbon dioxide content of water also influence dosage. Low temperature, high alkalinity and low carbon dioxide decrease effectiveness of copper sulphate.

Table 29 shows the approximate amount of copper sulphate required as lethal dose for various algae. It may be noted from the table that the mean recommended dose is 0.3mg./l; thus this dose may be used even in absence of laboratory control.

Points to be taken into account while formulating Copper Sulphate dosage

The dose of copper sulphate, to be added to unknown water depth, has to be calculated by considering 4.5 metres depth of water as algae congregate in the upper zone only. For alkaline water (alkalinity above 50mg./l as calcium carbonate) the dose should be based on surface area rather than volume of water as *algaecide* will be precipitated as copper bicarbonate before it can diffuse to lower depths. This difficulty can be overcome by scattering fine granular copper sulphate over the water surface. Water of intermediate alkalinity may be treated on volume basis. Copper Sulphate is not effective at pH 8.5, hence before copper sulphate treatment pH should be adjusted to maximise result.

Laboratory tests should be performed ensuring that copper content is within permissible limit in water supplied (i.e. 0.05 mg/l).

Depletion of dissolved oxygen due to decomposition of dead algae and clogging of gills of fish by dead algae clusters can be avoided by starting application of copper sulphate at the dams or reservoirs, which gives ample time to fishes to get away from treatment sites.

Methods of Application

Several methods of applying Copper Sulphate are available:

1. *General practice:* a bag containing required amount of copper sulphate crystals is hung at the point of entry of raw water into treatment plant.
2. *Burlap bag Method:* Required quantity of crushed copper sulphate crystals is placed in a cloth bag, which is dragged under the water surface by using a boat.
3. *Box Method:* Perforated wooden box containing copper sulphate crystals is supported in such a way that the depth of submergence can be varied as required at the point of entry of raw water into the treatment plant. The box should be filled to a point above
4. *Spray Method:* 0.5-1% copper sulphate solution may be sprayed over the surface of water by conventional spraying equipment.
5. *Blower Method:* Large quantities of copper sulphate may be distributed over large reservoirs or lakes by using blower fitted motor boats. Finely granulated copper sulphate is fed into air entering the blower from a hopper fitted with a control valve.

Chlorine Treatment

General

Chlorine treatment is relatively cheap, readily available and provides prolonged disinfecting action. Though chlorine is generally used for disinfecting potable water it can also be used as an algaecide. Pre-chlorination has specific toxic effect and causes death and disintegration of some of the algae. It also assists in removal of algae by coagulation and sedimentation. It prevents growth of algae on basin walls and destroys slime organisms on filter sand thus prolonging filter run and facilitating filter washing.

Dosage: Lethal dose of chlorine for common types of algae is given in Table no. 5.9. Effective chlorine dose should be such that sufficient chlorine is there to react with organic matter, ammonia, iron, manganese and other reducing substances in water and at the same time leave sufficient chlorine to act as algaecide. Dose required for this purpose may be over 5mg/l. With chlorine treatment essential oils present in algae are liberated which may lead to development of odour and color and taste. Occasionally these oils as well as organic matter of dead algae may combine with chlorine to form intensified odour and taste. In such cases break point - chlorination is required. Post chlorination dose can be adjusted to obtain minimum 0.2mg/l residual chlorine in potable water at consumer end.

Methods of Application

Chlorine is preferably applied as a strong solution of chlorine from chlorinator. A slurry of bleaching powder can also be used. For algal growth control, generally, chlorine is administered at the entry of raw water before coagulant feeder.

Chlorine Treatment Vs Copper Sulphate Treatment

Chlorination is preferred over copper sulphate treatment in certain conditions, which are as follows:

1. Copper Sulphate cannot be used when the application is too close to pipeline, as copper will plate out on metal thus becoming inactive.
2. Copper sulphate cannot be used to prevent algal growth in coagulant basin, as it will be immediately thrown out of solution.
3. If adequate time (for proper precipitation of the added copper sulphate) is not available between copper sulphate treatment and supply of water, copper sulphate treatment should be avoided and chlorine treatment should be preferred.
4. Death and decay of algae imparts taste and odour to water. It also results in increase of organic matter, which supports proliferation of saprophytes (organisms growing on dead organic matter) resulting in lowering of oxygen content of water. Breakpoint prechlorination helps in removal of taste and odour, also assists in coagulation and controls growth of saprophytes.
5. Certain algae are resistant to copper sulphate treatment.

MICROSTRAINER

Algae can be removed from water by using microstrainer. The infested water can be passed through stainless steel drums with cloths of mesh size ranging from 15-45 µm. Microstraining is a useful process for the removal of filaments and colonial algae, but it does not remove smaller species or reproductive forms which can multiply later on, creating problems. Microstraining cannot constitute a complete treatment for effective disposal of algae, but it can be used as a part of treatment line. Moreover, this procedure requires frequent cleaning of strainer.

REMOVAL OF IRON MANGANESE

Note: Only a brief description of removal of iron and manganese is being given in order to help the operator to understand and take effective steps in operating and maintaining such plant processes. For more details a reference may be made to “Chapter of Manual of Water Supply and Treatment” (1999 edition).

INTRODUCTION

Minerals like iron and manganese generally make their way into ground water from shale, sand stone and other rocks. These minerals dissolve in water containing carbon dioxide in absence of oxygen; the insoluble oxides of these elements being reduced and transformed into their soluble bicarbonates. These soluble bicarbonates when exposed to air by pumping lead to the formation of brown coloured oxides of iron and manganese which creates unaesthetic condition giving characteristic metallic taste and colour from brownish to blackish. It also stains plumbing fixtures and laundered material.

IRON

Occurrence

Iron exists as reduced ferrous and chelated forms dissolved in ground water or in deeper layers of some water reservoirs lacking oxygen. In surface water, iron is generally found in its precipitated ferric form. Reduced iron in water promotes the growth of autotrophic bacteria in distribution mains creating serious nuisance. The problem is further aggravated when water also contains sulphates, as reduction of iron and sulphate compounds leads to the formation of disagreeable odour and black deposits of iron sulphide.

Removal of Iron

Chemical analysis of water for iron content as well as its various forms is a good start to provide clue to the removal method to be adopted. But it is always advisable to perform laboratory analysis and pilot plant studies before any particular method is adopted.

Suggested – To be adjusted according to alkalinity and Temperature)

Table 30: Approximate Amount Of Chrorine And Copper Sulphate Required As A Leathal Dose For Various Algae

Organism	Ordour, Taste & Colour	Cause of other trouble	Copper Sulphate Dosage (Mg/L)	Chlorine Dosage (Mg/L)

The most common method for iron removal from water is oxidation followed by sedimentation and filtration. In certain types of water treatment like pH correction and chemical oxidation can be carried out in addition to above mentioned processes.

a) Oxidation by Aeration

The first stage of iron removal involves the oxidation of bivalent iron with oxygen present in air. Aeration also removes carbon dioxide and taste and odour producing substances. The rate of aeration depends on pH, alkalinity and organic content of water. Iron is oxidised at wide pH range. Increased aeration time is necessary for water containing carbon dioxide and hydrogen sulphide. Oxidation of iron on the other hand is retarded by the presence of humic acid.

b) Oxidation by Chlorination

Oxidation of iron can be inhibited possibly due to binding of ferrous iron with organic substances, ammonia and other reducing agents. Chlorination can bring about oxidation of organic matter and other reducing agents in such conditions, which facilitates ferrous iron oxidation. Chlorination will oxidize iron without lime treatment for pH adjustment.

c) Oxidation by Potassium permanganate

Potassium permanganate is more effective oxidising agent than chlorine. The reaction is independent of pH above 7.0 and is rapid, except in presence of hydrogen sulphide and organic matter where reaction time increases to 5-20 minutes prior to filtration.

d) Catalytic Method

The process involves only oxidation and filtration and does not involve base exchange. In this method water is percolated through suitable contact material which oxidizes the iron. The contact material is made up of siliceous base exchange material, successively treated by solution of manganese chloride and potassium permanganate. It is used as filter as such or a layer of this material may be sandwiched between sand bed of pressure filter. Iron is oxidized when water percolates through this bed and also filters out. At intervals, filters should be backwashed to remove the deposits. The bed can be regenerated by potassium permanganate solution treatment.

e) Zeolite Plants

Many times ground water or bottom strata of deep reservoirs contain iron in reduced state (i.e. its soluble form). In such condition Zeolite beds are used which takes up iron by process of ion exchange.

O & M and Remedial Measures of Typical IRP (Iron Removal Plants)

Two types of such plants are described below:

Compact type plant

The process comprises of

i. Spray Aeration through a grid of pipes to flush out CO_2, H2S and to improve pH level.
ii. Trickling of aerated water through a contact catalytic media viz., limestone of 20 mm size or a combination of MnO2 (Manganese dioxide) and lime; or hard coke, MnO_2 and limestone.
iii. Sedimentation.
iv. Filtration through Rapid Gravity Filter.
v. Disinfection.

The structure consists of ordinary masonry or concrete. The aerator with contact media may be placed at the top of the sedimentation tank. Sedimentation tank may be rectangular with a length to breadth ratio of 3:1. The detention time may be around 3-5 hours. The surface loading may be around 25 m3/d/m2. Filter media shall consist of sand with effective size 0.5-0.7 mm and a depth of 750-1000 mm over a 450-600 mm deep gravel 3 to 50 mm size.

Operation and Maintenance

1. The nozzles/orifices attached to the aeration pipe grid shall have their angles so adjusted as to ensure maximum aeration and to prevent loss of water. These nozzles/ orifices shall require regular manual cleaning to remove incrusted iron. The residual iron deposits from inside the pipe grid shall be flushed out by opening end plugs or flanges. These operations should be repeated at least once in 2 months.
2. The limestone and other contact media require manual cleaning and washing at least once in 45-60 days.
3. The contact media bed should not remain exposed to sun for a long time to prevent hardening of bed by iron incrustation.
4. The sedimentation tank inlet baffle wall opening shall be cleaned of iron slime at least once in 45-60 days.
5. Sedimentation tank bed should be regularly scoured for removal of sludge.
6. Floc forming aid (coagulant aid) may be used for better coalescing and agglomeration.
7. The rapid gravity filter should have a water depth of about 1.2-1.5 m.
8. Since iron deposits create incrustation of filtering media, at least 100-150 mm of top sand layer of sand shall be scrapped and replenished with fresh sand at least once on 60 days. The whole bed may require replacement once in 2 years or so.
9. The characteristics of iron flocs are different from those of surface (river) water flocs. Due to the aeration process and contact of water with air, there may be incrustation of filter bed by residual oxidized deposits. To avoid this, common salt may be mixed with standing water and after 1-2 hours, the filter may be backwashed for better results and longevity of sand bed.

Package Type IRP (Iron removal plant)

The process incorporates the following steps:

i. Dosing of sodium aluminate solution to the raw water pumping line, to raise pH up to the optimum level and to ensure subsequent coagulation, as it is an alkaline salt.
ii. Injection of compressed air for oxidation of dissolved iron.
iii. Thorough mixing of raw water, sodium aluminate and compressed air for proper dispersion in a mixing chamber of M.S. welded cylindrical shell equipped with one M.S perforated plate fitted inside through which the mixture flows upward.
iv. Passing the mixture through an oxidation chamber of M.S. shell, in which a catalytical media of MnO2 (Manganese dioxide) is sandwiched between two M.S. perforated circular plates. (through which the mixture flows).
v. Passing the above mixture in to a M.S. welded cylindrical shell type of filter in which dual media comprising of Anthracite Coal or high graded bituminous coal, 3-6 mm size, is placed at the top and finer sand of 0.5-1.00 mm size with 98% silica content is placed at the bottom, over a gravel supported bed. At the bottom is the under drainage system.
   Backwashing is done by air agitation followed by backwash with water.
vi. Disinfection.

Operation and Maintenance

1. Sodium aluminate should be so mixed as to raise the pH up to 8.5-9.5.
2. The quantity of compressed air should be so regulated as to achieve the optimum oxygen level.
3. The MnO_2 (Manganese dioxide) may need replacement every 6-9 months.

4. The inside of both the mixing chamber and oxidizing chamber should be coated with epoxy resin to avoid corrosion and incursion.
5. The filtration rate should be controlled within a range of 100-125 lpm/m^2.
6. The inlet pipe at the top should be fitted with a cylindrical strainer to obviate the possibility of loss of anthracite coal during washing.
7. After backwashing, rinsing of filtering media for at least 5 minutes has to be done to resettle the filtering media before normal functioning.
8. Where the iron content is very high the whole media like MO_2 (Manganese dioxide), anthracite coal, sand, gravel, strainers etc. require replacement and replenishment at least once a year for effective functioning and performance. The interior epoxy painting should also be done simultaneously.

MANGANESE

Occurrence

In water manganese is usually present in soluble ionized form- manganese ion and manganese hydroxide. It can form complexes with bicarbonates, sulphates, silicates as well as with certain organic matter. It is often associated with iron and ammonium.

Removal of Manganese

Manganese can be removed following the same procedure as for iron removal i.e. by oxidation, followed by sedimentation and filtration. Removal of manganese is a little difficult and complicated as compared to the iron removal. Oxidation of manganese is carried out by using following methods.

a) By Aeration

Oxidation by aeration needs high pH of at least 8.5-10 with lime treatment to enhance the oxidation of manganese on coke or sand beds coated with manganese oxide; however, high removal is not assured.

b) By Catalytic Action

Oxidation by catalytic action of pyrolusite ore is used in absence of air to change complex manganese compound to manganese hydroxide which is further oxidized to insoluble manganese hydroxide by aeration in second contact bed followed by filtration.

c) By Chlorination

Manganese is oxidized by free residual chlorine at pH 8.4-10. The dose of chlorine should be selected to provide about 1.25 ppm free chlorine for each ppm manganese to be oxidized. Oxidation is aided by the use of 0.2 ppm copper sulphate, the copper acting as catalytic agent.

d) By Potassium Permanganate

Potassium permanganate provides better oxidation than chlorine and the reaction is independent of the pH in range above 7.0; so manganese may be oxidized without lime treatment. The dose is about twice the content of manganese.

e) By Manganese Zeolite

Manganese zeolite is an active contact material, which removes 1.63 kg. of manganese per cubic meter of by backwashing with solution of 3.26 kg. of potassium permanganate per cubic meter of zeolite. Incomplete regeneration will result in passage of manganese through contact beds.

INTRODUCTION

The disinfection of potable water is almost universally accomplished by the use of gaseous chlorine or chlorine compounds, because of the limitations of other procedures, for example ozone, ultraviolet light, chlorine dioxide etc.

Chlorine is easy to apply, measure and control. It persists reasonably well and it is relatively inexpensive.

Objectives Of Chlorination

The primary objectives of the chlorination process are disinfection, taste and odour control in the system, preventing the growth of algae and other micro organisms that might interfere with coagulation and flocculation, keeping filter media free of slime growths and mud balls and preventing possible built up of anaerobic bacteria in the filter media, destroying hydrogen sulphide and controlling sulphurous taste and odour in the finished water, removing iron and manganese, bleaching of organic colour.

It can also be used for flushing pipeline before it is brought into operation after carrying out repairs etc. However in such case chlorinator is adjusted to apply chlorine or hypochlorite solution at the rate of 50 p.p.m. Heavily chlorinated water should be allowed to stand in the pipeline for at least 30 min. and preferably for 12 hours before being replaced with potable water.

For more details please refer to Manual on "Water Supply & Treatment", (1999 Edition).

PRINCIPLES OF CHLORINATION

- Chlorine reacts with water to form hypochlorous acid (HOCl) and Hydrochloric acid (HCl). This hydrolysis reaction is reversible. The hypochlorous acid dissociates into hydrogen ions (H+) and hypochlorite ions (OCl—), free available chlorine is hypochlorous acid and hypochlorite ions.
- This free available chlorine can react with compounds such as ammonia, proteins, amino acids and phenol which may be present in the water, forming chloramines and chloro-derivatives which constitute the combined chlorine.
- Chlorination in presence of humic acid and fulvic acid forms Trihalomethane (THM) which is a health hazard.
- The combined available chlorine has less disinfecting properties as compared to free available chlorine.
- For more details please refer to Manual on "Water Supply and Treatment", (1999 Edition).

Method Of Application Of Chlorine

Disinfection is carried out by applying chlorine or chlorine compounds. The methods of application are as follows:

1. Preparing weak solution by bleaching powder, HTH etc.
2. Preparing weak solution by electrolyzing brine solution.
3. By adding chlorine either in the form of gas or solution prepared from dissolving chlorine gas in small feed of water.

DISINFECTION BY BLEACHING POWDER

GENERAL

Bleaching powder or calcium hypochlorite is a chlorinated lime, which contains about 25 to 34% of available chlorine by weight. Chlorine being a gas is unstable and as such it is mixed with lime to retain its strength for a longer period, as far as possible. The bleaching powder is hygroscopic in nature. It loses its chlorine strength rapidly due to storage and hence should not be stored for more than three months. The method of chlorination by bleaching powder is known as hypo-chlorination.

The general reaction of ionisation of bleaching powder when mixed with water is as follows:

$Ca(OCl)_2$ Ca+++2OC1–

H2O_H++2(OH)–

H++OCl–_HOCl

Ca+++2(OH)-=$Ca(OH)_2$

The calcium hydroxide settles as precipitate.

The combined action of hypochlorous acid and hypochlorite ion brings about the disinfection of water.

PREPARATION OF SOLUTION

i. The concentrated solution of bleaching powder is prepared in one or two tanks of capacity suitable for 24 hours requirement.
ii. The tank inside should be of glazed tiles or stoneware and should be covered.
iii. The powder is first put on a perforated slab placed longitudinally inside the tank at a higher level, with respect to bed level of tank.
iv. Water is sprinkled on the powder through a perforated pipe above this perforated slab.
v. The solution of bleaching powder & water now enters the tank.
vi. The solution is rotated for thorough mixing of powder with water by a hand driven/ motor-reduction gear operated slow speed stirrer.
vii. The precipitates of calcium hydroxide settles at the bottom of the tank. The supernatant water, which contains OCl-, Cl-, is now ready for use as disinfectant. (See fig. 8)

DOSING OF SOLUTION

i. The solution is discharged to a small measuring tank at a lower level through PVC pipe or any other material resistant to chlorine. The level of water in this tank is maintained constant through a float valve. A micrometer orifice valve discharges the solution at any pre-set rate, by adjustment on the scale fitted on it. The solution is dosed to the clear water channel by gravity at the time of entry to clear water reservoir. The waste precipitates at the bottom of tanks are taken out occasionally by scour valve. The system is shown in figure 8.

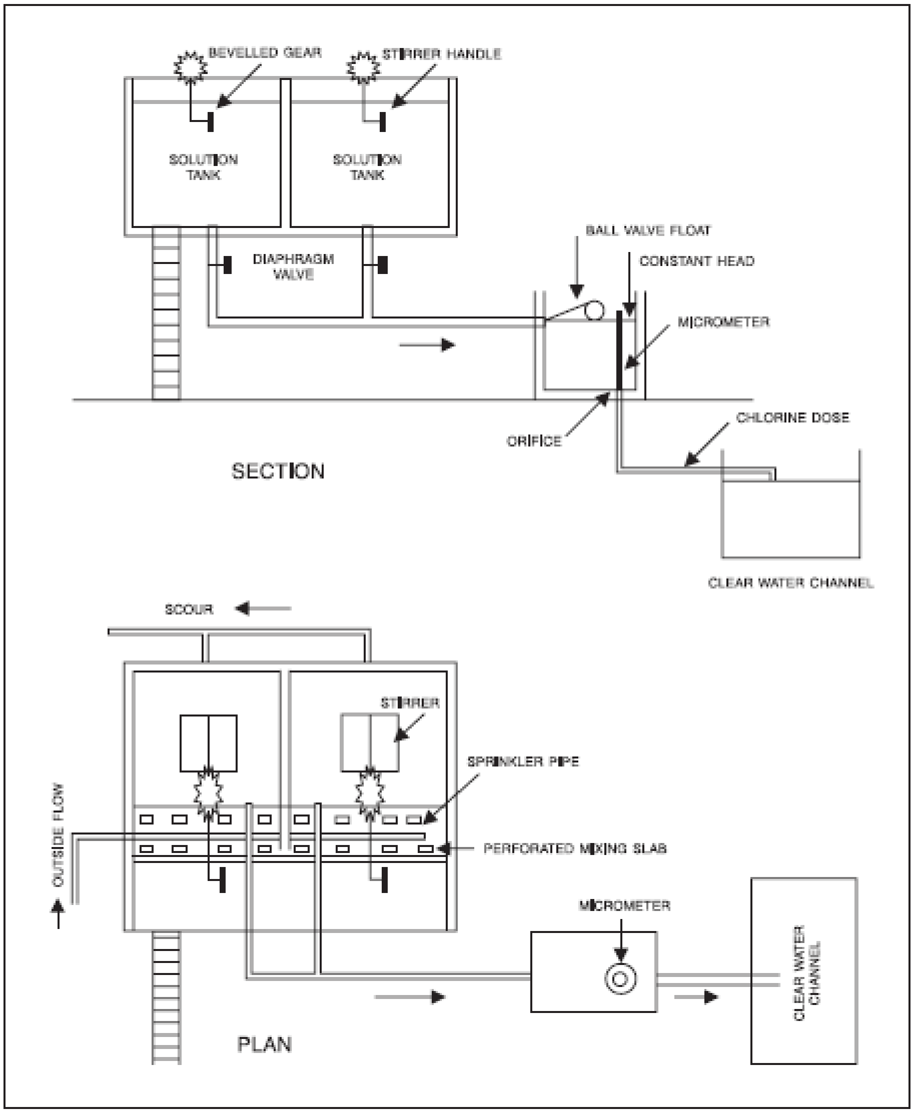


Figure 9: Typical Bleaching Solution Dosing

ii. The dose has to be monitored properly, depending on the desired residual chlorine required in clear water reservoir.

Precautions

i. The operating personnel should use hand gloves, aprons and other protective apparel, while handling and mixing.
ii. The valves, stirrer, tanks, plumbing arrangements require renovation at every 6 months or so.

Electrochlorinator

Principles Of Operation Of Electrochlorinator

Chlorine is instantly produced by electrolysing brine solution. Common salt is mixed with water to prepare brine solution. This solution is passed through an Electrolyser of electrodes comprising of anodes & cathodes, which are energised by D.C. current to produce NaOCl.

Overall reaction is as follows:

$$2NaOH + Cl_2\_ \; NaCl + NaOCl + H_2O$$

This solution of sodium hypo chlorite is used as disinfectant.

DESCRIPTION OF ELECTROCHLORINATOR

The electrochlorinator set basically comprises of two compartments one comprising of Brine solution tank, electrolyser, cooler, etc. and the other comprising of compact panel board (rectifier). The schematic diagram as well as various parts of electrochlorinator are given in figure-6.2 for a typical electrochlorinator.

Normal life of electrochlorinator is 12 years provided reconditioning of the electrodes at regular interval of four years is carried out. These chlorinators are available at various capacities ranging from 50 gm/hr. to 18 kg/h of active chlorine production. (Refer fig. 9)
The electolyser consists of a number of electrodes as required. For 500 gm./hr. capacity plant, there are 6 nos. of electrodes comprising of anodes and cathodes. The rectifier is having facilities for auto tripping if there is variation in certain set conditions.

PROCESS DETAILS OF ELECTROCHLORINATOR

1. Make a concentrated brine solution @ 310 gm. of industrial grade salt with 97% purity or more salt in 1 litre of water in a brine solution tank. After pouring salt, the mixture is stirred either manually or through motor driven reduction gear arrangement. In order to reduce the capacity of brine solution tank, a concentrated solution is prepared.
2. Allow brine solution to flow inside the electrolyser at a controlled rate as required for a chlorinator which depends upon active chlorine production. But the quantity of water in brine solution tank is to be replenished, for which fresh water at the same rate is simultaneously sent after controlling the flow, through one of the flow meters (flow meter no. 2) placed in front of brine solution tank.
3. Dilute the concentrated solution with fresh water to attain a strength of 30 gm of salt per litre. Accordingly, fresh water is added to electrolyser, after controlling flow through flow meter No.1 (for 500 gm/h capacity plant, this rate is about 65 l/h) It may be mentioned here that for effective functioning of flow meters to control flow, one valve is installed in the common line and pressure

through flow meters is controlled at specified pressure rating.

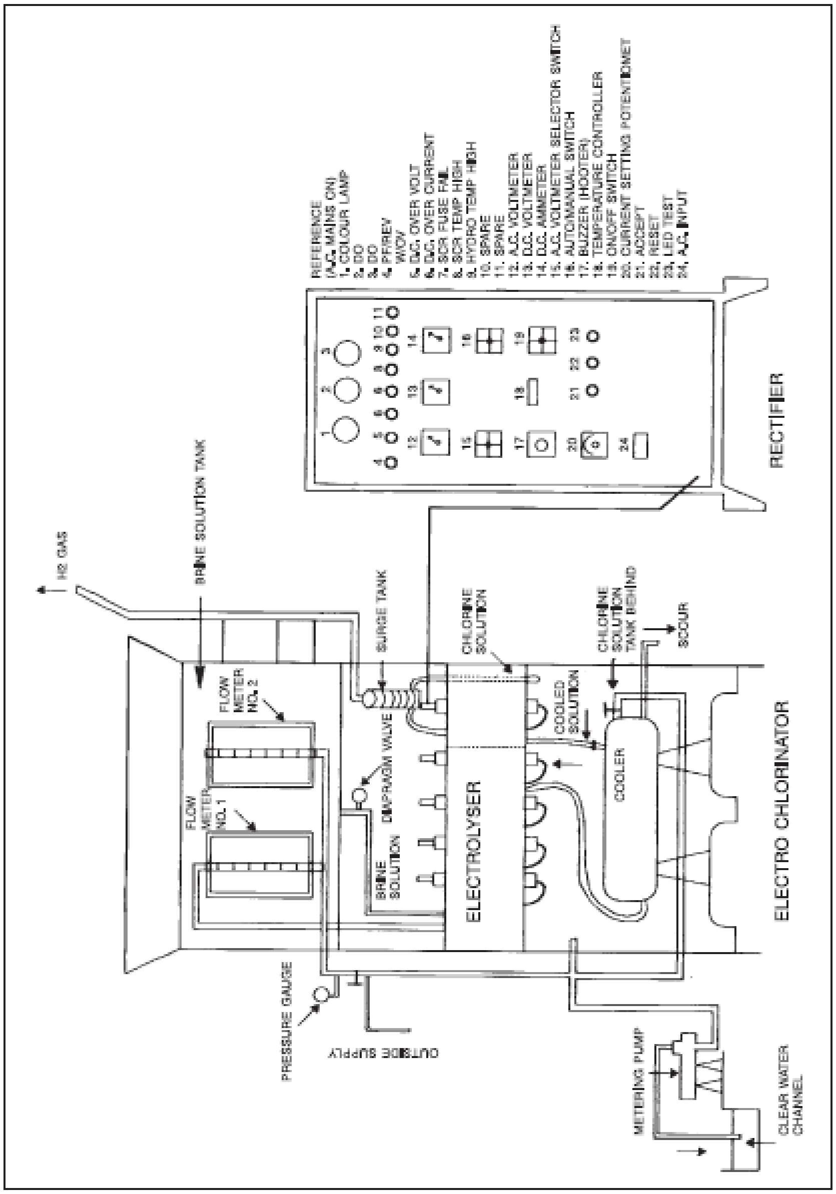


Figure 10: Onsite Production Of Hypo-Solution From Common Salt

4. After filling the electrolyser with the required solution of salt and water, D.C. power supply through rectifier is put on.
5. The electrolysis process evolves heat. The maximum permissible temperature is of the order of ambient temperature + 12 degree centigrade.
6. In order to control the temperature, the aqueous solution is, required to be cooled through a cooler placed below the electrolyser chamber. The solution is introduced at one end of the cooler and fresh cold water is circulated through coil pipe placed inside the cooler. The cold water used for cooling is continuously discharged to a sump connected with clear water reservoir. The electrolysed solution after cooling is continuously introduced to the 2nd chamber of the electrolyser.
7. After complete electrolysis process, the solution of sodium hypo chlorite ($NaOCl$), Sodium chloride ($NaCl$), Water (H_2O), hydrogen gas (H_2) is now passed on to a surge tank which is placed on the rear

side of electrolyser i.e. just below the brine solution tank. The hydrogen gas is allowed to escape through a pipe fitted at the top of the surge tank. The solution is now collected through an outlet pipe placed below the surge tank into a solution tank located below.

8. The concentration of active chlorine in the form of sodium hypochlorite solution is, therefore, 7.00 gm per litre.
9. The solution is now taken from the chlorine solution tank and dosed to the clear water reservoir through metering pump installed by the side of the electrochlorinator at the rate at which it is required.

OPERATION OF ELECTROCHLORINATOR

i. For starting the operation, open the brine solution diaphragm valve for a flow to electrolyser. Flow meter No.1, for fresh water is now opened, so that dilution starts inside the electrolyser. The pressure of incoming fresh water should be 1 to 1.1 kg/ Cm2. As soon as the outflow from surge tank starts, electrical operation through rectifier is to be started.
ii. Before starting rectifier, A.C MCB is to be put in 'ON' position. A.C. mains supply in 3 phases is to be checked through indicator lamps. A.C. voltage reading is checked so that requisite voltage of 355 V to 455 V comes to rectifier. By rotating potentiometer clockwise, the D.C. volt and D.C. ampere are set to 23-25 V & 95-100 Amps, respectively. Now electrolysis process is started.
iii. Before closing the operation, brine solution diaphragm valve is to be closed and fresh water is to be allowed inside the electrolyser for cleaning of electrodes for 15-20 mins. Simultaneously, potentiometer is to be operated in anticlockwise direction slowly to set to "zero" position. Now AC main MCB is put to "OFF" position.
iv. If there is any sudden power trip, potentiometer is to be set to 'Zero' position to avoid any sudden shock to the whole system, if power comes back again, immediately. In that case, brine solution diaphragm valve is also to be closed & only fresh water is allowed through flow meter No.1 for 10-15 minutes.
v. If the temperature of hypo solution is increased (i.e. more than ambient temperature + 120C), it is sensed through sensor & there will be auto tripping. Potentiometer is then brought zero position. Then brine solution is closed & fresh water is circulated through flow meter No.1 for 20 to 25 minutes, before re-starting. The cooler is checked conveniently to see its effectiveness.
vi. Before closing down of the electrochlorination the flow meter No.1 will be operated for 15 to 20 minutes for cleaning the electrodes. If the brine solution concentration is reduced, then the D.C volt will rise from 23 to 25 V & there will be corresponding fall of ampere reading from 95 to100 A. At that time, the concentration is to be restored by adding salt & water.
vii. Normally 4.5 kg. of common salt (NaCl) is required to produce 1 Kg. of chlorine with kWh power.

CONVENTIONAL CHLORINATION

The conventional chlorination facility i.e. adding chlorine for disinfection of water treatment consists of three essential parts:

1. Chlorine supply system
2. Metering system
3. Diffuser system

In addition to above, there are ancillary equipment, safety equipment, metering & control instrumentation and chlorine residual analysers.

CHRLORINE SUPPLY SYSTEM

Chlorine Gas Supply System

In gas supply system if the header run passes through an area where ambient temperature may fall below the temperature of the gas leaving the supply containers, it is necessary to install a pressure reducing valve in the gas supply system. This valve prevents reliquefaction of the gas downstream of it. It is also a good practice to install liquid chemical trap upstream of the valve. The trap will serve to prevent liquid chemical from entering and flashing across the valve seat resulting in poor pressure regulation (Fig.9).

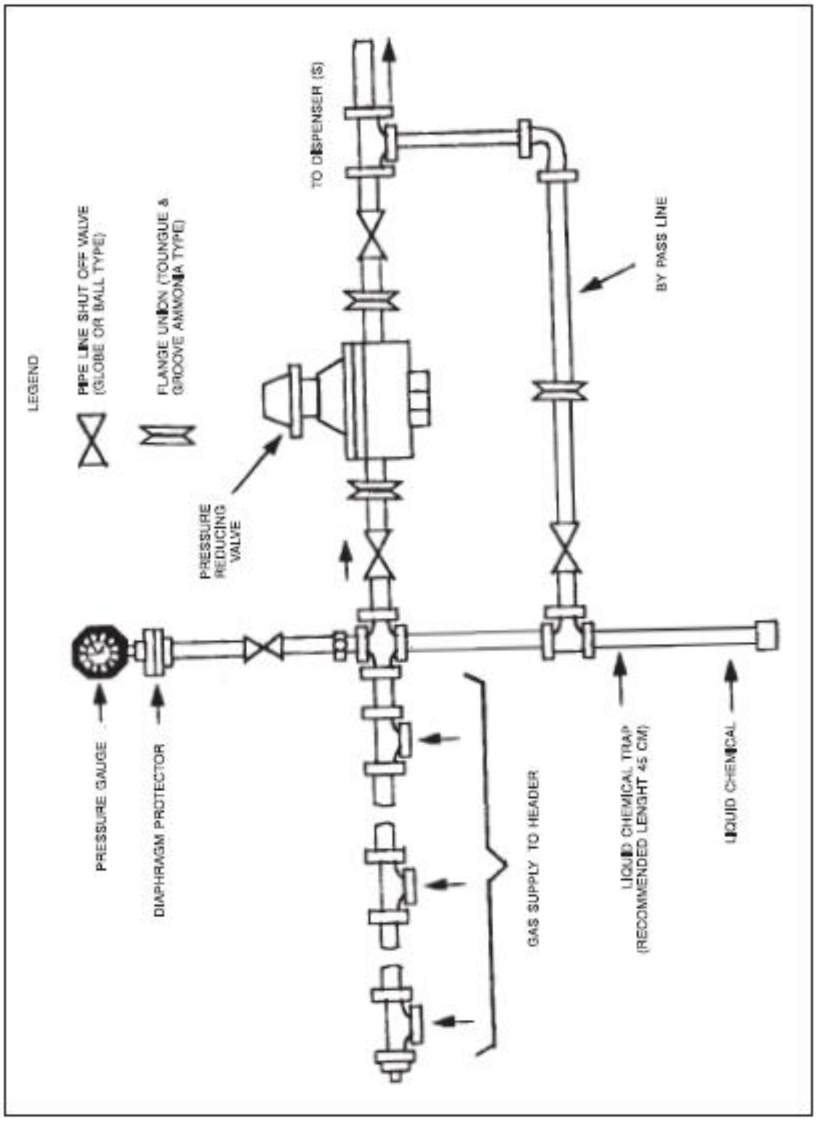


Figure 11: Gas Supply System

Evaporator Supply System or Liquid Chlorine Supply System

By means of an evaporator, liquid chlorine is converted into gaseous form. Chlorinator operates the evaporator as per its requirement of chlorine. If requirement of chlorine gets reduced, pressure in the evaporator increases causing liquid chlorine level in it to reduce, thereby reducing its area, which in turn reduces heat transfer. On the contrary, if requirement of chlorine increases, the pressure in the evaporator decreases. As a result of it more liquid is pushed into the evaporator where it is evaporated at higher rate.(Refer Fig.11).

Chlorine Gas Filter
Small chlorinators usually have same sort of built-in chlorine filter. However, any installation using ton containers (tonners) should have a chlorine gas filter as close as possible to the last cylinder, and always upstream of any external reducing valve. Commonly used material for this purpose is glass wool.

External Chlorine Pressure Reducing Valve
Any installation using the variable vacuum system for automatic control requires such a valve to reduce the chlorine supply pressure to 2 to 2.75 kg/cm^2 ahead of the chlorinator to ensure the maximum possible accuracy of the control system. Secondly, this valve also reduces the pressure in the chlorine supply header to prevent reliquefaction of the gas in the header between the last cylinder connected and the chlorinator (Fig.12).

Metering System: Chlorinator
A chlorinator is a device for feeding chlorine to a water supply. It also serves as gas metering device. Chlorinators are classified into two categories.
- Pressure type
- Vacuum type

Pressure-type chlorinator
It consists of a stop valve, gas filter, pressure reducing valve, regulating valve, an orifice tube with manometer and moisture seal.

The pressure type may be further classified into two groups on the basis of gas or solution feed.
a) Dry Feed Type
These are not used in water treatment presently due to safety reasons.
b) Aqueous Solution Feed Type
It has been established that the only satisfactory method of applying chlorine gas to water is to dissolve the measured feed of gas in a minor flow of water which is then added to the main bulk of the water. For this purpose three distinct types of solutionisers are available. In these systems minimum 1500 litres of water is required per kg of chlorine for making chlorine solution. If the pressure is increased the quantity

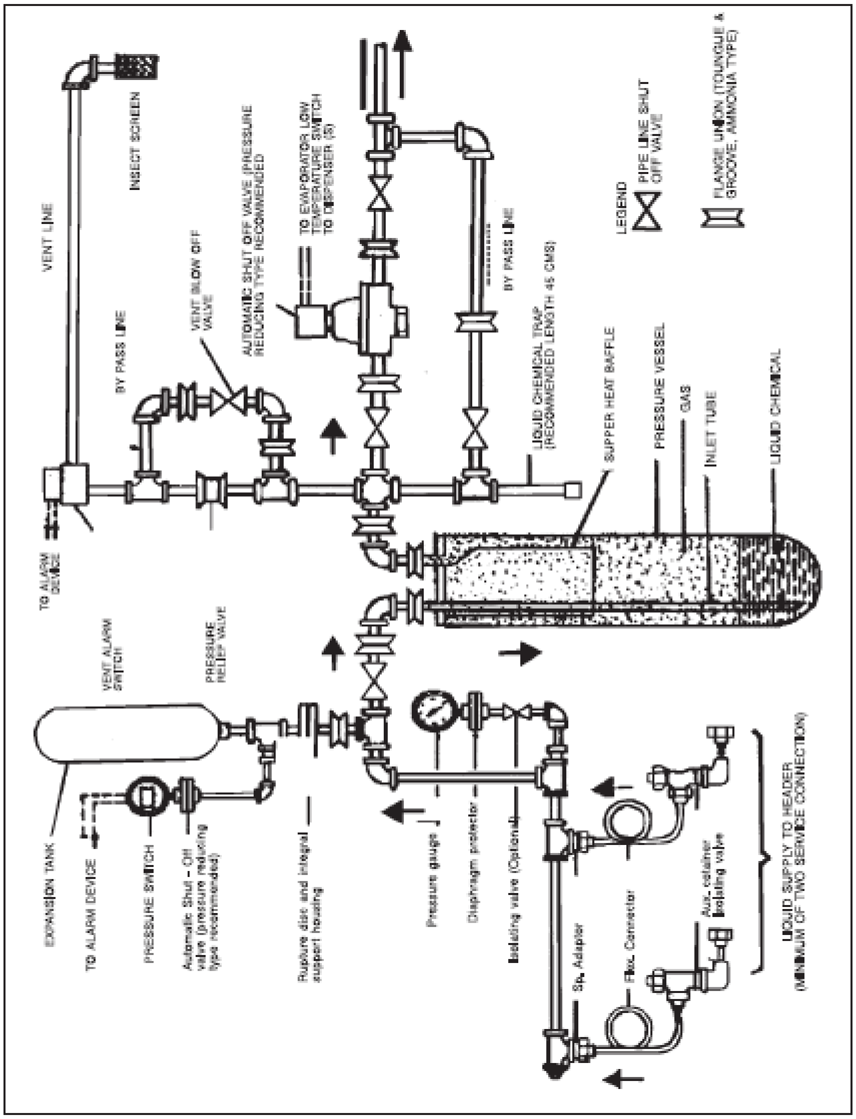


Figure 12: Liquid Withdrawal System

required for making the solution is decreased. The temperature of the water used for preparing the solution must be more than 10ºC. If the temperature of the water is less it must be heated by safe methods before using for solution.

- Gravity feed or Absorption tower feed type.
- Application of the chlorine into a main under pressure i.e. Injector solutioniser

Gravity Feed

This can be used where the hydraulic gradient at the point of injection is below the level of the base of the tower. The tower is an ordinary tubular vessel filled with pebbles for percolation of water. A perforated tray is kept at the top of the tower to have an even distribution of water. A perforated PVC or ebonite tube is situated centrally in the tower for efficient and uniform distribution of gas. The water while trickling absorbs the gas and the resulting chlorinated water is delivered through an outlet at the base of the tower. Further it is conveyed to the point of application by a rubber hose.

Injector Solutioniser

It serves the dual purpose of the conversion of chlorine gas into a chlorine solution and of injecting it into water mains under a hydraulic pressure. The metered gas is introduced to a water-sealed cavity surrounding the injector. The water emerging with high velocity from the jet of injector absorbs chlorine gas due to partial pressure developed around the throat. The resulting solution is passed through a recovery zone to regain the pressure and subsequently injected into water mains (Fig 13).

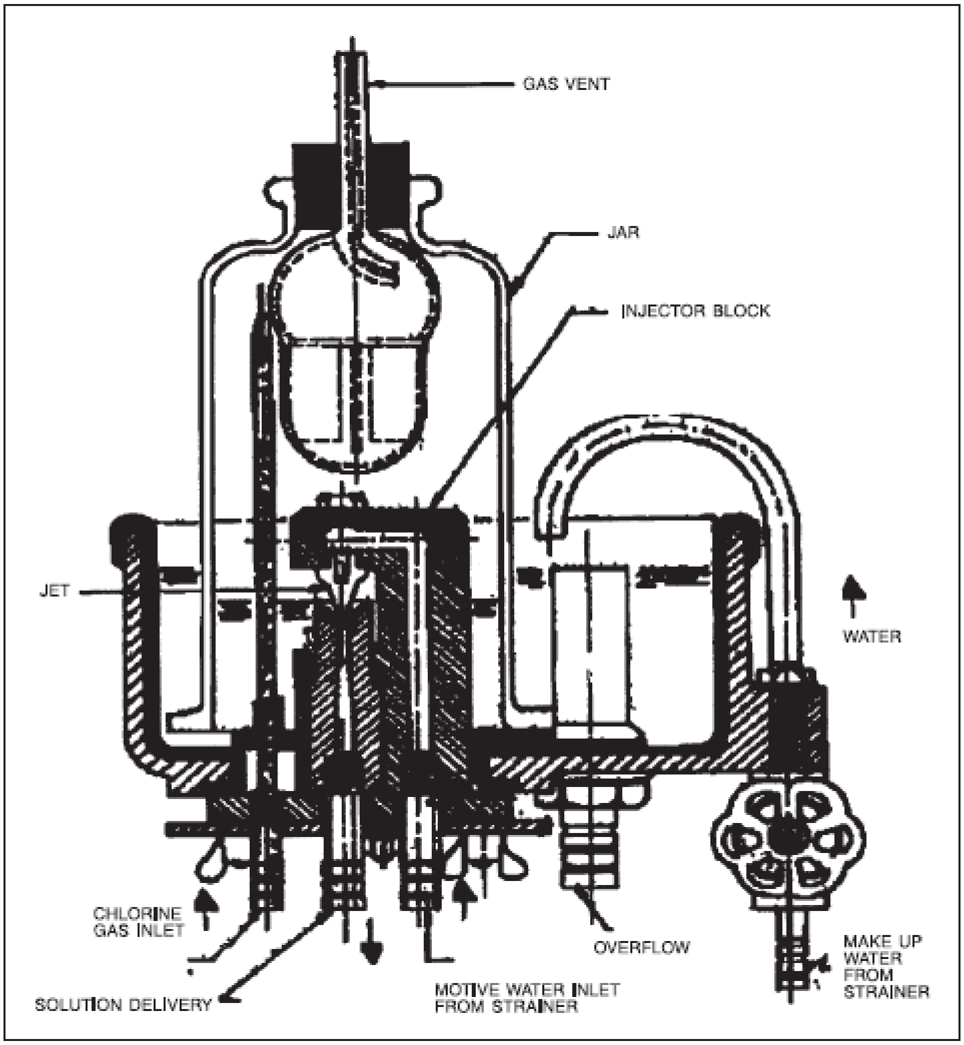


Figure 13: Chlorine Gas Apparatus Injector (Pressure Type Solutionizer)

It will be seen from the figure that make up water connection maintains the seal of the water across the injector. Hence chlorine does not leak through the jar unless pressure in the jar is increased. For letting the gas outside a gas vent is provided through HCl seal. This arrangement also serves the purpose of vacuum breaking in the system.

Operation of Pressure Chlorinator with Aqueous Solution – Gravity Feed Type

a) Start up of the chlorinator

1. Turn on and adjust the water supply to the solutionizer.

2. With all cylinder connecting valves and regulating valves closed, open one cylinder valve; check the joint for leakage.
3. Slowly open the cylinder connecting valve and stop valve (when fitted). Check for leaks.
4. Open the cylinder connecting valves on any other cylinders that are to be brought into use if connected in parallel. After checking the joints for leakage, open the cylinder valves.
5. Slowly open the regulating valve until the meter indicates the required rate of discharge.

b) Shutting down

1. Close the cylinder valve and wait until the meter reading returns to zero.
2. Close stop valve when meter shows zero.
3. Shut off the water supply to the tower.

Operation Of Pressure Chlorinator With Aqueous Solution Injector Solutionizer Type

a) Start up of the Chlorinator

Carefully check all connections and make certain that all unions, hose clips are in order.

- Close the stop valve in the operating water supply and open the regulating cock when one is fitted in series with it. A regulating cock is incorporated except when a booster pump or pressure reducing valve is used.
- If the water pressure is to be 'boosted', start the pump.
- Open the water stop valve to the full extent immediately. It is important to open this valve quickly in order to apply full pressure as soon as possible.
- The make up water valve on the side of the tray should next be set so that there is a small surplus of water passing over the overflow tube.
- Close the chlorine regulating valve and stop valve if fitted and also the cylinder connecting valve. Open cylinder valve slowly and check the union joint on the cylinder for leakage.
- In the case of leakage attend to the same and set right the union joint.
- Slowly open the cylinder connecting valve attached to this cylinder and test for leakage at all joints between the cylinder connecting valves and the control panel.
- Open the chlorine stop valve (when fitted) and test for leaks up to the chlorine regulating valve.
- Open the cylinder connecting valves on the remaining cylinders. Test the unions on the cylinders for leakage.
- Open the chlorine regulating valve very slowly until the required rate of flow is indicated by the meter.
- The following conditions should then be noticed in the injector unit.
    a) The acid in the pressure released bulb should have risen about 6 mm to 12 mm up inside the inner tube.
    b) The quantity of water passing over the overflow should have increased slightly and there should be further increase if the flow of chlorine is set at a higher rate.
- It may then be possible to reduce the quantity of water by the injector, by reducing the pressure, either by throttling the regulating cock; by lowering the discharge pressure from the water supply pressure reducing valve or, by adjusting the pressure at which the by-pass type pressure relief valve comes into operation, according to the water supply arrangement incorporated. Such an adjustment is indicated when the suction created by the injector is such that it becomes impossible to maintain the seal in the tray. The adjustment should be made with the maximum flow of chlorine and when the pressure against which the injector is operating is also at maximum i.e. when the operating conditions are most exacting. The minimum suitable operating pressure is that which will

deal with the chlorine without the acid in the lower part of the pressure release being forced into the upper part. When this condition arises, the acid seal is broken and chlorine is allowed to escape via the vent pipe.

- Following the adjustment of operating water supply, temporarily shut off the chlorine and, if necessary, reset the make up water valve until there is again a small surplus passing over the overflow. This volume is not critical from an operating point of view but it is desirable to avoid undue wastage of water.

b) Shutting down

1. Close the chlorine stop valve (or other cylinder connecting valve when there is no stop valve) and wait until the meter reading returns to zero.
2. Shut off the water supply to the solutionizer by means of the stop valve, and stop the booster pump when one is used for the supply.

N.B. For a prolonged stoppage close the cylinder valves and then the cylinder connecting valves before closing the stop valve.

Vacuum Type Chlorinator

In this type of chlorinator, chlorine is handled below the atmospheric pressure. The vacuum system has several advantages:

- It is the easiest method of dissolving chlorine in water.
- Chlorine is easily handled when in solution.
- This is the most accurate way of metering chlorine gas since a constant density is maintained under vacuum and it is not affected by ambient temperature changes.
- Operation under vacuum is safer than operating under pressure.
- A metering system can be easily designed to stop automatically if the vacuum should fail.
- It consists of a gas filter, pressure regulating valve, variable area flowmeter (Rotameter), vacuum regulating valve, pressure vacuum relief valve, drain valve and injector assembly. (Fig 13)

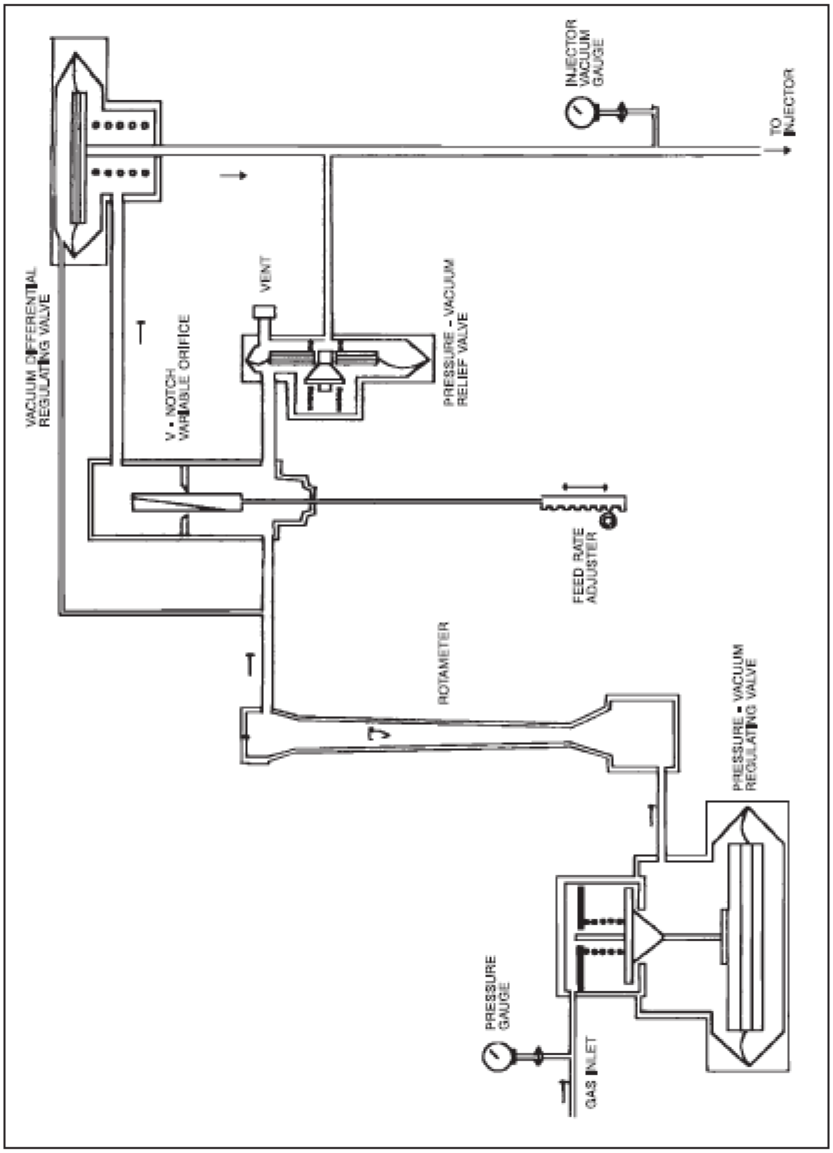


Figure 14: Typical Chlorinator

If the system is designed for chlorine gas withdrawal, the following procedure for starting up the system is adopted.

Start Up Gas Chlorination System

1. First start the booster pumps and make certain that the hydraulic conditions are satisfactory. For that purpose see the delivery water pressure & injector vacuum gauge reading. If the conditions are satisfactory, the vacuum gauge should show reading above 590 mm of Hg. If the chlorinator is not equipped with vacuum gauge, remove the tubing at the injector vacuum inlet and place a hand over the opening. If the injector is performing properly, the suction will be felt instantly on the portion of the hand over the opening. But it is advisable to have a vacuum gauge for proper operation of the plant with safety.
2. Check that all the chlorine valves on the supply line to chlorinators are closed.

3. When the injector system is functioning properly, open the valve of chlorine cylinder partially to allow the gas. Chlorine container should be connected to the system and kept ready before starting the plant.
4. Verify that all of the tubing, manifold and auxiliary valve connections are correct and that all union joints are properly gasketed. Check the leakage with ammonia stick and if there is any leakage, close the cylinder valve immediately and attend to the leaking joint to make it leak proof.
5. Check all the joints between cylinder valve to end.
6. Open the chlorine valve slightly to injector and check all the tubing and components of chlorinators for leakage. Attend if necessary by closing inlet valve. If there is no leak, then the chlorinator is ready for further testing.
7. Open fully the chlorinator gas inlet valve and check the chlorinator for range, automatic control and so on.
8. If at any stage leakage of chlorine is found, close the cylinder valve. Allow the gas in the system to be consumed through injector and then attend for leaking joints.
9. If the leakage is due to missing gaskets etc., close the cylinder valve. Leave the site immediately for safe area. With the help of breathing apparatus carry out the gas evacuation procedure through the chlorinators.
10. After all leaks have been corrected the next step will be to see that the chlorinator will reach its maximum capacity as specified. This is the most important operative criteria of the chlorinator installation.
11. If the chlorinator is not giving specified dose check for injector vacuum and chlorine pressure in the system and attend to the defects. The fault is normally in the hydraulics of the injector system. The next likely place is within chlorinator itself.

    A malfunction in either place is reflected by a low vacuum reading on the injector vacuum gauge.

    i. The first step in this case is to check the vacuum leak within the chlorinators. If the leak is major, it can be discovered by shutting off the injector water suddenly and using ammonia on all the joints. This sudden removal of vacuum will create slight pressure and chlorine will be expelled into atmosphere. Very small leak will not show up in this procedure.
    ii. Then check for ‘O’ ring seal in metering tube, vacuum relief valve, for defective spring or seat etc. and attend to it.
12. Vacuum will be affected due to long vacuum line between injector and chlorinator. If this is filled with air, the large amount of air reduces injector vacuum. Moreover if this line is leaking it will also reduce the vacuum. Like a long vacuum line, a long chlorine solution line will also affect the injector vacuum. The air in this line, therefore needs to be removed.
13. Defective injector may also affect vacuum.

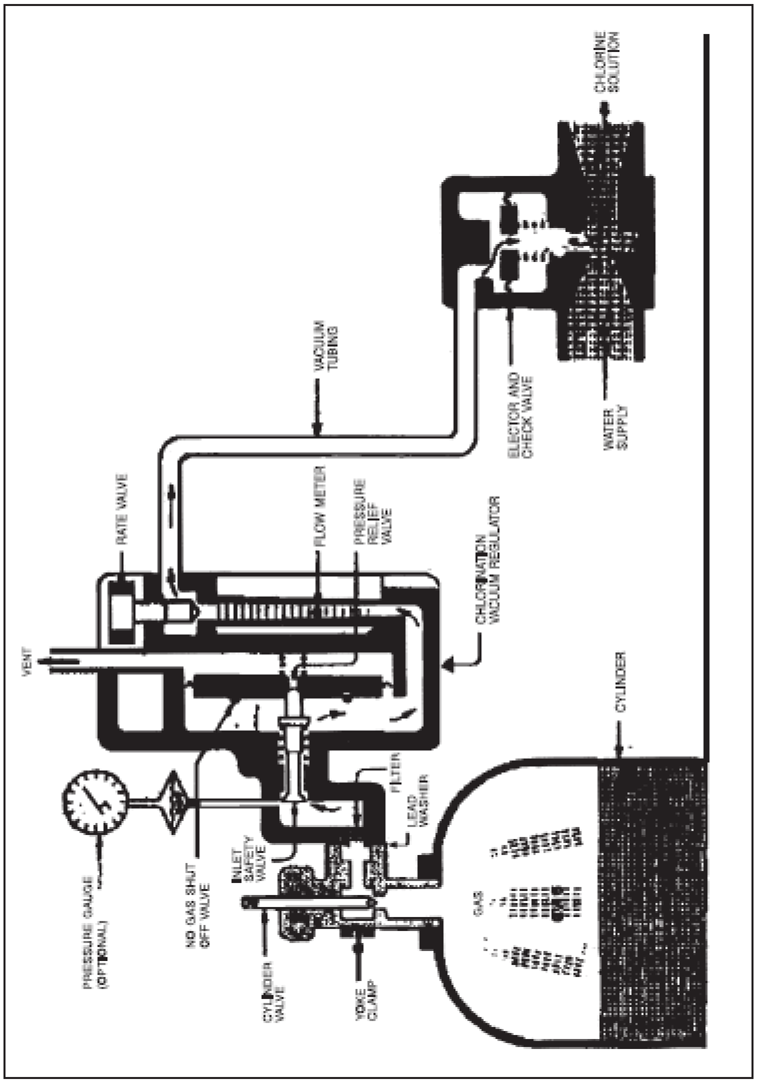


Figure 15: Cylinder-Mounted Chlorinator

Start-Up of Liquid Chlorine System

If the system is designed for liquid withdrawal, the following procedure should be adopted for starting it up. The procedure for start up on a liquid system is similar to gas system except for the role of evaporator. The evaporator is an extension of chlorine container system. Whatever happens in the container reflects into the evaporator pressure changes. The danger existing in liquid system is the possibility of trapping liquid chlorine in a pipe line. If this occurs and there is a significant rise in the ambient temperature, the liquid chlorine will expand & rupture the pipe line. For this reason, the liquid line between the evaporator & chlorine supply system should always remain open while the evaporator is operating. From safety point of view, rupture disc system with expansion chamber is provided on this line.

The first step preparatory for starting up a liquid system is to verify that the system is dry, because the moisture after coming in contact with liquid chlorine & metal of container forms ferric chloride which will pass through the chlorine control mechanism with stoppage of chlorine. Whenever this occurs the entire chlorine system must be flushed with water & thoroughly dried. In addition to this, chlorination equipments must be dismantled and cleaned.

When the operator is convinced that the chlorine supply system is clean & dry, the next step is to start up the evaporators. This is done by filling the water bath and adjusting the control devices. When the water bath reaches 65oC temperature, the chlorine pressure reducing valve & shut off valve will open and the system is ready for operation. When water temperature reaches 82^0C, start the injector water system and follow the procedure mentioned in gas system.

Procedure for Stopping the Plant

Stopping the chlorination system is also important in order to avoid chlorine leakages as well as for the system safety. The procedure is as follows:

1. Shut off the chlorine supply system.
2. When the chlorine pressure gauge reaches zero remove the cylinder connection & allow the air to evacuate all the residual chlorine gas in the system while the injector is still in operating condition.
3. After the chlorine has been purged to the satisfaction of the operator, the injector system may be shut down.
4. Connect the openings with plastic plugs.
5. For liquid system the chlorine in the evaporator shall be completely consumed.
6. Then close the heater supply to the evaporator.

Maintenance of the Chlorination System

Chlorine being hazardous chemical, its operating machinery should be maintained properly. In view of this, it is advisable to carry out preventive maintenance of all these equipment keeping in mind the followings for effective maintenance management programme.

1. Deploy trained personnel
2. Prepare daily schedule i.e.
   - Check chlorine leakage by ammonia torch
   - Check exhaust fans working.
   - Check rotameter functioning.
   - Carry out physical verification of stock and position of tonners.
   - Check position of safety equipment.
   - Check vacuum of chlorinator.
3. Quantify the work.
4. Use of work permit system. A written work permit system is essentially a document which identifies the plant to be worked on and details precautions to be taken before a work can start. It predetermines the safe procedure and is a clear record of the hazards that have been anticipated defining the appropriate precautions to be taken to avoid them. It is also a statutory requirement.
5. Keep equipment record i.e. history cards.
6. Analyse and plan every job.
7. Forecast yearly & monthly maintenance programme.
8. Prepare check lists for different types of preventive maintenance.
9. Set up a manpower control.
10. Set up a preventive maintenance programme.
11. Use budgetary control – yearly & monthly budget.
12. Provide material control.
13. Always use recommended spares.
14. Plan plant shut downs.

15. Establish major overhaul procedures.
16. Develop standard practices.
17. Improve efficiency of the equipments.
18. Train the supervisors.
19. Train the maintenance staff.
20. Analyse performance and cost.
    a) Since the properties of Chlorine differ in liquid form, gaseous form, and solution form suitable material has to be selected for various components of chlorine equipment. (refer to appendix 6.1 for materials).

    b) Predominantly observed impurities in chlorine are Ferric chloride, Hexachlorethane and Hexachlorbenzene. Normally the chlorine available for disinfection purpose is 99.8% pure (IS 646).

    c) Ferric chloride is formed due to reaction of chlorine with water vapour & metal. This is deposited in the equipment during corrosion from liquid form to gaseous form. While carrying out maintenance of this equipment, warm water is used to clean the equipment. The cleaned equipment is dried thoroughly before putting into the system.

    d) Hexachlorethane & Hexachlorbenzene being volatile impurities, are deposited from the chlorine gas in the equipment wherever pressure changes occur in the system, for example with pressure reducing valve. These impurities are removed while carrying out maintenance by means of trichloroethane or Isopropyl alcohol, Carbon Tetra Chloride (CTC) should never be used as it is carcinogenic.

    e) Sometimes amongst other impurities, nitrogen trichloride may be present. This impurity is present when the brine solution from which chlorine is manufactured by electrolysis method, contains ammonia or its compound. Because of vapour pressure difference in nitrogen trichloride and chlorine in the evaporator, chlorine is evaporated first leaving more concentration of nitrogen trichloride in evaporator. If under such condition, the evaporator temperature exceeds 940C, the evaporator may explode. It is, therefore, always recommended not to exceed evaporator temperature of 900C.

    f) Before carrying out any maintenance of the equipment, it should be confirmed that all the chlorine present in equipment is purged out completely. Any chlorine present in the piping will prove hazardous if welding work is carried out on it. Similarly while putting the chlorination system into use all the water vapours should be removed by means of moisture free dry air. The piping carrying chlorine of a length more than 3 mtrs. Running from cylinder to the equipment should be provided with a pressure reducing valve just down stream of the cylinder. These two aspects reduce the maintenance problems to a minimum. Whenever cylinders are removed from the system, the disconnected piping should be plugged with Teflon or similar kind of material in order to avoid entry of humid air into it.

Table 31: Suggested Maintenance Of Chlorine Equipment Pressure Chlorinator – Aqueous Solution Feed Type

S.No	Name of Item	Period	Action Needed
1.	Chlorine Leakage	Daily	Inspect and take necessary action
2.	Pebbles in tower	15 Days	Clear with water
3.	Calcium Chloride	1 month or earlier if shape is changed	Replace
4.	Orifce	1 month	Clean with Tricholoroethene
5.	Orifice valve & regulating valve	3 months	Clean with Tricholoroethene
6.	Diaphragm	3 months	Clean with Tricholoroethene
7.	Manometer	3 months	Calibrate
8.	Manometer	3 months	Clean with water
9.	Gasket	3 months	Replace
10.	Sleeves	3 months	Replace
11.	Filter	3 months	Clean or replace
12.	Pressure gauge	3 months	Inspect and calibrate if necessary
13.	Injector	3 months	Clean with water
14.	Tube	3 months	Replace
15.	Nut bolt	3 months	Replace
16.	Sulphuric acid	3 months	Replace
17.	Rubber hose	3 months	Replace

Table 32: Suggested Maintenance Of Chorine Equipment And Fittings - Vacuum Chlorinator Type

S.No	Name of Item	Period	Action Needed
1.	Chlorine leakage through fittings e.t.c.	Daily	Inspect and take every necessary action
2.	Chlorine leakage detector and exhaust fans	Daily	Inspect and take every necessary action
3.	Safety equipment and breathing apparatus	Weekly	Inspect and take every necessary action
4.	Chlorine neutralization system	Weekly	Inspect and take every necessary action
5.	Water pump	3 month	Inspect and take every necessary action
6.	Chlorine gas filter	6 months	Clean
7.	Sedimentation trap	6 months	Clean
8.	Rotameter tube & metering orifice	6 months	Replace
9.	Wind cock	6 months	Replace
10.	Gas header valve packing	1 year	Replace
11.	Stem and Seat valve	1 year	Clean
12.	Injector throat	1 year	Replace
13.	Lifting tackle/crane	1 year	Inspect and take every necessary action

14.	Copper tubing between header & cylinder	1 year of screeching sound is hear on bending	Replace
15.	Header system	After every 240 tonnes passing of chlorine	Clean with water and dry it
16.	Springs in the Valves	2 years	Replace
17.	Pressure gauges and pressure switches	5 years	Replace
18.	Diaphragm in spring loaded valves	5 years	Replace
19.	Joints	Whenever opened	Replace gasket with new one. Wire brush the thread & use Teflon tape for lubricant
20.	Evaporation Valves	250 tonnes of chlorine passage	Clean

Table 33: Comparison Of Chlorinators

S/No.	Description	Pressure-Type Chlorinator			Vacuum Type Chlorinator	
		Dry feed	**Aquoes solution feed**			
			Gravity feed	**Injector solutionizer**	**With differential vacuum regulator**	**Sonic flow type**
1.	Rate of feed (max)	230 Kg/d	230 Kg/d	230 Kg/d	4800 Kg/d	240 Kg/d
2.	Water requirements per KG of chlorine	NIL	1, 500 Lit	Less than 1, 500 Lit but more than 300 Lit	300 Lit	300 Lit
3.	Accuracy	Low	Low	Low	High	High
4.	Flowmeter	Manometer	Manometer	Manometer	Rotameter	Rotameter
5.	Pressure at point of application	$0.7Kg/cm^2$ (Max)	$0.7Kg/cm^2$ (Max)	More than $0.7Kg/cm^2$	More than $0.7Kg/cm^2$	More than $0.7Kg/cm^2$
6.	Energy requirement	Low	Low	Low	Morderate	High
7.	Status	Not in production	Not in production	Not in production	In production	In production
8.	Maintenance	Extensive	Extensive	Extensive	Moderate	Less
9.	Remarks	Not suitable below 10^0C water. It is used when quality of water for making solution is not good. It is less safe.	Suitable below 10^0C provide water for making the solution is beyond 100C. It is used when quality of water for making solution is good.	Suitable below 10^0C provide water for making the solution is beyond 100C. It is used when quality of water for making solution is good.	Suitable below 10^0C provide water for making the solution is beyond 100C. It is used when quality of water for making solution is good.	Suitable below 10^0C provide water for making the solution is beyond 100C. It is used when quality of water for making solution is good.

Table 34: Important Facts About Chlorine From Safety Point Of View

S/No	Facts	Reasons	Remedy
1.	Chlorine is supplied in liquid form under pressure and it requires heat for turning it into gas	It occupies less space	Proper ventilation and proper handling
2.	It is not poisonous but irritant	It forms corrosive acid with body moisture and hence inhalation can cause respiratory injury ranging from irritation to death depending upon its concentration & duration of inhalation	Use breathing apparatus
3.	Dry gas is not corrosive but wet gas is highly corrosive	It forms acid with water	Do not use water or leaking container
4.	It is neither flammable nor explosive but supports combustion of carbon steel at 251^{0}C	Container are made up of carbon steel	Do not carry out welding work on chlorine containers or piping unless purged out
5.	Gas combines with ammonia and forms white smoke	White smoke detects chlorine leak.	Use of detecting chlorine near the fire or source of heat.
6.	Liquid chlorine has large coefficient of expansion	If the container is filled with filling ratio of 1:19, complete container will be occupied by liquid chlorine at 84^{0}C and hydrostatic rupture may take place	Do not place the container near the fire source of heat
7.	Vapor pressure increases with temperature rise	Container may rupture due to rise in pressure.	Do not place the container near the fire source of heat
8.	Gas is 2.5 heavier than air	Leaked chlorine settles at the ground level	Install exhaust fans at ground level & inform the public to take higher level during chlorine leakages
9.	It is slightly soluble but it gets absorbed in caustic soda, soda ash and hydrated lime.	During the reaction with caustic soda, Soda ash and hydrated lime, heat is evolved.	Use soda ash, caustic soda or hydrated lime for neutralization of chlorine. Do not use water neutralization purposes. Do not push containers into solution
10.	Liquid leaks 15 times more than the gas	It is because of viscosity differences as well as different laws of gas and liquid	Turn the liquid container such as to allow leakage in gaseous form.
11.	Chlorine forms hydrate with water at temperature below 9.4^{0}C	Solid layer is formed	In case of liquid leak if chilled water is sprayed onto of the solid layer formation will reduce the

			rate of evaporation of the chlorine.
12.	It is dangerous with ammonia gas, turpentine, hydrogen, and hydrocarbons as reactions with these explosives; powdered metal may cause fire chlorine.	Fire may start in storage of chlorine	Avoid storage of these materials in the chlorine storage. Do not lubricate the valves

Safety Aspects Of Chlorine

General

Chlorine is potentially dangerous. It is, therefore, important that person engaged in a chlorine plant or in any activity involving handling of chlorine should understand the hazards of chlorine and should know preventive measures needed. These are given below:

Cylinders

Cylinders are fabricated as per IS: 7681. In a vertical position with the valve at the top, chlorine in gaseous form can be drawn from the cylinder. If, however, liquid chlorine is to be drawn, the cylinder can be inverted to bring the valve towards the bottom with the use of an inverting rack which holds the cylinder at 60^0C. The withdrawal rates of Cl2 at 20^0C are 2 kg/hr and 10 kg/hr for gas and liquid chlorine respectively for 100 kg. The withdrawal rate depends upon ambient temperature and it reduces with reduction in temperature. (Fig. 14)

SPECIFICATION OF CHLORINE GAS CYLINDER

Water Capacity (Litres)		84
Gas Capacity (Kg.)		100
Maximum Working Pressure (Kg/Cm^2 at 65°C)		19.90
Hydraulic Test Pressure (Kg/Cm^2)		29.85
Nominal Dia	Inside (d)	356
Approx (mm)	Outside (D)	368
Nominal Wall Thickness (I) mm		6
Approx Height excluding		988
Valve & Cap (H) mm		
Tara Weight excluding Cap (Kg)		65
Construction		3 Piece

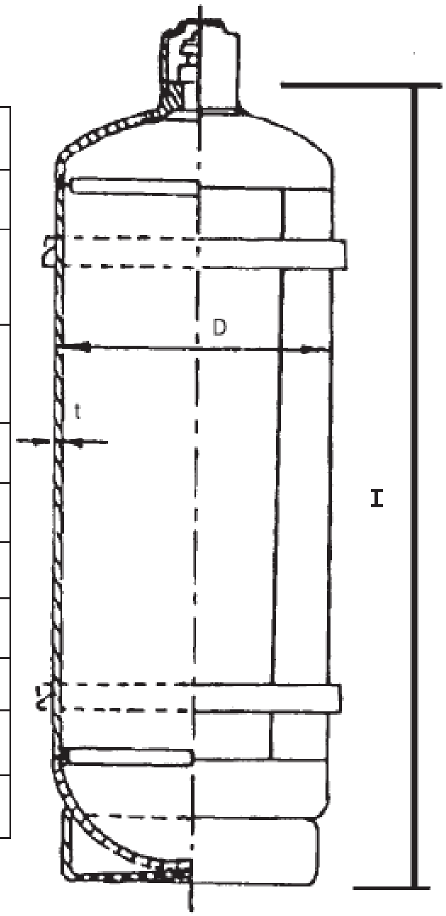
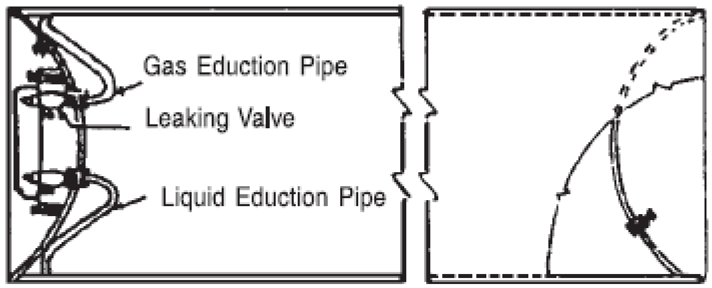


Figure 16: Details Of Chlorine Cylinder

TONNERS

Bigger containers are commonly known as 'Tonners" Indian tonners are generally fabricated conforming to the British standards (B.S:1500). These are kept horizontally so as to bring the two valves in vertical plane. Each has a capacity of approx. 900 kg. It has built-in safety by way of providing concave dished ends. Both the valves are covered by a protective hood connected to the container by means of lugs. The inside ends of the valves are connected to the eduction pipes. (Fig. 16).



GENERAL SPECIFICATION

Water Capacity (approx.) Kg.	-	780
Chlorine Capacity (approx.) Kg.	-	930
Design Pressure, Kg/Cm^2	-	19.9
Inside Diameter (approx.) mm	-	760
Shell Thickness, mm	-	10
Dished Ends Thickness, mm	-	9.6 (Min.)
Overall Length (approx.) mm	-	2085
Tare Weight (approx.) Kg.	-	520

Figure 17: Details Of Chlorine Tonner

Tonners manufactured in India after 1981 do not have fusible plug as per the Gas Cylinder Rules 1981. However, in imported design where these are provided, they melt between the temperatures of 70^0C and 74^0C thereby reducing the pressure inside the container in case of fire or high temperature. The withdrawal rates of Cl2 at 20^0C are 7 kg/hr and 180 kg/hr for gas and liquid respectively. It depends upon ambient temperature.

CONTAINER VALVES

Both chlorine cylinder as well as tonners must be fitted with standard valves conforming to IS: 3224 (Fig. 17).

STORAGE AND HANDLING OF CHLORINE CYLINDERS

Chlorine is stored in special grade steel containers. As per IS:4379-1967, the colour of Chlorine container should be ‘golden yellow’.

a) Storage Area

1. Obtain storage licence from controller of explosives under Gas Cylinder Rules 1981 if the quantity of Cl2 containers to be stored is more than 5 Nos.
2. Storage area should be cool, dry, well ventilated, and clean of trash and protected from external heat sources. Please refer to Manual on “Water Supply and Treatment”, (1999 Edition), for further details.

3. Ventilation must be sufficient to prevent accumulation of vapour pockets. The exhaust should be located either near the floor or duct be provided extending to the floor. All fan switches should be outside the storage area.
4. Do not store container directly under the sun.

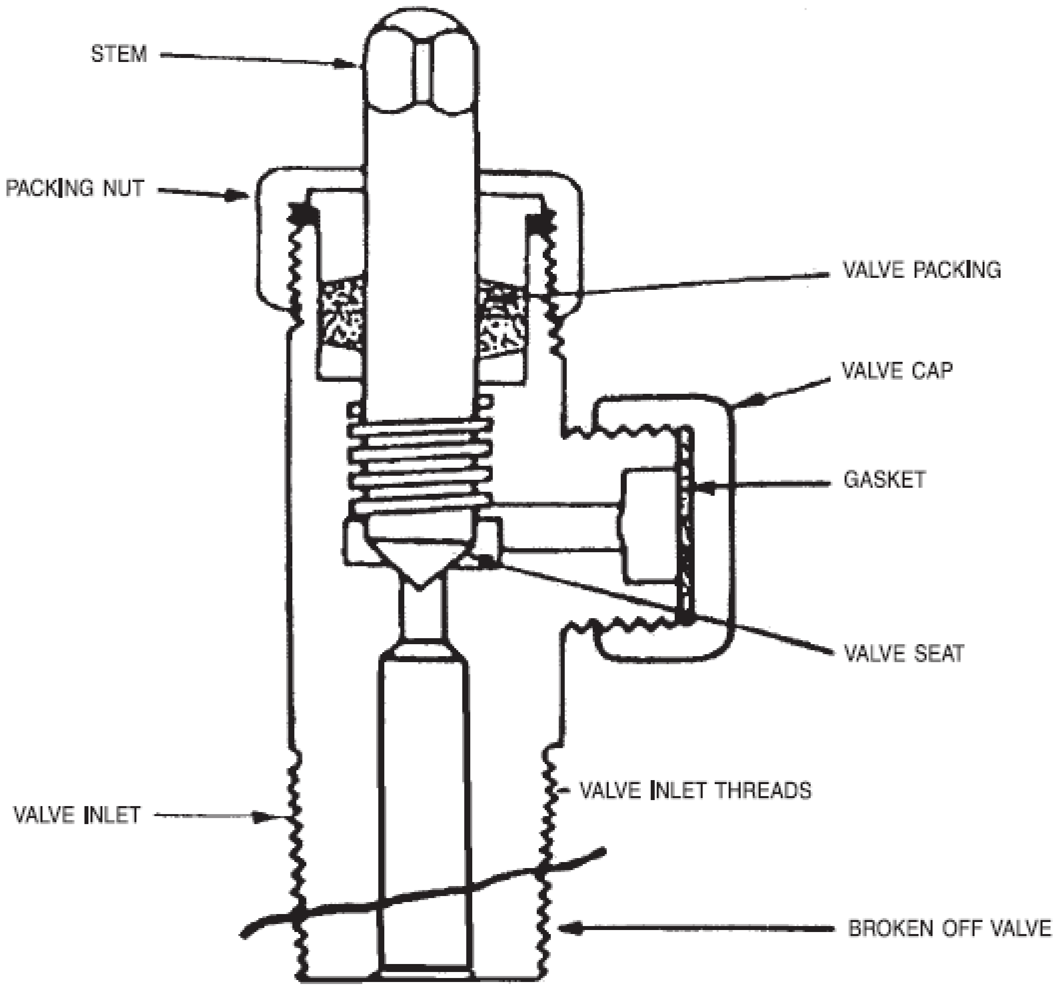


Figure 18: Standard Chlorine Container Valve

5. Weather cock should be installed near the storage to determine wind direction.
6. The storage building should be of non-combustible construction with at least two exits opening outside. Neutralization system should be provided.
7. Continuous monitoring of chlorine leak detection equipment with alarm should be installed in the storage area.
8. The area should be free and remote from elevators, gangways or ventilating system to avoid dangerous concentration of Chlorine during leak.
9. Two portable foam type fire extinguishers should be provided in the premises.
10. Corrosive substances shall not be stored nearby which react violently with each other.
11. Unauthorized person should not be allowed to enter into the storage area.

12. The floor level of storage shed should be preferably 30 cms (at least one foot) higher from the ground level to avoid water logging.
13. Ensure that all containers are properly fitted with safety caps or hooks.

b) Cylinder & Drum Containers

1. Store chlorine cylinders upright and secure them so that they do not fall.
2. Drum containers should be stored on their sides on rails, a few inches above the floor. They should not be stacked one upon the other. They should be stored such that the valves are in vertical plane.
3. Keep enough space between containers so as to have accessibility in case of emergency.
4. Store the containers in a covered shed only. Keep them away from any source of heat as excessive heat may increase the pressure in container which will result into burst.
5. Do not store explosives, acids, turpentine, ether, anhydrous ammonia, finely divided metals or other flammable material in the vicinity of Chlorine.
6. Do not store containers in wet and muddy areas.
7. Store filled and empty containers separately.
8. Protective covers for valves are secured even when the containers are empty, except during use in the system.
9. Never use containers as a roller to move other equipment.
10. Never tamper with fusible plugs of tonners.
11. Check leakages every day by means of ammonia torch. However, it should not be touched to brass components like valves of container for safety.
12. Never carry out any welding work on the chlorine system as combustion of steel takes place at 2510C in presence of chlorine.
13. The boxes containing emergency kit, safety applications and self-contained breathing apparatus should be kept in working order in an easily approachable area.

c) Use of Cylinders & Drum Containers in Process System

1. Use containers in the order of their receipt, as valve packing can get hardened during prolonged storage and cause gas leaks.
2. Do not use oil or lubricant on any valve of the containers.
3. Badly fitting connections should not be forced and correct tool should always be used for opening and closing valves. They should never be hammered.
4. The area should be well ventilated with frequent air changes.
5. Transport the cylinders to the process area by using crane, hoist or railings etc.
6. The drum containers should be kept in a horizontal position in such a way that the valves are in a vertical plane. The upper valve gives out gas and the lower one gives out liquid chlorine.
7. The cylinder should be kept in upright position in order to release gas from the valve.
   For liquid chlorine withdrawal, it should be inverted with the help of an inverted rack.
8. Connect the containers to the system by using approved accessories.
9. Use copper flexible tube, with lead washer containing 2 to 4% antimony or bonded asbestos or teflon washer. Use yoke clamp for connecting chlorine container.
10. Never use rubber tubes, PVC tubes etc. for making connections.
11. Use the right spanner for operating the valve. Always keep the spanner on the valve spindle. Never use ill-fitting spanner.
12. After making the flexible connection, check for the leakage by means of ammonia torch but it should not come in contact with a valve.
13. Keep minimum distance between the container valve and header valve so that during change-over of the container, minimum amount of gas leaks.

14. The material of construction of the adopter should be same as that of valve outlet threads.
15. The valve should not be used as a regulator for controlling the chlorine. During regulation due to high velocity of Chlorine, the valve gets damaged which in turn can cause difficulty in closing.
16. The tools and other equipment used for operating the container should be clean and free of grease, dust or grit.
17. Wear breathing apparatus while making the change-over of the container from the process header.
18. Do not heat the container to withdraw more gas at faster rate.
19. Use pressure gauge and flow measuring device to control the flow and to know the quantity of gas left in the container.
20. Use an inverted U type barometric leg or vacuum breaking arrangement for connecting the container to the process piping.
21. Withdrawal of the gas should be stopped when the gas pressure inside the container is between 0.1 to 0.5 kg/cm^2 approximately.
22. If withdrawal of the gas from the container connected to the process system has to be suspended for long intervals, it should be disconnected from the system, and the valve cap and hood replaced.
23. Gas containers should be handled by trained persons only.

d) Disconnecting Containers from Process System

1. Use breathing apparatus before disconnecting the container.
2. First close the container valve fully. After removal of chlorine the process valve should be closed.
3. Remove the flexible connection, plug the flexible connection in order to avoid entry of humid air. Replace the valve cap or hood on the container.
4. Put the tag on the empty container & bring it to storage area marked for empties.
5. Check for the leakage.

e) Loading and Unloading of Containers

1. The handling of containers should be done under the supervision of trained and competent person.
2. It should be done carefully with a crane, hoist or slanted ramp. Do not use magnet or sharp object for lifting the containers.
3. Small cylinders should not be lifted by means of valve caps as these are not designed to carry the weight.
4. The containers should not be allowed to strike against each other or against any hard object.
5. Vehicles should be braked and isolated against any movement.
6. After loading, the containers should be secured properly with the help of wooden wedges, rope or sling wire so that they do not roll away.
7. The containers should never be dropped directly to the ground or on the tyre from the vehicle.
8. There should be no sharp projection in the vehicle.
9. Containers must have valve caps and plugs fitted properly.
10. Check containers for leakage before loading/unloading.

f) Transportation of Container

1. The name of the chemical along with diamond pictorial sign denoting the dangerous goods should be marked on the vehicle.
2. The name of the transporter, his address and telephone number should be clearly written on the vehicle.
3. The vehicle should not be used to transport any material other than what is written on it.
4. Only trained drivers and cleaners should transport hazardous chemical
5. The driver should not transport any leaking cylinder.

6. The cylinder should not project outside the vehicle.
7. The transporter must ensure that every vehicle driver must carry "Trem Card" (Transport Emergency Card) and 'Instructions in writing booklet' and follow them.
8. Every driver must carry safety appliances with him, viz; Emergency kit, breathing apparatus etc.
9. The vehicles must be driven carefully, especially in crowded localities and on bumpy roads. Do not apply sudden brakes.
10. Check for the leakage from time to time.
11. In the case of uncontrollable leakage the vehicle should be taken to an open area where there is less population.

g) Emergency Kit

It consists of various tools and appliances like gaskets, yokes, studs, tie rods hoods, clamps, spanners, mild steel channels, screws, pins, wooden pegs etc. of standard sizes. Separate kits are used for cylinders and tonners. All the gadgets are designed for using in controlling or stopping the leakages from valves, fusible plug and side walls of cylinders and containers used for handling chlorine.

1. Leakage may occur through the valve. There are basically four types of valve leaks.
   i. Valve packing
   ii. Valve seat
   iii. Defective inlet thread
   iv. Broken valve thread

For controlling the leak please refer Fig. 14 & Fig. 16 for tonner & cylinder respectively.

2. Leakage may occur through container wall. For controlling such leakages, clamps are used for cylinders and chain and yoke arrangement is used for tonner. Sometimes wooden peg is used by driving into the leaking hole as a temporary arrangement.

For controlling leak please refer Fig. 14 & Fig. 16 for tonner & cylinder respectively.

3. Leakage may occur through fusible plug.

i. If the leakage is through the threads of fusible plug, yoke, hood and cap nut arrangement is used to control the leak.
ii. If fusible metal itself in the plug is leaking, yoke and stud arrangement is used to control the leak.

h) Health Hazards

Wet chlorine being corrosive, it forms corrosive acid with body moisture. Inhalation can cause respiratory injury ranging from irritation to death depending upon its concentration and duration of inhalation.

1. Acute Exposure

The first symptom of exposure to chlorine is irritation to the mucous membranes of eyes, nose and throat. This increases to smarting and burning pain. Irritation spreads to chest. A reflex cough develops which may be intense and often associated with pain behind the breast-bone. The cough may lead to vomiting. Cellular damage may occur with excretion of fluid in the alveoli. This may prove fatal if adequate treatment is not given immediately. Vomit frequently contains blood due to lesions of the mucous membrane caused by the gas. Other common symptoms include headache, retrosternal burning, nausea, painful breathing, sweating, eyes, nose, throat irritation, coughing, vomiting, increase in respiration and pulse rate. Massive inhalation of chlorine produces pulmonary oedema, fall of blood pressure and in a few minutes, cardiac arrest.

2. Chronic Exposures

Persons rapidly lose their ability to detect the odour of chlorine in small concentrations. On account of this, the concentrations beyond threshold limit value may exceed without notice. Prolonged exposure to concentrations of 5 ppm results in disease of bronchitis and predisposition to tuberculosis and concentration of 0.8-1.0 PPM can cause moderate but permanent reduction in pulmonary function.

Person exposed for long period of time to low concentrations of chlorine may suffer from acne, tooth enamel damage may also occur.

(i) First Aid - Trained Personnel and Equipment

In the plant trained first aider having the knowledge in the use of aid equipment and rendering artificial respiration should be available. First aid box with necessary contents should be available. Properly designed showers and eye fountains should be provided in convenient locations and they should be properly maintained. If oxygen is available the same should be administered by authorized person. Such training is imparted by civil defence.

1. General

Remove the affected person immediately to an uncontaminated area. Remove contaminated clothing and wash contaminated parts of the body with soap and plenty of water. Lay down the affected person in cardiac position and keep him warm. Call a physician for medical assistance at the earliest.

Caution: Never attempt to neutralize chlorine with other chemicals.

2. Skin Contact

Remove the contaminated clothes, wash the affected skin with large quantity of water.

Caution: No ointment should be applied unless prescribed by the physician.

3. Eye Contact

If eyes get affected with liquid chlorine or high concentration of chlorine gas, they must be flushed immediately with running water for atleast 15 minutes keeping the eyelids open by hand.

Caution: No ointment should be used unless prescribed by an eye specialist.

4. Inhalation

If the victim is conscious, take him to a quiet place and lay him down on his back, with head and back elevated (cardiac position). Loosen his clothes and keep him warm using blankets. Give him tea, coffee, milk, peppermint etc. for making good effect on breathing system. If the victim is unconscious, but breathing, lay him down in the position mentioned above and give oxygen at low pressure until the arrival of doctor. If breathing has stopped, quickly stretch him out on the ground or a blanket if available, loosen his collar and belt and start artificial respiration without delay. Neilson arm lift back pressure method is useful. Automatic artificial respiration is preferable if available. Continue the respiration until the arrival of the doctor. Amboo bag can also be used for this purpose.

i) Fire & Explosion Hazards:

Chlorine may react to cause fires or explosions upon contact with turpentine, ether, ammonia gas, hydrocarbons, hydrogen, powdered metals, sawdust and phosphorus. Due to fire in the vicinity, the temperature of the containers rises excessively which results in explosion. In order to avoid explosion of the containers, remove all the movable containers from the fire zone immediately by wearing full protective clothing with respiratory protection. In the case of immovable containers, use water for cooling provided there is no leak.

j) *Emergency Measures*

In case of leakage or spillage:

1. Take a shallow breath and keep eyes opened to a minimum.
2. Evacuate the area.
3. Investigate the leak with proper gas mask and other appropriate Personal protection.
4. The investigator must be watched by a rescuer to rescue him in emergency.
5. If liquid leak occurs, turn the containers so as to leak only gas.
6. In case of major leakage, all persons including neighbours should be warned.
7. As the escaping gas is carried in the direction of the wind all persons should be moved in a direction opposite to that of the wind. Nose should be covered with wet handkerchief.
8. Under no circumstances should water or other liquid be directed towards leaking containers, because water makes the leak worse due to corrosive effect.
9. The spillage should be controlled for evaporation by spraying chilled water having temperature below 9.4^{0}C. With this water crystalline hydrates are formed which will temporarily avoid evaporation. Then try to neutralize the spillage by caustic soda or soda ash or hydrated lime solution carefully.

   If fluroprotein foam is available, use for preventing the evaporation of liquid chlorine.
10. Use emergency kit for controlling the leak (Figs. 18, 19).
11. On controlling the leakage, use the container in the system or neutralize the contents in alkali solution such as caustic soda, soda ash or hydrated lime.

    Caution: Keep the supply of caustic soda or soda ash or hydrated lime available. Do not push the leaking container in the alkali tank. Connect the container to the tank by barometric leg.

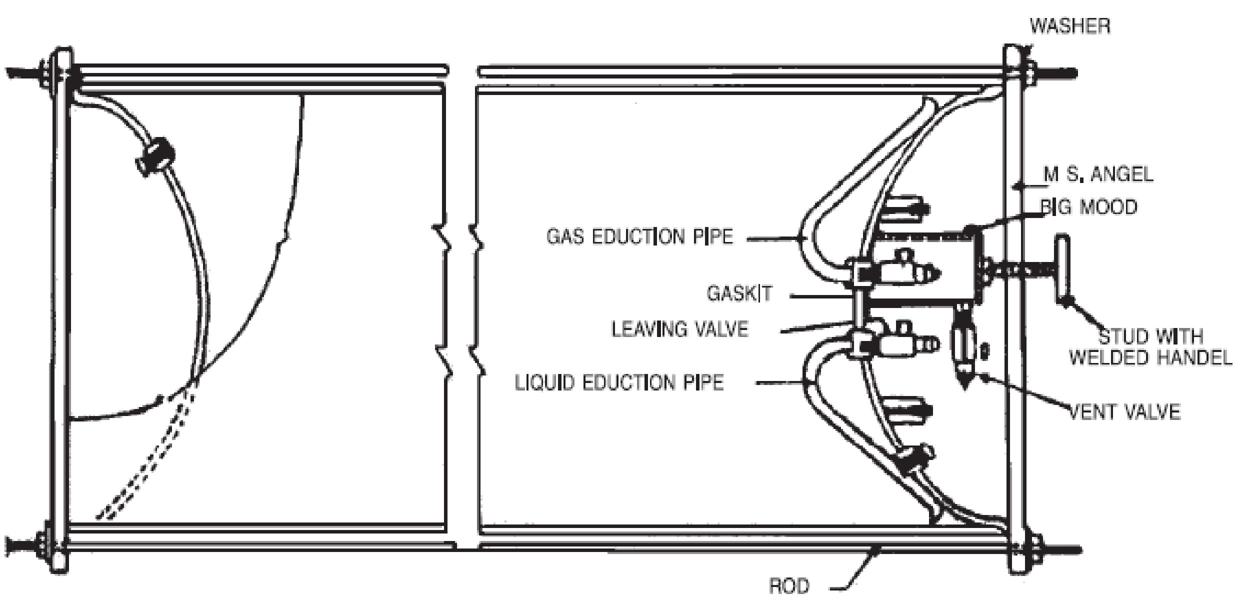


Figure 19: Application Of Emergency Kit

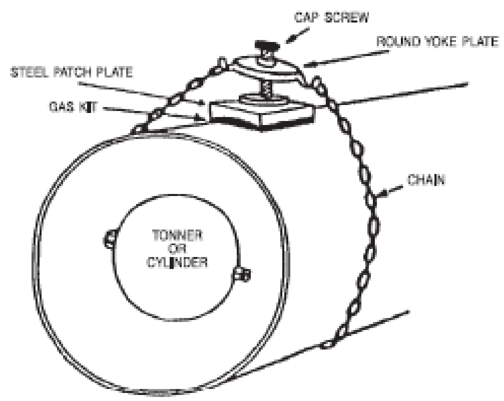


FIG. 6.12: USE OF CHAIN AND ROUND YOKE PLATE FOR TONNER CYLINDER WALL LEAK

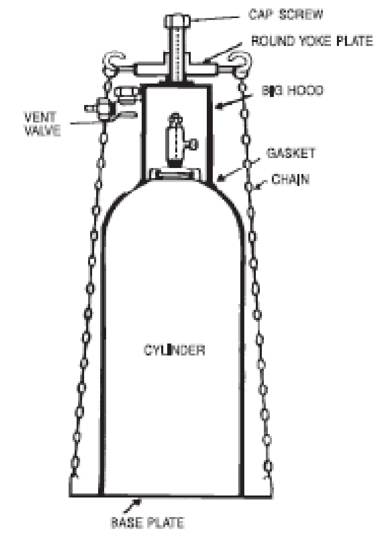


FIG. 6.13: CYLINDER VALVE HOOD ASSEMBLY DEVICE

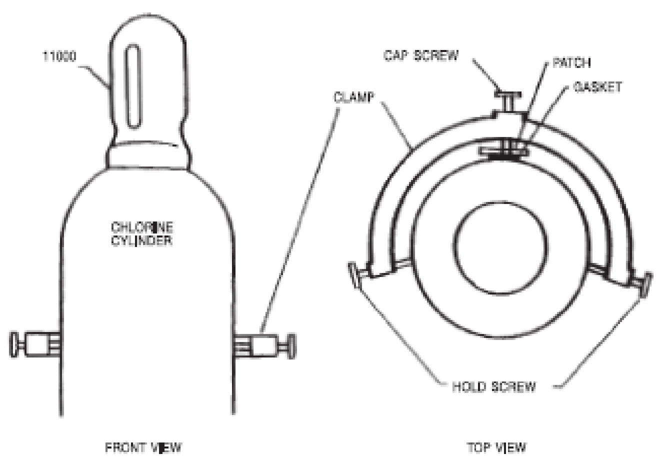


Figure 20: Container Wall Leak

12. If container commences leak during transport, it should be carried on to its destination or manufacturer or to remote place where it will be less harmful. Keeping the vehicle moving will prevent accumulation of high concentrations.
13. Only specially trained and equipped workers should deal with emergency arising due to major leakage.
14. If major leak takes place, alert the public nearby by sounding the siren.
15. Any minor leakage must be attended immediately or it will become worse.
16. If the leakage is in the process system, stop the valve on the container at once.

k) Personal Protective Equipment

1. Breathing Apparatus

Various types of respirators and their suitability are as follows:

i. *Self-contained breathing apparatus*

This apparatus is equipped with a cylinder containing compressed oxygen or air which can be strapped on to the body of the user or with a canister which produces oxygen chemically when the reaction is triggered.

This type of equipment is suitable for high concentration of chlorine in an oxygen deficient atmosphere. (Fig. 6.15).

ii. *Air-line respirator:* Air-line length 90 mtrs. (max.)

It is suitable for high concentrations of chlorine provided conditions permit safe escape if air supply fails,. This device is suitable in any atmosphere, regardless of the degree of contamination or oxygen deficiency, provided that clean, breathable air can be reached. (Fig. 6.16).

FIG. 6.15 SELF-CONTAINED BREATHING APPARATUS

FIG. 6.16 AIR LINE RESPIRATOR

iii. *Industrial Canister Type Mask :* Duration: 30 min. for 1% Cl_2

It is suitable for moderate concentration of chlorine provided sufficient oxygen is present. The mask should be used for a relatively short exposure period only.

If the actual chlorine concentration exceeds 1% by volume or oxygen is less than 16% by volume, it is not useful. The wearer in such cases must leave the place on detection of chlorine or experiencing dizziness or breathing difficulty. (Fig. 19)

2. **Protective Clothing**

Rubber, or PVC clothing is useful in massive exposure which otherwise creates mild skin burns due to formation of acid on the body.

3. **Maintenance of Protective Equipment**

1. Clean with alkali after every use.
2. Keep in polythene bag at easily accessible place.
3. Check them periodically about their suitability. Many times the seal ring of face mask gets hardened.

l) Employees Selection

Preplacement medical examination should be carried out of the persons to confirm that they are free from Asthma, Bronchitis and other chronic lung conditions.

Follow up medical examination should be carried out once in a year.

m) Employees Training

It is essential to impart training to the employees who have to face emergency.

This training should include following:

i. Instructions in the action to be taken in an emergency.
ii. Use of emergency kit.
iii. Handling of containers.
iv. First aid.
v. Use of protective equipment.
vi. Knowledge of Chlorine hazards.
vii. Fire fighting

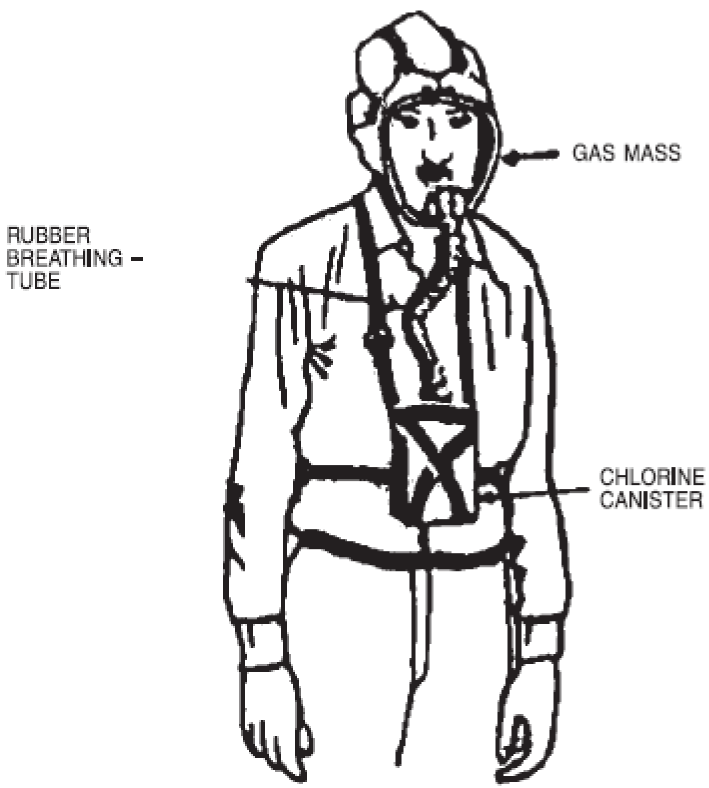


Figure 21: Use Of Chlorine Canister Gas Mask

viii. Use of safety showers and eye fountains. (Fig. 6.18).
ix. Crash shut down procedure for valves and switches.
x. Communication system.
xi. Study of plant layout with diagram.
xii. Mock drills.

Figure 22: Emergency Shower And Eye Wash Fountain

n) Neutralization of Chlorine

A suitable provision should be available for emergency disposal of chlorine from the leaking container. Chlorine may be absorbed in solution of caustic soda, soda ash and hydrated lime. Caustic soda is recommended as it absorbs chlorine more readily. If hydrated lime is used, the slurry must be continuously agitated and recirculated for chlorine absorption. The neutralization can be carried out by:

- Neutralization tank holding caustic soda or hydrated lime or sodium carbonate in solution form.
- Scrubber.

i. Neutralization tank

For the neutralization tank, following proportion of alkali and water is recommended in order to neutralize 900 kg. of Cl_2.

Chorine	Caustic Soda		Soda ash and water		Hydrated Lime and Water	
Kg.	Weight (kg)	Volume (lit.)	Weight (kg)	Volume (lit.)	Weight (kg)	Volume (lit.)
900	1160	3,680	2,720	9,050	1,160	13,501

This system can be used only after controlling the leaking container by emergency kit and connecting it to the tank by inverted U tube of 11 m height. It is desirable to provide excess quantity of alkali solution over indicated quantities in the table in order to facilitate ready absorption. A suitable tank to hold the solution should be provided in a convenient location.

ii. Scrubber

This system consists of a blower, an alkali (NaOH) tank, an absorption tower packed with rasching rings, alkali circulation pump, piping valves, light weight FRP and PVC duct. In the event of leak which is uncontrollable with emergency kit this system would allow the person to breath easily rather than panic. In this system, the leak is confined by a hood covering the leaking container, sucking the Chlorine by blower and delivering it to absorption tower (Fig.6.19). Chlorine leak absorption capacity of the system is kept 100 kg/h & 200 kg./h for 100 kg. cylinder and 900 kg. tonner respectively.

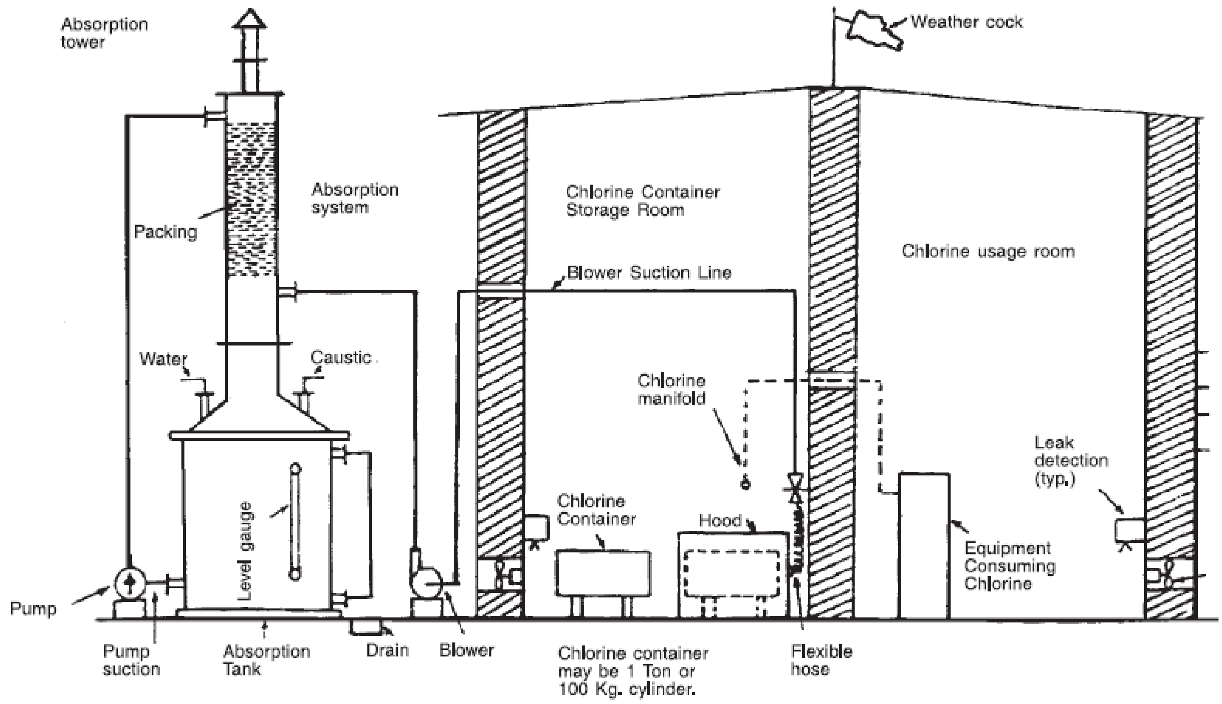


Figure 23: Typical Chlorine Leak Absorption

o) Emergency Response Planning

When a large quantity of chlorine or similar toxic or flammable gases are stored it is essential to have an emergency response planning as leakage of such gases may lead to a major accident such as emission, fire or explosion resulting from uncontrolled developments in the course of an industrial activity, leading to serious danger to man, immediate or delayed, inside or outside the establishment and/or to the environment, and involving one or more dangerous substances. It has, therefore, become obligatory on the part of occupier to take all measures necessary to prevent accidents and to limit their consequences for man and the environment. The hazard control can be achieved by drawing an effective 'onsite emergency plan' for individual organization and if necessary 'offsite emergency plan' by the local authority for that area.

Onsite emergency Plan

As chlorine is a hazardous chemical, handling and storage of it demand adequate precautions to avoid possible hazards. Leakage of chlorine may develop into a major emergency. Therefore the emergency procedure to cover this eventuality is essential. It is drawn in the form of onsite emergency plan.

The elements of onsite emergency plan are as follows:

1. *Identification of hazard chart*

In this case the site risk is evaluated by the expert and the extent of the probable damage is calculated on the basis of stored chlorine quantity, nearby population, wind direction, type of equipment failure etc. For this purpose hazard analysis is conducted in which case all the hazardous properties of chlorine are considered. If evacuation is required, the range of it is calculated.

2. *Appointing key persons*

In order to control the incident like chlorine leakage, it is essential to appoint various persons with their well-defined responsibilities. Taking into account the various activities likely to be involved, the following key persons are appointed (i) Site Controller, (ii) Incident controller, (iii) Shift Executive Incharge, (iv) Communication Officer, (v) Safety Officer, (vi) Fire and Security Officer, (vii) Utilities and Services Incharge, (viii) Traffic Controller, (ix) First Aider

3. *Assembly Points*

These points are set up where persons from the plant would assemble in case of chlorine leakage. At these points the in-charge for counting the heads will be available.

4. *Emergency Control Center*

The control centre is the focal point in case of an emergency from where the operations to handle the emergency from are directed and coordinated. It contains site plan, telephone lines, public address system, safety equipment, first aid boxes, loud speaker, torches, list of essential telephone numbers, viz. fire brigade, police, hospital, civil defence, collector, factory inspector, organizational authorities, chlorine suppliers, mutual aid group, social workers, list of key persons and their addresses, copy of chemical fact sheet, location plan of fire hydrant, details of dispersion model of chlorine gas, population distribution pattern, location of alarm system.

5. *Procedure to meet Emergency*

The actions to be taken by the staff and authority are given below; Emergency Alarm: An audible emergency alarm system is installed throughout the plant. On hearing the alarm the incident controller will activate the public address system to communicate with the staff about the emergency and give specific instructions for evacuations etc. Anyone can report the occurrence of chlorine leakage to section in-charge or incident controller through telephone or intercom or in person.

6. *Communication*

Communication officer shall establish the communication suitable to that incident.

7. Services

For quickness and efficient operation of emergency plan the plant is divided into convenient number of zones and clearly marked on the plan. These are emergency services viz. fire fighting, first aid, rescue, alternative source of power supply, communication with local bodies etc. The incident controller will hand over the charge to the site controller of all these coordinating activities, when the site controller appears on the site. The site controller will coordinate all the activities of the key persons. On hearing the emergency alarm system all the key persons will take their charge. Incase of their absence other alternatives are nominated.

The person nominated for personnel and administration purposes will be responsible for informing all statutory authorities, keeping account of all persons in the plant including contract labour, casual workers and visitors. He will be responsible for giving information to press or any outside agencies. He is also responsible for organizing canteen facilities and keeping informed the families of affected persons. The person nominated as security officer should guide police, fire fighting and control the vehicle entries. The site controller or any other nominated person will announce resumption of normalcy after everything is brought under control. The onsite emergency plan needs to be evaluated by mock drill. Any weaknesses noticed during such drills should be noted and the plan is modified to eliminate the weaknesses.

ANNEXTURE: MATERIALS OF CHLORINE EQUIPMENT AND ANCILLIARIES

S/No.	Equipment	Material
1	Piping Rigid	Seamless carbon Steel ASTM A 106 grade “B” schedule 80 or Equivalent to BIS 1030-1974
	For gas below atmospheric pressure	Rigid uPVC (for under shed), polyethylene tube, HDPE (outside shed)
2	Piping Flexible	Annealed Copper with Cadmium plating
3	Globe Valves	Body: Rigid Carbon Steel Trim: monel or hastelloy C Stuffing box or graphite packing
4	Ball Valves	Body & end piece: Forged steel ASTM A 105 Seat: PTFE Ball: Monel
5	Springs	Tantellum alloy
6	Gasket	Lead Containing 2 to 4% antimony or bonded asbestos
7	Chlorinator	Vacuum regulator body: Regulator Diaphragm: Cabinet: FRP “O” Ring and gaskets: Florocarbon Lead Oxide (lithurgy cured) viton
8	Pressure gauge	Diaphragm: Silver, tantalum, hastelloy, monel alloy Liquid: Frourocarbon, Silicon oil, Frourolube “MO 10”
9.	Differential regulator	Body: uPVC, ABS, ebonite PVDF
10	Pressure Relief Valve	Body: uPVC, ABS, ebonite PVDF
11	Injector	Stem: Ag, hastelloy, monel
12	Evaporator	Block: ebonite or PVC, ABS
13	Rupture Disc	Silver: monel tantalum, Hastelloy C
14	Rotameter	Glass: borosilicate Float: PTFE, tantullum or hastelloy , glass
15	Filter media	Glass-wool

16	Diffuser and solution line	Rigid uPVC, saran or rubber lined steel, HDPE, natural rubber hose
17	Pressure Reducing Valve	Body: Ductile Cast Iron Diaphragm: FPM (Viton), ECTFE/FEP Plugs: Silver or tantullum or hastelloy Plugs: Seats: PTFE
18	Check Valve Springs	tantullum or hastelloy
19	Non-permanent joints	Mixture of Linssed oil and white lead or mixture of linssed oil and graphite or teflone tape
20	Permanent joints	Glycerin and Lithergy
21	Screws	Monel and Stainless Steel

ANNEXTURE: LIST OF SFETY SYTEMS AT CHLORINATION PLANT

1. Breathing apparatus.
2. Emergency kit.
3. Leak detectors.
4. Neutralisation tank.
5. Scrubber system.
6. Siren system.
7. Display of boards in local language for public cautioning, first aid and list of different authorities with phone numbers.
8. Communication system.
9. Tagging system for equipments.
10. First aid including tablets and cough mixtures.
11. Exhaust fans.
12. Testing of pressure vessels, chlorine lines etc. every year as per factory act.
13. Training & mock drill.
14. Safety showers.
15. Eye fountain.
16. Personal protective equipments.
17. Protecting hoods for ton-containers.
18. Fire extinguishers.
19. Wind cock.

Annexure: Trouble Shooting Chart For Vacuum Type Chlorinator

Trouble	Cause	Remedy
1. **Required gas flow not achieved at start up**	a) Insufficient ejector vacuum caused by insufficient water supply or excessive back-pressure. b) Leakage at vacuum line connection at outflow of flowmeter, rate control valve, differential pressure regulator, or inlet to ejector. c) Vacuum flowmeter, if flexible, crimped.	a) Refer to trouble at Sn.6 b) Inspect each connection and remake if necessary. c) Replace vacuum tubing and arrange line (s) to eliminate crimping
2. **Required gas flow not achieved on start up following an extended period of shut-down**	a) Insufficient ejector vacuum b) Leakage at vacuume line connection at outflow of flowmeter, rate control valve, differential pressure regulator, or inlet to ejector. c) Vacuum flowmeter, if flexible, crimped. d) Leakage around flowmeter gaskets	a) Refer to trouble at Sn.6 b) Inspect each connection and remake if necessary. c) Replace vacuum tubing and arrange line (s) to eliminate crimping. d) Inspect and align flow meter or replace gaskets.
3. **Flow meter float observed bouncing and/or maximum gas flow cannot be achieved during normal operation**	a) Gas inlet filter of vacuum regulator dirty. b) Rate valve dirty. c) Flow-meter dirty. d) Water supply pressure	a) Replace gas inlet filter assembly b) Clean rate valve c) Clean flow meter d) Correct water supply pressure as necessary
4. **Flow meter fails to indicate gas flow during normal operation but there is no out-of-gas indication**	a) Rate valve plugged b) Gas flow-meter plugged c) Vacuum flowmeter, if flexible, crimped	a) Clean rate valve b) Clean gas flow meter c) Replace vacuum tubing and re-arrange lines to eliminate crimping
5. **No gas indication during normal operation**	a) Gas supply valve(s) closed b) Gas supply exhausted c) Clogging of filter in vacuum regulator	a) Open gas supply valves b) Replenish gas supply c) Replace filter
6. **Insufficient ejector vacuum**	1) Y-Strainer on the water supply strainer is dirty 2) Back-pressure is greater than the value listed for one the following reasons: a) Solution valve if present , not fully open	1) Clean Y-Strainer 2) Open solution valve, clean solution line 3) Clean nozzle and/or throat dirty

	b) Solution valve if present , partially blocked c) Back-pressure at point of application has increased above its original value. 3) Ejector nozzle and/or throat dirty	
7. Loss of gas feed	1) Dirty plugged ejector nozzle 2) Insufficient water pressure to operate the ejector 3) No gas supply	1) Check for vacuum ejector. Clean nozzle 2) Provide roper water pressure. 3) Replenish gas supply.
8. Flooded feeder	Dirt lodged on the check valve	Clean or replace seat

Operation Of Reservoirs

The main function of Reservoirs and Service Reservoir (SR) is to cater for daily demands and especially peak demands of water. Operators/managers must be concerned with the amount of water in the storage reservoir and the corresponding water levels at particular times of the day. Procedures for operating the Service Reservoir will depend upon the design of its storage capacity and on the water demand.

Normal Procedures For Operation Of Service Reservoir (SR)

Service Reservoirs have to be operated as per the design requirements. Normally the service reservoirs are constructed to supply water during periods of high water demand and hence the SRs are filled in low water demand period. At times pumps may be used only for filling the SR before the next supply timing or can be used also during supply hours to maintain the levels in the SR.

In some systems reservoirs are allowed to float at the end of distribution system when pumps are used to pump directly into the distribution system and excess water flows into the SR. In such systems multiple pumps are used to cater to varying demand and pressures in the system. Small changes in the distribution system such as pipeline extensions or the addition of few more connections will not require additional storage requirement. Major system changes such as addition of larger size of main pipelines and increase in large number of connections may require additional storage.

Operation Of SRS During Abnormal Conditions

Abnormal operating conditions arise:

- Whenever demand for water goes up suddenly due to fire demand, or due to excessive demand on one command area/zone of a system.
- Due to failure or breakdown of water supply of another zone of the distribution system.
- Breakdown or out of service pumps or pipelines or power breakdowns or out of service SRs.

The operator/manager must have a thorough knowledge of the distribution system emanating from the SRs. Closure or adjustment of valves at strategic points in the distribution system can focus or divert the flow of water towards the affected areas. Emergency plans must be developed in advance to cope with such situations. Further details for emergency planning may be seen in Chapter 14 – System Management.

Storage Level

Most of the distribution systems establish a pattern of levels for assuring the required supplies at the required pressures. A water usage curve over a 24 hour period should be prepared for each SR. It can be seen from the usage curve that the pattern varies not only during the different times of the day but also during different days of the week especially on week-ends, holidays and festivals. Demand pattern also changes during different times of the year depending on the weather conditions such as summer, winter etc. From the usage curve the operator can better anticipate and be ready for the expected high consumption periods. The maximum water levels to be maintained in the SR at each morning should be known to ensure that the system demands are met for the day. In case of intermittent supply, timings for supply of water in the areas are fixed in advance.

In large command areas, the water can be supplied to sub-zones during particular fixed hours by operation of the necessary valves. The operator should work out a programme for compliance.

Storage Capacity

Capacity of storage reservoir at different levels can be calculated and charts or tables can be prepared and kept at the SR site. Proper functioning of water level indicators is required to read the water level in the SR and assess its capacity. Usually water levels are read at the same time each day and the readings recorded. Checks of water levels at other times of the day will enable to determine if any unusual consumption conditions have occurred. If any significant increase in consumption is anticipated the operations should ensure a corresponding increase in supply into the SR. Automatic valves are used to prevent overflows from SR and maintain a constant level in the SR as long as the pressure in the distribution system is adequate. Often the pumps feeding into a SR are switched off or switched on as per the water levels in the SR. In some SRs advance warning alarms are provided to signal when water levels in SR are either too low or too high. The operator shall ensure that the automatic operations work as and when needed. Sometimes time clocks are often used to control the water coming into the reservoir. At some places the overflow is connected to the distribution system; in such cases some mechanism must be in place to indicate that the reservoir has started overflowing.

Routine valve operations are normally done at the SRs. Problems in operation of valves in SRs can also be caused by valve seat getting jammed, and hence cannot be opened, or non-seating of valves, and hence cannot be closed properly. Sometimes two valves are fixed in series on the outlet and the downstream valve only is usually operated. Whenever the valve under operation is jammed the upstream valve is closed and the jammed valve is repaired. Such an arrangement enables repair of valves without emptying the SR. In some SRs a bypass line is provided direct from the inlet line to the outlet line for drawing water without feeding the SR. Identification of the valves as to their intended purpose such as inlet, outlet, scour, bye-pass etc. and their direction of opening are to be prominently marked. The operator/manager shall ensure that all valves in a SR are in good working condition and are operated as per the schedule for such operations.

Storage Level Control

A simple system used to read and control the levels in SRs is a gauge/water level indicator. Whenever the SR reaches the maximum water level, the operator informs the pump house to stop pumping. In place of the traditional telephones, mobile phones or dedicated wireless units can also be used. Electrodes, ultrasonic signals or solid state electronic sensors are also used to sense the rise and fall in water levels and send signals to the pumps to be stopped or started through cables or wireless or radio frequencies.

It is also desirable to have an indication of levels of SR in the pump house. Automation of level controls at SR s is to be attempted with caution since most of the authorities require only a small amount of instrumentation and control. It is desirable that only simple level control instruments are chosen keeping in view availability of skilled personnel. However, it is desirable that trained and qualified operators only are permitted to repair the instruments.

Sampling For Water Quality

Water from all SRs should be regularly sampled especially once, before and after monsoon to determine the quality of water that enters and leaves the SR. Sampling data can help in setting up periodic cleaning of SR. Indicators that help to decide when the tank is due for cleaning is turbidity, excessive colour, taste and odour.

Water quality problems may be of microbiological type which could be caused by loss of residual chlorine due to bacterial contamination. Chemical water quality problems may also occur due to leaching from reservoir lining and coating for RCC and masonry tanks and due to corrosion of steel tanks. Common cause of physical water quality problems includes collection of sediment, rust and chemical precipitates. Water quality in a SR may also deteriorate due to excessively long periods of stagnant conditions. Sometimes poor design, and improperly applied/and or cured coatings and linings may also cause water quality degradation. Proper investigation is required to find the reasons for water quality degradation, determine the source of the problem and address the same. Wherever seasonal demands fall and the residual chlorine levels get depleted, it may be necessary to add additional chlorination facilities.

Plan For O & M Service Reservoirs

The plan for O&M of the service reservoirs shall contain operational procedures, maintenance procedures and the manufacturer's information in respect of the instruments/gauges.

PROCEDURES FOR OPERATION

The operational procedures inter-alia will contain:

- Design criteria for the reservoir such as: capacity in liters, size and depth of storage; size of piping of inlet, outlet, scour and overflow; sizes and locations of control valves of inlet, outlet and scour; source of feeding the reservoir; hours of pumping or gravity feeding into the reservoir; rate of flow into the reservoir; hours of supply from the reservoir and quantity to be supplied from the reservoir; areas to be served/ supplied; highest and lowest elevations to be commanded from the SR and the water levels to be maintained in the SR for command of the entire area.
- Structural drawing of the SR and the layout drawing showing the alignment of pipe connections, by pass lines, interconnections and location of valves, flow meters, pressure gauges and alignment of out-fall drain to lead off the scour and overflow water from the reservoir.
- Schedule of suppliers' names, addresses and telephone numbers of the equipment installed in the SR such as valves, flow meters, level indicators etc.
- A spot map showing the location of the piping and valves. The map shall also indicate open or closed positions of valves to be operated. This map shall be preserved by a glass cover or laminated to prevent unauthorized meddling.
- Step by step operating instructions indicating how to operate and control various valves located on the inlets and outlets, so as to ensure the required quantity of water is supplied to the command areas at the desired pressures during the period required to be supplied.
- A record sheet for each valve showing direction for turning, number of turns, inspections, repairs and whether open or closed. The direction of operation of valves shall be clearly marked as "open" or "close".
- The name of the valve and piping such as washout, inlet, outlet, by pass, overflow etc. shall be painted clearly and repainted regularly.
- In the case of mechanized operation of valves, the steps to include starting, running and stopping the operations.

- Instruction for situations when valves cannot be operated due to some problems regarding authority to be informed and receive further instructions.

Maintenance Procedures

The maintenance procedures shall contain step by step procedure to cover every piece of equipment used in SRs such as valves and flow meters preferably following the procedures indicated in the manufacturers' catalogues.

(a) Valves

- All valves should be inspected and operated regularly.
- The manager shall specify frequency of inspection.
- A small amount of penetrating oil is poured down the spindle to lubricate packing gland and soften the packing.
- Valve spindles that develop leaks on turning should be repacked.
- Rust and sediment in the valve is removed by shutting the disc hard in the seat, then opening about a quarter way and closing tightly several times; the increased velocity usually flushes the obstructions away.
- Valve chambers of the SR also require maintenance to ensure that the interiors of chambers are not silted up and also ensure that the covers are in good condition and are in position.

(b) Service Reservoirs

SRs have to be inspected regularly and the manager can prescribe frequency of inspections. Leakage from structure of SR and through the pipes and valves has to be attended to on priority. It is advisable to resort to pressure grouting to arrest leaks from structures and sometimes an additional coating of cement mortar plastering is also done using water proof compound to arrest leaks from the structure.

Maintenance is concerned with mainly protection against corrosion both externally and internally. Corrosion of roof slab of RCC reservoirs due to the effect of chlorine is also quite common. Internal corrosion is prevented by cleaning and painting at regular intervals. Toxic paints should not be used for painting interior surface of SRs. Anticorrosive painting (epoxy) is also done to the interiors when corrosion due to chlorine is expected. Painting of steel tanks once in a year and external painting with waterproof cement paint for exteriors of RCC Tanks once in 5 years is usually done. The inside of painted SR shall be disinfected before putting into use for a period sufficient to give chlorine residuals of at least 0.2 mg/l.

Cleaning Of Service Reservoirs

- Routine inspection is the best way to determine when a tank requires maintenance and cleaning. A visual inspection can be made from the roof manhole with water level lowered to about half full or less. Alternatively a detailed inspection can be made after draining the tank and then cleaning or washing. Best time of the year to take up cleaning of SRs is during the period of lowest water consumption.
- The following activities are normally involved in cleaning of a tank/SR:
- Make alternate arrangement for water supply to consumers served by the SR.
- Close the inlet line before commencing cleaning of SR.
- Draw the water from the SR till 200-300 mm water is left in the SR.
- Close the outlet valve so that no water will be used while the tank is being cleaned.
- Collect sample of water and silt/mud accumulated in the Tank and get the biological analysis and for presence of snails and worms. If snails and worms are found find the source and eliminate it.
- Drain and dispose off the remaining water and silt.

- Wash the interior of tank walls and floor with water hose and brushes.
- Inspect the interior of walls and ceiling of tank for signs of peeling off or deterioration.
- Apply disinfectant (Supernatant of Bleaching powder) to the walls and floor before start of filling the tank/SR.
- Frequency of cleaning of SR depends on the extent of silting, development of bio films and results from water quality monitoring.

Personnel

Recommended minimum O&M staff for SR s is contained in the Manual on Water Supply and Treatment. The required personnel have to be trained in the maintenance of the valves, flow meters, water level indicators etc; training to include fault location, dismantling and assembling after repairs and replacement of the parts of the valves, flow meters and water level indicators. The supervisory personnel (managerial staff) have also to be trained in supervision of the maintenance.

Spares And Tools

Spares

The maintenance procedures shall contain a list of spares which are likely to be damaged due to wear and tear and have to be replaced in a SR. This list will also indicate the minimum quantity at which replenishment should be made. The list of probable spares to be kept in stock may include the following:

- Spare check nuts and spindle rods and assorted bolts, nuts and washers for the flangs.
- Gaskets for flanged joints for all sizes of sluice valves installed in the SR.
- Spare pulleys.
- Threads, floats and indicators for water level indicators.
- Spare manhole covers, spare fly proof mesh for ventilators and
- Consumables like the gland rope, grease, cotton waste.

Tools

The necessary tools to repair and correct the routine problems and for facilitating repairs and replacements in a SR have to be identified and provided to the maintenance staff.
Some of the tools for the maintenance work in a SR are:

- Key rods for operation of all sluice valves.
- Hooks for lifting manhole covers.
- Pipe wrench of appropriate sizes (200, 300 or 450 mm).
- DE spanner set, Ring spanner set.
- Screw Drivers, Pliers.
- Hammers, Chisels.
- Excavation tools such as crow bars, spades, iron baskets and
- Housekeeping accessories such as long brooms and coir brushes.

List Of Available Spares And Tools

A list consumables such as gland rope and list of spares such as spindle rods or stems, check nuts or wedge nuts and a list of suggested Tools available at each SR site shall be prepared and shown in the premises of each SR.

Manufacturer's Information

For each SR compilation shall be made which contains the information about the equipment used in the SR such as sluice valves, Butterfly (BF) valves, air valves, water level indicators, pressure gauges, flow meters, water level indicators etc. The information for the equipment shall include manufacturer's name, address telephone number etc. and also the technical information furnished by the manufacturers. The test certificates, inspection reports and warranty certificates of these equipment shall also be kept along with the manufacturer's information.

Records And Reports

Record System

A record system has to be developed which should be realistic and apply to the operating problems involved at the particular SR site. The most efficient way to keep records is to plan what data is essential and then prepare the formats followed by the persons to fill the data, frequency and to whom the record is to be sent for review and report. Sample records to be maintained at a SR site are given below for guidance.

Records To Be Kept For The Operation

Note the following:

- Water levels in the SRs (for all compartments) at hourly intervals.
- Time and relevant operation of control valves with time of opening and closure or throttling position of the valves.
- Hourly flow meter readings both on the inlets and outlets.
- Hourly residual chlorine readings of inflow water and outflow water.
- The man-hours spent on routine operations at the SR in previous year and the cost thereof.

Maintenance Record

- Maintain record on each of the following maintenance/repair works along with the cost of materials and labour.
- When the gland ropes of the valves at the SR were changed.
- When the spares of the valves were changed.
- When the manhole covers were changed/replaced.
- When the water level indicator was repaired or replaced.
- When the reservoir was last cleaned.
- When the out-fall drain for scour and overflow was last cleaned.
- When the ladder was changed.
- When the structure of the reservoir was last repaired to attend to structural defects or arrest leakage.
- When the reservoir was last painted.
- When the piping at the reservoir was last painted.
- Total cost of repairs and replacements at the SR in previous year along with break up of material cost and labour cost with amount spent on outside agencies for repairs and replacements.

Reports

With the accumulation of all essential data a report can be prepared evaluating the O&M of the facility. The report can identify the deficiencies in the SR and its appurtenances and then plan future repairs to the structure or valves and other equipment or for replacement of defective valves or other equipment or additions to the storage capacity where the existing capacity is inadequate.

Checks to be carried out at SRS

A programme has to be prepared for each SR which shall contain procedures for routine tasks, checks and inspections at intervals viz. Daily, weekly, quarterly semi-annually or annually. This plan shall fix responsibility, timing for action, ways and means of completing the action as to when and who should take the action and mention the need to take this actions. Simple checklists for use by the managerial staff can be prepared to ensure that the O&M staff have completed the tasks assigned to them.

Table 35: Checklist for clear water sump & Reservoir

S/No.	Checks required/Undertaken	Status	Frequency of *
1	Proper closure of wash-out valves ; any abrupt stoppage during operation.		
2	Proper operation of inlet valves; any abrupt stoppage during operation.		
3	Proper operation of outlet valves; any abrupt stoppage during operation.		
4	Proper operation of bypass valves; any abrupt stoppage during operation.		
5	Does any valve pass water even after closure		
6	Leaks through valves; glands and bolts and nuts		
7	Leaks through pipes and joints at SR		
8	Status of valve chambers and their covers		
9	Status of finial ventilators; fly proof mesh intact or is to be replaced		
10	Status of manhole covers; are they corroded		
11	Functioning of water level indicators		
12	Functioning of flow meters		
13	Status of ladders and railing; are they corroded?		
14	Check whether the quality of the water in the SR is OK		
15	Possibility of the quality of the water in the SR getting polluted?		
16	Check for the need for cleaning and disinfecting the SR		
17	Check for the presence of residual Chlorine in the water stored in the SR		
18	Check for the signs of corrosion of interior of the roof due to chlorine		
19	Check for structural damages in the SR		
20	Check for leaks through the structure of the SR		
21	Status of Interconnecting Pipework? Is it corroded?		
22	Status of lightening arrestors		
23	Status of outfall drains of scour and outflow at SR		
	Availability of:		
24	• Spares		
25	• Consumables		
26	• Tools		
27	Check for Painting		
28	Check for availability of drawings and designs of the Sr		

*****To be decided by the respective Utilities

Objectives of the Distribution System

The overall objective of a distribution system is to deliver wholesome water to the consumer at adequate residual pressure in sufficient quantity at convenient points and achieve continuity and maximum coverage at affordable cost. To attain this objective the organisation has to evolve operating procedures to ensure that the system can be operated satisfactorily, function efficiently and continuously, and as far as possible at lowest cost. Routine and emergency operating procedures should be in written form and understandable by all operators of the authority to act in emergencies. Further, specific operational procedures are required for inspecting, monitoring, testing, repairing and disinfecting the system as well as for locating the buried pipes and valves. System records and maps should be updated and have sufficient details of the system facilities, their condition, routine maintenance that is needed and done, problems found and corrective actions taken. Analysis of the records will enable the organisation to evaluate how well the installations are functioning and how effective its services are and hence assess their adequacy to meet the needs of the consumers.

Normal Operations

Normally, the operations are intended to maintain the required supply and pressure throughout the distribution system. Critical points are selected in a given distribution system for monitoring of pressures by installation of pressure recorders and gauges. These pressures are either measured manually and transmitted to the control station or automatically measured and transmitted by telemetry to control station. In the direct pumping systems, whenever water pressures in the distribution system or water levels in the Service Reservoir (SR) drop below the minimum required levels, pumps would be manually or automatically started. In an intermittent water supply system, pumps and valves are operated during fixed hours. These pumps will run till the maximum levels in SR and maximum pressures in the distribution system are reached. Operators are required to ensure the accuracy of the measuring instruments for pressures and levels so that the pumps operate or stop at the proper levels. Sometimes, online Booster pumps are introduced to work on line to start whenever the desired pressures fall below the required pressures. Both upstream and downstream pressures are sensed and transmitted to the booster pumping station for automatic starting or stopping of the pumps when the actual pressures are below or above the desired pressures.

Issues Causing Problems In The Distribution Systems

Intermittent System

The distribution system is usually designed as a continuous system but often operated as an intermittent system. Intermittent supply creates doubts in the minds of the consumers about the reliability of water supply. This leads to limited use of the water supplied, which does not promote personal hygiene at times. During the supply period the water is stored in all sorts of vessels for use in non-supply hours, which might contaminate the water. Often, when the supply is resumed, the stored water is wasted and fresh water again stored. During nonsupply hours polluted water may enter the supply mains through leaking joints and pollute the supplies. Further, this practice prompts the consumers to always keep open the taps of both public stand posts and house connections leading to wastage of water whenever the supply is resumed. Intermittent systems and systems which require frequent valve operations are likely to affect equitable distribution of water mostly due to operator negligence.

Non-Availability of Required Quantity of Water

Failure of source or failure of power supply may cause reduced supplies. Normally, the distribution reservoirs are designed for filling in about 8 hours of pumping and whenever the power supply is affected the pumping hours are reduced and hence the distribution reservoirs are not filled up leading to reduced supply hours and hence reduced quantity of water.

Low Pressure at Supply Point

Normally peak demand is considered ranging from 2 to 3, whereas the water supply is given only for a different duration, leading to large peak factors and hence affecting the pressures in the distribution system. This is a common with most water supply systems.

Leakage of Water

Large quantity of water is wasted through leaking pipes, joints, valves and fittings of the distribution systems either due to bad quality of materials used, poor workmanship, corrosion, age of the installations or through vandalism. This leads to reduced supply, loss of pressure and deterioration in water quality.

Unauthorized Connections

Illegally connected users will contribute to the reduction in service level to authorized users consumers and deterioration of quality of water. Sometimes, even legally connected users draw water by sucking through motors causing reduction in pressures.

Extension of Area Of Distribution System

Due to extension of service area without corresponding extension of distribution mains, the length of house connections will be too long leading to reduction in pressures.

Age of The System

With age there is considerable reduction in carrying capacity of the pipelines due to incrustation, particularly unlined CI, MS and GI pipes. In most of the places the consumer pipes get corroded and leaks occur resulting in loss of water and reduced pressure and pollution of supplies.

Lack Of Records

System maps, designs of the network and reservoirs and historic records of the equipment installed in the distribution system are often not available, whereas some minimum information is required to operate and maintain the system efficiently.

Operation Schedule

Mapping And Inventory of Pipes And Fittings in Water Systems supply

Availability of updated distribution system maps with contours, location of valves, flow meters and pressure gauges or taping points is the first requirement for preparation of operation schedule. The agency should set up routine procedures for preparing and updating the maps and inventory of pipes, valves and consumer connections. The maps shall be exchanged with other public utilities to contain information on other utility services like electricity, communications etc.

The activities involved in mapping are:

- Establishment of consultative process with management of other utility services like electricity, communications etc.
- Definition of maps such as layout, scale, representation of pipes, valves, connections etc.

- Establishment of procedures for storage and retrieval and updating of maps and inventory information including intersections.
- Setting up procedures for collecting map information in the field including verification in the field for compliance of the as built drawings with design.
- Setting up procedures for updating maps when any changes are made in the distribution system.

Procedures for Preparation and Updating of Maps

Content Of Maps

Comprehensive maps prepared for a scale of 60m/cm to 120 m/cm are used for O&M of distribution system. They provide an overall view of the system with location of reservoirs, pumping stations, valves and hydrants etc. Valve location maps apart from indicating their location also show the direction to open the valve, number of turns to open, make of valve and date of fixing of valve. At times, plan and profile drawings are also available which show the depth of pipe, pipe location vertical and horizontal and distance from reference point. Hydraulic gradient contour maps are also prepared to indicate the pressures in the system in peak demand period. They can be used for identifying high pressure or problem areas with low pressures.

FIELD SURVEY

Existing maps are used or conventional survey is employed for preparation and up-dation of maps. As an alternative to traditional survey and map preparation, 'total station method' is gaining popularity. Total station instruments can be used for survey and mapping of towns where data is not readily available.

Geographic Information System (GIS)

Geographic Information System (GIS) is a computer program that combines mapping with detailed information on physical structures with geographic areas. GIS has also compatibility with auto-cad design systems. The remote sensing maps can be used to prepare base maps of the utilities by using GIS. The GIS creates a database within a mapped area such as streets, valve chambers/manholes, pipe networks and pumping stations. The attributes can be address, number of valve chamber/manhole, pipe length, diameter, invert and quadrant (coordinates) and can also include engineering information, maintenance information and inspection information. The utility staff will get facility to update the maps and retrieve information geographically. These maps can be used to inform the maintenance crew to locate the place of work. The utility can use a work order system for new/repair works so that after completion of the work like a line is added or a valve is fixed or a new connection is given, the work order can be used by the map unit for up-dation of the map and the attributes also. These maps are used to indicate layers of maps for water lines, sewers, power cables, telecom cables etc.

Routine Operation Of The Water Supply Systems

The efficiency and effectiveness of a water supply system depends on the operating personnel's knowledge of the variables that affect the continuity, reliability, and quantity of water supplied to consumers. The operational staff should be able to carry out changes in the hydraulic status of the system as required depending on those variables promptly and effectively. Routine operations shall be specified which are activities for adjusting the valves and operation of pumps to match the prevailing conditions (flows, pressures, levels and operation of pumps).

Valve and pump operations will have to be controlled as per a schedule. The schedule shall contain procedures for operating the distribution system. It should contain procedures to obtain, process, and analyze the variables related to water flows, pressures and levels as well as the consequences of manipulating control devices, such as operation of valves and or pumps so that the hydraulic status of the system can match the demand for water. When operators change their shifts information on valve closure and opening must be exchanged.

Operations In Other Than Normal Conditions

Operations other than routine viz. during breakdowns and emergencies have to be specified and should be carried out in specific circumstances when normal conditions change i.e. when flows, pressures and levels and operation of pumps change.

Measurement Of Flows, Pressures And Levels

It will be necessary to monitor regularly operational data concerning flows, pressures and levels to assess whether the system is functioning as per requirements. Analysis of data may reveal overdrawal of water to some reservoirs and or bulk consumers. At such places appropriate flow control devices may be introduced to limit the supplies to the required quantity. A list of priority points in water supply system have to be identified such as installation of meters to measure flows, pressures and levels. A detailed map showing location for each measuring point has also to be prepared. The degree of sophistication of the devices used at each measuring point with regard to indication, integration, recording, transmission and reception of data depends mainly on the skills of the O&M personnel available with the agency and affordability of the agency.

Evaluation Of Hydraulic Conditions

A continuous evaluation of the hydraulic conditions of the water supply system can be done by the O&M personnel after obtaining the data on water volumes and flows at various points in the system, the water pressures and levels in the reservoirs and comparing with expected performance. This evaluation shall lead to identification of operational problems and or system faults. Depending on the type of problems actions have to be initiated to ensure that the system functions as per the requirement.

Systems Pressures

Maintenance of a continuous positive pressure at all times (during supply timings) to consumers is the main concern of O&M. Negative pressures can cause contamination of water supplies especially in intermittent supplies. Very high pressures may damage the pipelines and valves, which can be corrected with pressure reducing valves. Complaints from consumers about low pressures have to be promptly investigated if necessary by measuring pressures with pressure gauges. Low pressures may be under the following circumstances:

- Purposefully or accidentally a line valve is left closed or partly closed or blockage due to any material causing loss of pressure.
- Too high velocities in small pipelines.
- Low water levels in SR.
- Failure of pumps/booster pumps (either due to power failure or mechanical failure) feeding the system directly.

Simulation Of Network

Operations have to be planned for specific circumstances such as failure at source, failure of pumps, leakages or bursts or sudden changes in demand etc. Criteria have to be determined on the basis of analysis of the effects of particular operations on the hydraulic configuration of the water supply system. These effects can be seen in simulated operating conditions.

Mathematical simulation models can be developed from basic data on the network such as length, size, flow, characteristics of pumps, valves, reservoir levels etc. This approach can be very useful for analysing the effects of variables on large and complex distribution networks water supply systems.

Sampling for Water Quality

The agency operating the water supply system is charged with the primary responsibility of ensuring that the water supplied to the consumer is of an appropriate quality. To achieve this objective it is necessary that the physical, chemical and bacteriological tests are carried out at frequent intervals. The minimum number of samples to be collected from the distribution system should be as prescribed in the Table 15.1 of Chapter 15 of the Manual on "Water Supply & Treatment". Samples should be taken at different points on each occasion to enable overall assessment. In the event of epidemic or danger of pollution more frequent sampling may be required, especially for bacteriological quality. For each distribution system a monitoring programme has to be prepared showing the location of sampling points. Based on historic records of a system it will be possible for the manager of the system to decide locations for bacteriological sampling and residual chlorine testing.
Possible water quality problems and causes and remedies are given in Table 30.

Table 36: Water Quality Problems, Causes and Remedies

S. No.	Taste and Odour	Possible Cause	Suggested Remedies
	Taste and Odour	High Chlorine Residual	Lower Chlorine Dossage
		Bacteriological growth or micro-organism in dead ends of resevoiur	Chlorinate, flush mains and clean the reservoir
	Turbidty	Silt or clay suspension	Flushing or proper operation of WTP
		Micro-organsims	Same as above
		Floc carry over	Same as above
	Colour	Decay of vegetable matter	Chlorination
		Microscopic organisms	Chlorination
	Positive Coliform results	Contamination in the distribution systems	Locate and remove source of contamination
		Cross Connection	Install backflow prevention such as double reflex valves
		Negative Pressure	Maintain positive pressure after disinfection
		Improper disinfection	Improve disinfection process

Management In Times Of Water Shortage

The objective of developing a programme for managing in times of shortage of water is to reduce the excessive use of water particularly when the source is limited due to adverse seasonal conditions. Basically it involves that a water conservation policy is developed and implemented among water consumers. The following activities can be considered while formulating such a water management project:

- Installation of accurate water meters and establishment of a realistic tariff structure to encourage water conservation and prevent wastage of water.
- Introduction of restrictions on use of flushing, showers and other household fittings.
- Introduction of devices to limit water consumption in flushing of toilets.
- Enforcement of restrictions on use of treated water for watering lawns, cooling, construction, washing of vehicles etc.
- Encouragement and/or enforcement of the reuse of treated industrial effluents and municipal wastewater.
- Development and implementation of public education programmes to encourage water conservation.

Surveillance Systems

Surveillance of distribution system is done to detect and correct.

- Sanitary hazards.
- Deterioration of distribution system facilities, [to detect].
- Encroachment of distribution system facilities by other utilities such as sewer and storm water lines, power cables, telecom cables etc. and
- Damages of the system facilities by vandalism. [detecting and correcting].

In addition, checks are carried out under special circumstances for assessing damage of the system after flooding of streets following a heavy storm. All these checks are done for above ground water facilities such as valves and valve chambers or exposed pipelines. Some less frequent inspection of underground pipelines will also be required, wherein critical areas of the distribution system should be patrolled routinely so that the water utility can watch out for early warning of any adverse conditions of the distribution system. Any activity or situation that might endanger the water facility or water quality shall be investigated and corrective action is to be taken. Surveillance shall also include looking for unauthorised construction activity on or near the utility's pipelines, which may pose a physical threat to the mains. Any digging or excavation or blasting near the mains shall be closely supervised by the utility staff.

Maintenance Schedule

A maintenance schedule is required to be prepared to improve the level of maintenance of water distribution networks and house connections through improved co-ordination and planning of administrative and field work and through the use of adequate techniques, equipment and materials for field maintenance.

- The schedule has to be flexible so that it can achieve team action with the available vehicles and tools.
- Co-ordination of activities is required for spares and fittings, quality control of materials used and services rendered.
- Training of maintenance staff shall include training to achieve better public relations with consumers apart from the technical skills.

Activities In Maintenance Schedule

Following activities are to be included in the schedule:

- Establishment of procedures for setting up maintenance schedules and obtaining and processing the information provided by the public and the maintenance teams.
- Formation of maintenance teams for each type of service with provision for continuous training.
- Establishment of repair procedures for standard services.
- Specification of appropriate tools.
- Allocation of suitable transport, tools and equipment to each team.
- Establishment of time, labour and material requirement and output expected; time required and other standards for each maintenance task, and
- Monitoring the productivity of each team.

Preventive Maintenance Schedule

A preventive maintenance schedule for Servicing of Valves and Maintenance of Valve Chambers, Maintenance of the pipelines: may include the tasks, set priorities, issue of work orders for tasks to be performed, list of scheduled tasks not completed, record of when the tasks are completed and maintaining a record of tools, materials, labour and costs required to complete each task.

Servicing Valves

Seating of valves which are subject to operations several times is likely to become leaky or pass the flow downstream even after closing tight. Periodical servicing will be required for valves on hydrants and public taps, flow meters and pressure gauges. Corrosion of valves is a main problem in some areas and can cause failure of bonnet and gland bolts. Leaks from spindle rods occur and bonnet separates from the body. Stainless steel bolts can be used for replacement and the valve can be wrapped in polyethylene wrap to prevent corrosion.

Manufacturers Catalogues

The manufacturer's catalogues may be referred and comprehensive servicing procedures shall be prepared for periodical servicing. These procedures shall contain manufacturer's name, address, telephone number etc. and also the technical information furnished by the manufacturer of the equipment used in the distribution system such as sluice valves, Butterfly (BF) valves, air valves, pressure gauges, flow meters, etc. The test certificates inspection reports and warranty certificates of this equipment shall also be kept along with the manual.

List of Spares

A list of spares required for the distribution system shall be prepared and the spares shall be procured and kept for use. The list should indicate the minimum level at which action for replenishments should be initiated. The list of probable spares to be kept in stock may include the following:

Spare check nuts and spindle rods and assorted bolts, nuts and washers for the flanged joints, gaskets for flanged joints for all sizes of sluice valves installed in the distribution system, spare manhole covers and consumables like the gland rope, grease, cotton waste, spun yarn, pig lead and lead wool.

List of Tools

The necessary tools to properly repair and correct both the routine problems and for facilitating repairs and replacements in a distribution system have to be identified and provided to the maintenance staff. Some of the tools for the maintenance work in a distribution system are: Key rods for operation of all sluice valves, hooks for lifting manhole covers, pipe wrench of appropriate sizes (200, 300 or 450 mm), Double ended (DE) spanner set, Ring spanner set, Screw Drivers, Pliers, Hammers, Chisels, caulking tools for lead and spun yarn, ladles and pans for melting and pouring lead joints, excavation tools such as crow bars, spades, iron baskets, buckets and de-watering pumps.

Maintenance of Valve Chambers for Appurtenances

Valve chambers shall be checked to ensure that they are not damaged, nor filled up with earth nor buried in pavement. Covers of valve chambers are stolen or broken up by vandalism or by accident resulting in damage to the valves or may lead to accidental fall of a person into the open valve chamber. Such situations have to be corrected on priority. Road improvement works require constant attention of water utility staff since the valves may be lost or at times the valve chambers in the roads have to be reconstructed to match the renewed road surface.

Maintenance Schedule For Pipes

Main Breaks

Pipeline bursts/main breaks can occur at any time and the utility shall have a plan for attending to such events. This plan must be written down, disseminated to all concerned and the agency must always be in readiness to implement the plan immediately after the pipe break is reported. After a pipe break is located, a decision is to be taken as to which valve is to be closed to isolate the section where the break has occurred. Every consumer (some important consumers may be having an industrial process dependent on water supply which cannot be shut down as fast as the water supply lines are cut off) should be notified about the break and informed about the probable interruption in water supply and also the estimated time of resumption of water supply. After the closure of valve, the dewatering/mud pumps are used to drain the pipe break points. The sides of trenches have to be properly protected before the workers enter the pit.

The damaged pipe is removed, and the accumulated silt is removed from inside the pipe and the damaged pipe is replaced and the line is disinfected before bringing into use. After every pipe break a report shall be prepared in regard to the cause of such break, the resources required for rectification and the time and cost required for repairing etc. so that the agency can follow up with measures for avoiding such breaks and also modify their plan to address such breaks in future.

Pipe Deterioration

Pipes deteriorate on the inside due to corrosion and erosion and on the outside due to corrosion from aggressive soil and water/moisture. Depending on the material of pipes, these are subjected to some deterioration, loss of water carrying capacity, leaks, corrosion and pitting, tuberculation, deposition of sediment and slime growth. Preventive maintenance of distribution system assures the twin objectives of preserving the bacteriological quality of water in the distribution system and providing conditions for adequate flow through the pipelines. Incidentally, this will prolong the effective life of the pipeline and restore its carrying capacity. Some of the main functions in the management of preventive maintenance of pipelines are assessment, detection and prevention of wastage of water from pipelines through leaks, maintaining the capacity of pipelines, cleaning of pipelines and relining. The topic of assessment of leaks is dealt in detail in Chapter 15 on Water Audit and Leakage Control in this manual.

Flushing of Pipelines

Flushing is done to clean the distribution lines by removing impurities or sediment that may be present in the pipe. Routine flushing of terminal pipelines is often necessary to avoid taste and odour complaints from consumers. It is advisable that a programme for flushing is prepared and followed so that water mains are flushed before consumers start complaining.

The routine for flushing can be prepared by taking into consideration the consumer complaints and type of deposits found while cleaning. Since in distribution system flushing is not the only solution for water quality problems, proper operation of treatment process and cleaning of service reservoirs supplying water to distribution system shall also be planned along with the flushing of distribution system. Flushing is usually done during low water demand, when the weather is favourable. Prior planning and good publicity with public will allow the flushing to proceed quickly and without confusion.

Cleaning of Pipelines

Mechanical cleaning devices such as swabs and pigs are some times used if flushing does not improve the water quality. Scrapers or brushes are used in pipelines with hardened scales or extensive tuberculation. Sometimes scrapers and brushes are used before taking up lining works. The topics of cleaning of pipelines including cleaning and swabbing are dealt in Chapter 10 of Manual on “Water Supply & Treatment”.

Cement Mortar Lining

The present trend is to use Cement Mortar lined Ductile Iron (DI) pipes or Mild Steel (MS) pipes so that they will not lose their carrying capacity with use and age. Still many new pipelines are proposed with unlined metallic pipes and there are several existing pipelines with bare metal surface such as CI or MS. With passage of time these pipelines deteriorate and require rehabilitation. Cement mortar stifles corrosion through its ability to develop high alkalinity. The application of cement mortar lining to pipe in place is done by a lining machine, containing a device that projects cement mortar against the pipe wall. Directly behind this device are mechanically driven rotating trowels, which give the surface smooth finish. In-situ Cement Mortar lining of existing metallic water mains has been beneficial where:

- Pipe carrying capacity may reduce due to tuberculation.
- Water quality is affected due to release of corrosion products from the pipes to the water, and
- Leaks occur through joints and pipe walls.

Leakage Control

Wastage of water in the system and distribution network occurs by way of leakage from pipes, joints & fittings, reservoirs and overflow from reservoirs & sumps. The objective of leakage control programme is to reduce the wastage to a minimum and minimize the time that elapses between the occurrence of a leak and its repair. The volume of water lost through each leak should be reduced by taking whatever action is technically and economically feasible to ensure that the leak is repaired as quickly as possible. To achieve this, the organisation shall prescribe procedures for identifying, reporting, repairing and accounting for all visible leaks. It will be beneficial for the agency if the procedures involve the conscious and active participation of the population served by the agency apart from its own staff. For details on detection and leakage control, please refer chapter 13.0. Water Audit and Leakage Control. The Management has to process the data and evaluate the work on detection and location of leaks and for dissemination of the results and initiate actions to control the overall problem of water loss. Interim measures for reduction/control of leakage can be initiated by controlling pressures in the water distribution system where feasible.

Leakage Through House Connections

Leakage can be controlled at the point of house connection and in the consumer pipe by adopting correct plumbing practices and improving the methods used for tapping the main and giving house connection and strict quality control on the pipe material used for house connection. An analysis of leaks in house connections and investigation of reasons for leaks in the house connections shall be carried out to initiate action on reducing the leakage through house connections.

Procedures for Reporting Visible Leaks

The water utility has to establish procedures whereby the population served by the agency can notify the visible leaks. The agency staff can also report visible leaks found by them while carrying out other works on the water supply system. Utility has to establish procedures for prompt repair of leaks and for attending efficiently and accurately to the leaks. Critical areas where leaks often occur have to be identified and appropriate corrective measures have to be implemented.

Procedures for Detecting Visible Leaks

Establishment of procedures for detecting and locating non-visible leaks shall be compatible with the technological, operational and financial capability of the agency. Selection and procurement of equipment for detection and location of leaks must take into account the cost effectiveness and the financial capability of the Organization.

Cross Connections

Contaminated water through cross connections of water supply lines with sewers and drains is a problem prevailing widely. Intermittent supply further aggravates the problem since, during non-supply hours polluted water may reach the supply mains through leaking joints, thus polluting the supplies. In certain instances, when there are extremely high water demands, the pressures in the supply mains are likely to fall below atmospheric pressure, particularly when consumers start use of pumps with direct suction from supply mains.

Regular survey has to be undertaken to identify potential areas likely to be affected by cross connections and back-flow. All field personnel should be constantly alert for situations where cross connections are likely to exist. After identifying the cross connections, remedial measures are taken up which include: providing horizontal and vertical separation between the water main and the sewer/drain, , providing a sleeve pipe to the consumer pipes crossing a drain, modifying the piping including changing corroded piping with non-corrodible piping, providing double check/non return valves at the consumer end etc.

Chlorine Residual Testing

A minimum chlorine residual of about 0.2 mg/l at the selected monitoring point is often maintained to ensure that even a little contamination is destroyed by the chlorine. Hence, absence of residual chlorine could indicate potential presence of heavy contamination. If routine checks at a monitoring point are carried out, required chlorine residuals and any sudden absence of residual chlorine should alert the operating staff to take up prompt investigation. Immediate steps to be taken are:

- Re-testing for residual chlorine.
- Checking chlorination equipment.
- Searching for source of contamination, which has caused the increased chlorine demand.
- Immediate stoppage of supplies from the contaminated pipelines.

Monitoring System Performance

Normally the managers of O&M of water utilities monitor levels in service reservoirs, pressures and flows in the distribution system and operation of pumps such as hours of pumping, failure of pumps and monitor water quality by measuring residual chlorine. The manager usually uses telephone line or wireless unit to gather the data, maintain records analyses, uses his discretion gained with experience and takes decisions to ensure that the system is operating with required efficiency. Manual collection of data and analysis may not be helpful in large undertakings if water utilities have to aim at enhanced customer service by improving water quality and service level with reduced costs. In such cases Monitoring system performance can be done with use of Telemetry and SCADA.

Plumbing Practices

The internal plumbing system of the consumer shall conform to the National Building Code and also particularly to the bye laws of concerned water utility/local authority.

Quality of Pipe Materials In House Connections

The water utility shall ensure that the connection and communication pipe from the street main up to the consumer premises is laid as per correct plumbing practices and adopt improved methods for tapping the main. Strict quality control is required on the pipe material used for house connection. The bye Laws shall lay down rules for defining the ownership and responsibility for maintaining the point of connection and the communication pipe. In several utilities the communication pipes are leaking since they are corroded; however these are not replaced by the consumer or by the utility particularly where the O&M responsibility for consumer pipe rests with the consumers.

Contamination Through House Connection

While laying the consumer connection pipes there is a need to avoid contamination of water supplies. This can be achieved by maintaining horizontal and vertical separation between the water supply communication pipe and the sewer/drain. In some instances a sleeve pipe may be required to be provided to the consumer pipes crossing a drain. It is always recommended to provide a non-corrodible pipe material for the consumer connection. Contamination by possible back flow can also be prevented by ensuring provision of double check/non-return valves at the consumer end.

Rules for Consumer Connection

The water utility shall formulate rules for sanction of consumer connection, tapping the mains and laying the connection piping. Water utility shall undertake inspection of the consumer premises before releasing the connection to ensure that the internal plumbing system of the consumer conforms to the National Building Code. Water utility shall supervise the process of drilling/tapping of the main for giving connection and laying of the consumer piping. The process of submission of applications for connections by consumers and carrying out the connection work through licensed plumbers is also prevalent in some utilities. In such cases the utility shall formulate procedures for licensing the plumbers including the qualifications to be possessed by the plumber, facilities and tools to be available with the plumber for the work to be undertaken by the plumber. The utility shall closely observe the quality of materials used and works done by him and he should act as per procedures laid down in the bye laws for approval of the connection works, renewal or cancellation of the plumbers’ licenses or any other requirement depending on their performance or nonperformance.

Records and Reports

Record System

A record system has to be developed which should be realistic and apply to the operating problems involved in the distribution system. Management must be clear as to why the data/information is collected, as to who will review the data and who will respond to the results of review. The most efficient way to keep records is to plan what data is essential and then prepare the formats followed by the persons concerned for filling of the data, frequency and to whom the record is to be sent for review and report.

Sample records to be maintained are given below for guidance:

- Updated system map.
- Pressure and flow readings at selected monitoring points.
- Persistent low pressure or negative pressure areas.
- Age of pipes/quality of pipes.
- Pipelines to be replaced.
- Presence of corrosive water in the system.
- Water budget for each zone served by one SR.
- Number of connections given
- Number of meters out of order.
- Status of fire hydrants and public taps.
- Quantity measured at outlet of reservoir.
- Quantity distributed/measured or billed.
- Source of leaks and persistent leak points.
- Status of bulk meters - function or not.
- Status of consumer meters.
- Facilities for repairs of consumer meters.
- Number of unauthorized connections.
- Residual chlorine levels at the pre-selected monitoring points.
- Bacteriological quality of the water sampling points.
- Persistent areas where residual chlorine is absent/where bacteriological samples are unwholesome.
- Record on carrying out repairs on the following works and its cost:
    - The pipe line leaks or replacement of pipes.
    - Change of gland ropes of the valves in distribution system.
    - Replacement of parts.
    - Replacement of manhole covers.
- Record on man hours spent on routine operations in the distribution system in the previous year and the cost thereof.
- Record on total cost of repairs and replacements in previous year along with breakup of material cost and labour cost with amount spent on outside agencies for repairs and replacements.
- Record on when the exposed piping was last painted and the cost of materials and labour cost thereof.
- Record on the unserved areas - extension of pipelines- need for interconnections.

Reports

With the accumulation of all essential data a report can be prepared evaluating the O&M of the facility. The report can identify the deficiencies in the system and its appurtenances and then plan future repairs to the network or valves and other equipment or for replacement of defective valves or other equipment or additions and extensions to the distribution network.

Checks to be Carried out in Distribution Systems

Program for Carrying out Checks

A programme has to be prepared for each zone of the distribution system which shall contain procedures for routine tasks, checks and inspections at intervals viz. daily, weekly, quarterly semi-annually or annually. This plan shall fix responsibility, timing for action, ways and means of completing the action as to when and who should take the action and mention the need to take these actions. Simple checklists for use by the managerial staff can be prepared to ensure that the O&M staff has completed the tasks assigned to them.

Table 37: Check List for the operation and maintenance of valves

S/No	Checks required/Undertaken	Status	Suggested Frequency of Reporting
1	Check whether operation of valves is smooth without any abrupt stoppage during closure		
2	Check whether closure of the valves results in complete stoppage of flow of any or if any flow passes the valve (passing valve)		
3	Check for Status of scouring and then proper closure of washout valves		
4	Check for leaks through pipes		
5	Check for leakage through valves at gland, bolts or any other place		
6	Check for leaks at appurtenances		
7	Check for any signs of corrosion in the pipelines		
8	Check for the status of Manhole covers over the chambers: Are they corroded?		
9	Insect for any possibilities of pollution of the distribution system of water stored		
10	Status of outfall drain for scour and overflow		
11	Assess the need for painting of the pipework		
12	Check the availability of spares for valves and pipes and jointing materials		
13	Review the method of giving consumer connections in the field		
14	Preparation of water budget for each zone served by one reservoir		
15	Number of connections given		
16	Number of Meters out of order		
17	Status of Hydrants and PSPs		
18	Status of Distribution System		
19	Review of pressures		
20	Review of flows		
21	Age of Pipes/C-values		
22	Corrosive water		
23	Study inflows and outflows		
24	Status of bulk metering and consumer meters		
25	Unauthorized connections if any		
26	Availability of updated system map		
27	Need for any connection		
28	Identify source of leakage		
29	Metering		

It is one of the most important responsibilities of a Water Undertaking to properly maintain the transmission and distribution mains in order to prevent waste and provide a constant pressurized flow of potable water to the consumers. It is equally important to prevent damage to the public property which could arise for not properly repairing a defective pipe. Proper planning and implementation of remedial measures will avoid leakages and breakdowns.

Causes of Failure in Pipeline

For proper planning for the operation of the repair work it is necessary to assess the probable causes of failure. Following guidelines outline some of the factors to be duly considered to ensure protection of pipes from damage/failure.

Handling and Storage of Pipes

1. Damage during transport of the piping material.
2. Defective stacking and storage.
3. Damage to the pipe wall and coating.
4. Cracks in pipe during careless unloading and pipes striking against each other.
5. Weathering effect due to unfavorable environment.
6. Mixing up of different classes of pipes and their jointing materials.

Laying of Pipeline

1. Deviation from proper laying procedures.
2. Improper bedding
3. Loss of support of bedding after laying.
4. Slipping of trench sides.
5. Sinking of soil after laying.
6. Poor quality of backfill material.
7. Improper compaction of trench backfill and its subsequent settling.
8. Excessive overburden on piping trenches, not taken care of during the design of pipeline.
9. Point loads coming on the pipe through the backfill.
10. Excessive vibrations due to traffic during the laying of pipeline.

Jointing of Pipes

1. Defective jointing material.
2. Direct strike on the body of the pipe with any sharp edge, while jointing.
3. Slipping of jointing material like rubber ring or lead etc.

Characteristics of Soil

1. Corrosive nature of soil causing damage to the external surface of the pipe.
2. Extremes of climate: frost heave or clay shrinkage.
3. Loss of support or anchorage (horizontal or vertical), both in case of pipes embedded and those laid above ground level.
4. Movement of soil due to filled soil, mining.

5. Movement of soil while work of laying pipes or other activities like laying of cables etc. is taken up. Changes in soil moisture or water table conditions.

Excessive Temperature Changes

1. Expansion: severe compression, end crushing.
2. Contraction: pull out or separation of joint.
3. Freezing: pipe blockages and splits.

Internal Pressure

1. Excessive test pressure.
2. Pressure surge, water separation, vacuum.
3. Extending pipe connections without proper precautions.

Aggressive Soil

Damage to the internal surface of pipe as well the lining material.

Galvanic Action

Special observation on failure of Pipes

Pipe Barrel

Certain failures connected with the deterioration of the barrels of pipe are given below.

Brittle-Type fractures

These may be found in rigid and semi-rigid materials such as cast iron, asbestos cement and PVC. These are characterized by relatively clean, sharp-edged splits or cracks. These may occur as circumferential breaks or longitudinal cracks which may run straight but more often irregularly curved along the pipe barrel.

Ductile -Type fractures

These occur in polyethylene and ductile iron. These are usually found as relatively short splits or tears with irregular edges which are often associated with some local swelling around the break.

Blow Outs

These are localized failures which only occasionally occur and are usually associated with high pressure, e.g. pumping surges in weakened brittle materials.

Pinholes

These may be caused by an impurity or inclusion in the wall of the pipe wall or, more often, by localized chemically or electrically induced corrosion which thins and weakens the pipe wall until a small plug is blown out by internal pressure. Pinholes often enlarge quite quickly due to erosion around the edges of the hole. Pin holes are frequently found within the metallic group of pipes.

Generalized deterioration

More generalized deterioration of pipe barrel may be due to a manufacturing defects but is usually the result of some form of chemical attack. The overall effect is reduction in wall strength depending on the material group. Some of the examples are the graphitization of iron mains, sulphate attacks on AC and concrete, lime leaching from cement lining by soft waters and solvent attacks on the polymeric group of materials leading to softening or delamination of composites such as GRP.

Failure at Pipe Joints

Some of the points for consideration are given below:

General

1. Failures may occur due to originally careless installation practices causing displacements of the seal and/or eventual separation of the mating surfaces.
2. Stress cracking of pipe material around the joint.
3. Biodegradation of the sealing components.

Flanged Connection

Stress cracking of the flange can occur due to unequally tightened bolts. Such a situation arises during ground movement or the forceful activation of a valve or hydrant.

Crushing of Pipe ends

Cracking may occur due to crushing of pipe ends when they touch or bind and are then subjected to high compressional or bending forces.

Lead Joints

Hardening of lead in association with joint movement may lead to ‘weeping’ which gradually develops into a more serious leak.

Sealing rings or gaskets

Many mechanical joint designs rely upon the compression of sealing rings or gaskets which have varying compositions and different resiliences. The physical breakdown (e.g. biodegradation) or change of resilience with time can lead to leaking joints. The loss of compression combined with corrosion of pressure rings or collars or the bolts may aggravate the breakdown.

Repair Action Plan

General Procedure

Following procedure may be followed:

1. Internal mobilization.
2. Detection of pipe failure: Inspection of site
3. Notification of interruption in water supply and related issues.
4. Location and demarcation
5. Repair planning
6. Repair work: Selection of most appropriate method for repair.
7. Testing of ‘dry’ repair.
8. Restoration
9. Completion
10. Hygiene
11. Notice of restoration and completion

Implementation Of Action Plan

Some of the important activities relating to the mobilization of the internal activities are summarized below;

a) Senior Level Management

Necessary information to the Senior Level Management may be submitted and their interim approval sought. Details approval can follow in due course of time.

b) Operation and maintenance staff of the running water supply system

The entire staff must be made fully aware of the likely activities required to be undertaken so as to ensure minimum possible interruption in the system.

c) Alternative arrangement

Alternative arrangement for water supply may be planned and duties of staff fixed accordingly.

d) Existing installations

The operation of the water supply system with regard to Intake, Headworks, Pumping machinery, Treatment Plant, Piping system etc. must be co-related with the proposed repair work.

(e) Mobilization of men

Necessary staff may be arranged for the following duties;

1. Location of section;
2. Isolation of section;
3. Scouring of section;
4. Arranging transport, material, machinery, equipment, tools, pipes, fittings etc.
5. Other miscellaneous duties.

(f) Manpower, material, machinery, transport, lighting, safety measures, communication, pipes with fittings and specials etc. for the repairing operation.

These details are variable and depend upon various factors as per the local situation. Some of the factors to be considered are;

i. The importance, utility and function of the affected pipeline with the piping network.
   This may be the only transmission main of the system. It may be one of the two or many parallel transmission mains. It may be initial portion of the distribution system serving as the only main to supply water to the rest of the area to be served. It may be a distribution pipe serving only a part of the system.
ii. Size and material of the affected pipe.
   These are very important factors which determine the magnitude of the repair to be undertaken.
iii. Depth of the pipeline. Deeper pipes require more labour work for repairing.
iv. Subsoil water table.
   If the pipe is laid much below the local water table, additional work will be required to dewater the trenches excavated for repair.
v. Other unforeseen factors.
   Depending on these factors the requirement of manpower, material, machinery, tools, equipments, pipes, specials, fittings etc. is to be worked out. Given below is a list to meet the requirement of a big transmission main which is a life for the water supply system. This may be considered as a guideline only. Exact requirement may be worked out depending upon the local conditions.

Man Power

Designation	Manager	Supervisor	Fitters	Welders	Crane Operator	Excavator Operator	Truck Operator	Jeep Operator
Number	1	1	3	3	1	1	1	1

Designation	Emergency Van Operator	Electrician	Mechanic	Helper	Semi-Skilled	Pump Operator
Number	1	1	1	1	8	1

Electrodes, Gaskets, Rubber insertion, Bolts and nuts, Gland rope, Manila rope, Pig lead, Cotton waste, Wooden sleepers, PVC hose pipe, Canvas hose, Engine oil, Wire slings, Grease, M.S. Plates, Diesel, Kerosene, Fire wood, Cement, Sand, Spun yarn, Hard crete, M seal, Sand bags.

Machinery

Machinery	Crane Mobile	Excavator	Pump set (Electric)	Portable Diesel Pumpset	25KVA Generator	Welding Generator	Lighting Generator
Number	1	1	2	2	1	1	1

Machinery	Welding set	Mud pump	Gas Cutting set	Pressure grouting machine	Flexible grinder	Hand drilling
Number	2	2	2	1	1	1

Transport

Vehicle	Truck	Jeep	Emergency break-down van
Number	1	1	1

Tools

Scour rod with lever, motor driven pipe cutter with extra cutters, H.T.wire cutter, sheet cutter, screw jacks, hammers, spades, buckets, baskets, crow bars, hammers, showels, caulking tools (spun caulking, cement caulking, lead caulking), power wrenches 36 in. to 15 in., adjustable spanner 18 in. to 12 in., chain tong 36 in. long, ring spanner set, DE spanner set, screw drivers, cutting plier, knife, nose plier, knife, chisels, lead pan with sport and bucket, Temporary platforms, files, bench vice and pipe vice.

Pipe Spacials

MS gap special, MS barrels, MS split collars (different types available), ms girder, ms angle.

Communication

Wireless set, mobile wireless set, cell phone, pager.

Light

Flood lighting, tube light fittings, wire, 3 core cable, insulation tape, main switch, fuse wire, kit kats, welding cable, emergency lights, torch lights, gas lights.

Lighting
First aid box, helmets, headlight, gum shoes, hand gloves (rubber, leather), gas masks, oxygen cylinder.

Safety Equipment
First aid box, helmets, headlight, gum shoes, hand gloves (rubber, leather), gas masks, oxygen cylinder.

Amenities
Tents, water cans, jugs and glasses, tarpaulins, electric heaters, rain coats, food (tea and snacks, meals)

Detection of Pipe Failures
1. Inspect site and ascertain the nature of the failure.
2. Assess any possible damage or dispute that may arise and take steps to face such situations.
3. Investigate the access to the site so as to plan the arrangement of plant and equipment.
4. Assess urgency of repair, availability of men and equipment, effect on consumers and fix time and day of repair.
5. Locate isolating valves for proper control of requisite activities required for repair work.
6. Depending upon the seriousness of the leakage or burst, the likely effect on the local supplies, decision may be taken on:
   i. maintenance of supplies as long as possible
   ii. prevention of possible contamination of the pipeline and
   iii. quick location of the actual position of the pipeline.
7. Establish control and communication network after deciding the time of repair work to be undertaken.
8. Ascertain the sensitivity of the affected area and take steps to avoid undesirable situations.
9. Issue notification and warnings of the likely interruptions.
10. Mobilise men, material and equipment for repairs.

Notification
Issue notices to the affected consumers and the departments looking after other affected facilities like telephones, cables, electric lines etc. Such notifications may be by mobile loud speakers, hand bills, telephones, local media channels etc.
The contents of the notification will be as under:
- Time of closure and affected area;
- A brief and simple reason for interruption;
- An estimated time of restoration of supplies;
- Contact point for any problems;
- Advice on conservation, flushing, boiling, etc.

Location and Extent of Failure
a) Location of the failure
Make use of local knowledge, plan, and experience in locating the failure. Depending on the local conditions, if need be, leak detectors may be used.

b) Protective signs
Before undertaking any excavation work, all protective measures may be taken including signs, lighting etc. Traffic rules must be complied with. All local utilities must be located and marked and liaison kept with local representatives of these affected utilities.

c) Excavation

The conventional methods of excavation may be supplemented with more mechanized processes keeping in view the existence and location of the water main.

d) Shuttering and support

Pay due attention to safety below ground by providing support to trench sides and any exposed pipes and cables.

e) Extent of failure

The full extent of damage, both to pipe work and any support works, should be assessed.

f) Work space

Ample workspace should be created to allow for:

i. detailed inspection around the pipe.
ii. provision of sump for continuous operation of a drainage pump
iii. movement of men with jointing material and equipment to be used safely and effectively.

g) Provide safe dewatering system and discharge points

The discharge of any dewatering apparatus should be checked to ensure free outflow and to avoid any danger or inconvenience caused by flooding.

h) Control by Valves

Ensure effective operation of repair work by proper control of valves which should be in perfect working condition.

Repair Planning

a) Note details of existing pipe

The full details of the failed pipe and/or fitting should be noted including material type, approximate age, class and general condition. Reasons for failure should be established as accurately as possible and recorded. Check actual external dimensions of the pipe and determine any tendency to ovality for effective repair.

b) Type of repair–wet or dry

A 'wet' repair is defined as a repair which can be achieved while maintaining a nominal pressure in the pipeline. Split collars or identical fittings can be installed in this way if the conditions are favourable. A 'dry' repair is defined as one in which the main is completely isolated and drained out. 'Cut out 'repairs necessitating the removal of a section of the pipe and/or joints will require 'dry' main on which to work and the pipeline should be drained out.

c) Extent of repair work and availability of repair fittings and tool

The replacement pipe and/or repair fittings should be selected and their dimensions marked on the pipeline. For a 'dry' repair a final check should be made that all the required fittings and materials are available and are compatible before any attempt to cut the same is made.

d) Bedding material

Assess and make available the bedding material if required.

e) Report to Control

When ready to start repair, inform 'control'.

Repair Work

a) Repair of small, local defects - 'wet repair'

For small local defects such as pinholes a single split collar or wraparound clamp may be all that is required. The repair can be carried out at as a 'wet' or 'dry' operation. In case of 'wet' repair care should be taken to maintain a steady, gentle flow so as not to dislodge the sealing elements.

b) Cut out – 'dry repair'

For a more extensive damage e.g. a longitudinal fracture, a section of pipe is cut out and replaced by the use of two appropriate couplers. If full extent of the fracture is not clearly defined cuts should be made at least 300mm beyond each end of the visible crack or defect and in case of any doubt the full length of damaged pipe should be replaced. This necessitates cutting out the joint at both ends of the affected pipe, thus the repair normally requires two replacement pipe sections and three couplers.

c) Replacement repairs- following observations are important

- Carryout correct measurements and give allowance for expansion;
- All cuts should be made clean and square;
- In A.C. pipes, cuttings should be avoided;
- All cut edges should be prepared (scraped, deburred, chamfered etc.) to the manufacturer's recommendations.
- Both exposed ends of the existing pipe should be similarly treated;
- Couplers should have their sealing rings lubricated if recommended;
- Correct expansion gaps should be allowed;
- Good alignment is essential particularly if narrow couplers are used;
- All couplers and collars should be centralized;
- Tighten all bolts evenly;
- Do not over tighten bolts or compression joints;
- Restore any damaged coatings on the parent pipe;
- Ensure full protection to the bolts and any exposed bare metal before burial.

d) Record of repair

While the repair is still visible the details of repair should be recorded.

e) Record of pipe

Record the following items:

i. any visible damage to the pipe;
ii. state of protective system or coating;
iii. depth of cover
iv. description of the soil/backfill.

Testing of “Dry” Repairs

a) Give additional support to repaired pipe portion, if necessary;

All wet slurry should be removed to the extent possible, and the bottom of the excavation should be filled and the exposed pipe work rebidded, with suitable material sufficiently compacted to give adequate support to the invert and lower quadrants of the pipe and any fittings.

b) Renew bedding and compact

Additional material may be placed to support the repaired pipeline when under test pressure, but it is advisable to leave all joints visible in case of leakage.

c) Arrange air bleeding and slowly refill isolated section

Refilling the isolated section of the main with water should be done slowly and from one direction only. Arrangements should be made for the expulsion of the air by means of any convenient air valves, hydrants, washouts or taps. The repaired pipe is subjected to a pressure equivalent to the normal working pressure. The repaired pipe should remain under such working pressure until it is adjudged to be satisfactory. Some minor re-tightening of the joints may be necessary due to slight expansive movement of the assembly on being subjected to increase in pressure.

d) *Control –* Report situation to ‘Control’.

Restoration

a) *Restore valves and the system in accordance with the original operational plan*

The repaired section of main is reintroduced to the system by restoring all valves to their original status.

b) Checking restoration

The restoration of the supplies to the normal situation supplied at important points should be checked.

c) Removal of temporary supplies

All standby pipes, temporary supplies and emergency tankers should be removed.

d) Notification

Notification and acknowledgments should be made wherever necessary.

Hygiene

During the execution of the repair work hygienic conditions must be made to prevail at various stages till the completion of work.

a) Site cleanliness

During the repair work the area should be kept as clean as possible. All debris and contaminants should be removed from the site and the contamination of the trench from plant, equipment or any other potentially hazardous materials must be avoided.

b) Storage of tools and equipment

All pipes, fittings, tools, equipment and vehicles to be used on site should be regularly maintained and cleaned.

Equipment used for disinfection and sampling should be kept for this purpose and regularly maintained.

c) Prevention of contamination during repair work

Clean and spray with disinfectant, on all surfaces that come into contact with potable water including the broken main, repair fittings and replacement pipe. Ensure that the contaminants do not enter the main where it is cut for repair.

After completing the repair, flush the main at the nearest hydrant to remove any dirt etc.

d) Disinfection procedure

For small repairs which do not require the main to be cut, the fracture should be cleaned and this along with the repair collar should be sprayed with disinfectant. For more major repairs requiring cut out, every care must be taken to prevent contamination.

Completion

a) Finishing touches

Wherever joints have been left exposed for testing purposes these should be restored to their original position. The bolts, bare metal surfaces etc. should be properly protected prior to side fill.

b) Side filling work should be suitably accomplished

The dug material should be returned to the trench and placed in layers. The first side fill layer should be placed and compacted under the lower quadrants of the pipe and up to the springing level of the pipe. Successive layers of up to 100 mm thickness may then be placed and compacted to a maximum height above the crown of 250 mm. Light vibrating machinery may be used but not directly above the pipe or the fittings.

c) Clear site

On completion of the work all materials and protective barriers should be removed from site and the working area left clean and tidy. All records should be completed and submitted.

Notice of Completion

Notice of completion or interim or permanent reinstatement must be given within a reasonable period. Location of works and other relevant details should also be given.

Repair Methods for Different Types of Pipes

Some of the methods of repair for different types of pipes are given in the following tables.

Table 38: Maintenance of Pipes made of Cast Iron

MATERIAL	Cast Iron	
Burst	**Action**	**Repair**
Joint Failure	Enclose Joint Two-couplers	Special Joint clump Two-couplers and new section
Brittle Failure	Remove section/Joint Enclose failure	Two-couplers and new section Repair collar or clamp
Corrosion	Remove section/joint Rehabilitation Enclose failure technique	Two-couplers and new section Sliplining e.t.c. Repair collar or clamp

Table 39: Maintenance of Pipes made of Ductile t Iron

MATERIAL	Ductile Iron	
Burst	Action	Repair
Joint Failure	Enclose Joint Remove section/Joint	Special Joint clump Two-couplers and new section
Extensive pinholing	Rehabilitation technique Remove section/joint	Sliplining e.t.c. Two-couplers and new section
Ductile Failure	Remove section/joint Enclose burst	Two-couplers and new section Repair collar or clamp
Localised pinholing	Enclose burst	Repair collar or clamp

Table 40 Maintenance of Pipes made of Steel

MATERIAL	Steel	
Burst	Action	Repair
Extensive pinholing	Rehabilitation technique Remove Section/Joint	Sliplining e.t.c. Two-couplers and new section
Joint failure	Remove Section/Joint Enclose Joint	Two-couplers and new section Special joint clamp
Isolated pinholing	Enclose Joint	Patch and weld Repair collar or clamp

Table 41: Maintenance of Material made of Asbestos cement

MATERIAL	Asbestos Cement	
Burst	Action	Repair
Surface Softening	Remove complete pipe length	New pipe sections and fitting
Longitudinal Cracking	Remove complete pipe length	New pipe sections and fitting
Joint failure	Remove complete pipe length Enclose Joint	New pipe sections and fitting Joint Repair clamp
Circumferential failure	Enclose burst	Repair collar or clamp

Table 42 Maintenance of Material made of Prestressed Concrete

MATERIAL	Prestressed Concrete	
Burst	Action	Repair
Surface softening	Remove complete length/Joint or cracking	Two-couplers and new section
Joint failure	Remove complete length/Joint Enclose Joint	Two-couplers and new section Special Joint clamp

Table 43 Maintenance of Material made of Polyethylene/PVC

MATERIAL	Polyethylene/PVC	
Burst	Action	Repair
Fast crack propagation	Remove damaged section	Two-couplers and new section
Joint Failure	Remove damaged section Enclose burst	Two-couplers and new section Repair collar or clamp
Brittle Failure	Cut our Joint	Two-couplers and new section

Table 44 Maintenance of Material made of Glass reinforced plastic pipes

MATERIAL	Glass reinforced plastic pipes (GRP)	
Burst	Action	Repair
Joint Failure	Enclose Joint Replace Joint	Joint Clamp Repair Collar or camp
Delamination	Remove section Enclose failure	Two-couplers and new section Repair collar or clamp
Fracture/Damage	Remove section Enclose failure	Two-couplers and new section Repair collar or clamp

Repair Problems Specific to Pre-Stressed Concrete

The most difficult and time consuming repair problems relate to PSC Pipes, particularly the bigger diameter pipes. Some of the cases connected with the damage and leakage of such pipes along with their suggested methods are discussed below:

Extensive Damage to PSC Pipe Length

Sometimes the damage is so extensive that the entire length of a pipe needs replacement. The replacement is done by inserting a steel pipe which shall be fabricated in three pieces. One piece shall consist of a spigotted machine end, another of steel shell and the third a spigotted machine end. The middle portion shall be of steel barrel with an integral manhole. This man hole may be meant for temporary use only so as to be covered and rewelded suitably after the repairing operation has been satisfactorily carried out. The thickness of steel plate used for this purpose shall be equal to the design thickness plus 2 mm extra to take care of corrosion. A minimum of 10 mm may, however, be used. The burst pipe may be broken by taking due precautions and replaced with this set of three pieces. The two machine ends shall be fixed as per normal procedure for laying PSC pipes. The steel barrel shall be introduced in between and duly welded internally and externally.

Damage Restricted to a Small Length Only

Sometimes the damage is along a length of 1 m to 1.5 m only and the remaining portion of the pipe remains in a sound condition. To make the damaged portion functional, two plain M.S. Barrels shall be inserted into the pipe, to suit the internal diameter with a gap of 25 mm. on either side of the pipe, 50 mm less than the internal diameter of the pipe, to facilitate jointing with jute and cement mortar. The barrels shall have 2 nos. 12 mm dia. M.S. rings to fix over the shell at the ends. At least 500 mm of overlap on either side of the pipe, length wise, is provided for jointing. After following the normal procedure (as already discussed at length), break the damaged portion of the pipe to the extent (length wise) of cracks developed in the pipe for more than half of the pipe (diameter wise).

Cut the H.T. wires core reinforcement.

Clean the pipe internally, remove the broken debris and dewater the pipe.
Insert one piece of the M.S. Barrel, duly fabricated with a temporary manhole for entry into the pipe for internal caulking, welding etc.
Shift barrel to one side so as to facilitate the insertion of the second barrel.
Join the two pieces and weld the joint internally and externally.
Keep the barrel in position by covering the damaged portion duly keeping at least 500 mm of overlap for jointing with P.S.C. pipe.
Insert the M.S. ring at the ends and place at 150 mm from the outer ends of the barrels and tag weld the rings to the barrel to caulk the jute firmly.
Caulk both the ends of the barrel with spun yarn for 3 layers and with cement mortar 1:1 duly mixing quick setting cement solution.
Clean the pipe internally and paint with epoxy paint.
Close the manhole made on the M.S. pipe by welding and strengthening the joint with additional plates.
Weld angles on The barrel and support the edges of the PSC pipe.
Caulk the joints with cement mortar and cover the MS barrel with cement mortar.
Embed the damaged portion of the pipe in cement concrete to avoid movement of the M.S. barrel during surge.
(As alternatives to the above procedure, there are other methods in use, depending upon the local conditions and the diameters of the pipes).
Follow other prescribed procedure for completion.

Leakage Through Socket/Spigot Joint due do displacement of Rubber Joint

The joint has to be exposed. A medium leakage can be attended without taking the shut down by pushing the rubber gasket to the original position with the help of wooden caulking tools and also inserting lead pieces in the joint. Afterwards, caulking with cement mortar 1:1 will further strengthen the joint. The entire joint has to be caulked with cement mortar.

Leakage through damaged socket

Such leakage can be attended only by taking shut down and draining the pipe line. The joint shall be exposed by excavating the trench around the joint. The crack and joint shall be filled with lead wool, quick setting cement mortar and the stepped split collar fixed over the joint and filled with cement slurry or cement mortar mixed with quick setting solution.

Leakage through Circumferential Crack

Such leaks can be attended by providing split collars after arresting the leakage through crack either on running line or by availing shut down. Materials required for attending the leakage are lead wool, M seal, cement mortar, special adhesives like araldite and plain split collar.

Leakage through Hole

The hole can be covered with a plate and bolted to a flat inserted through the hole. The hole shall be covered with a lead washer under the plate and annular gap to be filled with mseal compound or other suitable sealing material.
If the hole is very close to the joint, a plane cover or a stepped split collar can be fixed and caulked with cement mortar after caulking the joint with lead pieces or lead wool.

Generation of Data and Life Cycle Analysis

Record of repair carried out with costs should be maintained systematically. This will help in assessing the useful life of different materials of pipelines. This data will be useful in carrying out Life Cycle Cost analysis of competing materials and take decision regarding replacements.

Appropriate Facilitator Background	Mechanic or technician skilled and qualified in the maintenance and repair of diesel engines.
Introduction	Diesel powered generators are used in many boreholes and water intakes to drive electrical pumps. There is a wide variety of makes, although Lister-Peter and Perkins are common. The principles of operation and maintenance are similar regardless of the make or model. Specific requirements for each make and model should be obtained from the manufacturer’s Operators Manual for the respective engine.
Objective	At the end of the session, the participants will be able to: • Identify the main components of air-cooled or water cooled diesel engines; • Start and stop the engine; • Undertake basic service the diesel engine; • Follow the safety measures and carry routine maintenance.
Outputs	An Operation and Maintenance Plan
Timing	Session should take approximately 6 hrs
Target Group	Operator, WASH committee and Board members.
Appropriate Venue	At the pump house where the diesel engine is located.
Methodology	This is intended to be a **PRACTICAL** session. The components will be taught by demonstration on the system itself. The flip chart can be used to illustrate details if necessary. Reinforce the learning by allowing participants to handle components and describe their functions to each other.
Materials	• Diesel engine • Fuel • 5 litres of engine oil • Fuel, oil and air filters (1 of each) • Spanners • Strapper
Session Guide	
Step 1: Identification of parts of the System & Diesel Engine	Facilitator starts by identifying the different parts of the pumping system and their purpose.

Component	Purpose
Pump House	Keep engine and control safe from uncontrolled access
Fuel Store	Keep fuel safe from uncontrolled access
Diesel Engine	Turns the alternator
Alternator	Generates electricity
Control Panel	Controls the current to the pump and protects the pump from high currents
Electrical pump (e.g. Surface pump)	Pumps water to tank
Master Meter	Measures water quantity withdrawn

	Now facilitator focuses on the diesel engine and explains the names and purpose of the different parts of the diesel engine.
Step 2: Operating Diesel Engines	Facilitator can ask operator to run through normal start-up procedures to see how system is currently run. Observe and discuss improvements. Start Up Procedure 1. Check oil level; 2. Check fuel level and fuel line is on; 3. Check water level in radiator reservoir; 4. Check for any loose wires or hoses; 5. Start engine (using crank or battery); 6. Record start time on Log Chart. Switching Off Procedure 1. Turn engine off; 2. Record end time on Log Chart; 3. Check for any oil leaks.
Step 3: Set Safety Rules	Facilitator should discuss safety rules Safety Rules: General 1. Keep fire extinguisher or bucket of sand close at hand to deal with fires; 2. No smoking in pump house or fuel store; 3. Wear protective clothing that fit well. No loose clothes that can get caught in the moving parts of the engine. 4. Never put cleaning rugs or other loose items in your pockets when you are in the pump house. It can get caught in the moving parts. 5. Wear good protective shoes. 6. Keep the floor of pump house and store clean and dry, so that you will not slip or fall. Safety Rules: Fuel & Lubricants 1. Keep spare fuel and lubricants in secure ventilated store; 2. Do not smoke in fuel store or while re-fueling. Ensure area is 3. clear of any spectators or smokers; 4. Use a pump or tap to take diesel out of a drum. Sucking diesel with a hose is not good for your health. 5. **NEVER** put fuel or oil into the engine while it is running. 6. Do not use kerosene as fuel. It reduces life of engine and fuel pump. Safety Rules: During Operations 1. Keep spectators out of pump house while engine is operating; 2. Open windows and ensure pump house is well ventilated; 3. Do not open radiator cap; 4. Do not top up radiator by pouring cold coolant in hot engine.

5. The cylinder head may crack;
6. Keep your fingers away from moving parts of the engine.
7. **NEVER** put fuel or oil into the engine while it is running.
8. Never clean the engine when it is running;
9. Do not operate the engine if the safety guard has been removed;
10. Only one person should control the engine;

Safety Rules: During Maintenance Work

1. Do not make any adjustments that you do not understand; Maintenance operations to be carried out on cold engine;
2. Maintenance operations to be carried out under sufficient
3. lighting;
4. Do not over fill engine oil in sump. This may cause engine
5. smoking;
6. Do not use salt water or any other coolant which can cause
7. corrosion in the closed cooling unit;
8. Disconnect the battery terminals before a repair is made to the
9. electrical system;
10. If you are working with chemicals, such as solvents, cleaners, chlorine etc., be careful. Read the instructions on the container and follow them. Some chemicals give out fumes that are poisonous if inhaled. Some of them will burn your skin.

Step 4: O & M Specific Tasks for Diesel Engines

Discuss the tasks relevant to the operations and maintenance of the system components. Draw up O & M Schedule with participants See attachment 5 for typical O & M Schedule for diesel engines

Step 5: Trouble Shooting

Discuss the potential unexpected problems and what might be the cause.

#	PROBLEM	Possible cause	Remedy
	WILL NOT START(i) Engine does not turn)	Battery flat or failed	a) Check liquid level. Fill if necessary. Recharge battery and check all cells working b) Replace battery if failed
		Starter circuit faulty	a) Check, clean and refit battery connections. b) Check circuit relay and starter solenoid.
		Starter faulty	a) Replace motor. Check starter engaging, attempt to turn engine by hand
		Lubricating oil too thick	Replace with correct grade
		Engine or alternator jammed	Inspection and remove any obstruction

	2	(ii) Engine turns but does not fire	a) No fuel atomizers. b) Air in fuel system. c) Dirty or water in fuel. d) Faulty lift pump. e) Faulty injection pump f) Injection timing wrong	a) Check fuel available in tank, check all fuel valves are open b) Bleed fuel system c) Clean or replace fuel filter d) Check fuel lift pump e) Check fuel injection pump f) Reset injection pump timing
	3	(iii) Start but loses Power	All possible causes shown under 2 above Air filter blocked Faulty cylinder head or inlet manifold joints Damaged or Dirty turbocharger	Attention as shown (a) to (g) above (under item 2 above) Clean or replace filter (k) Clean or replace filter
	4	Excessive Fuel Consumption	a) Faulty injection pump b) Worn or dirty injections c) Incorrect valve clearance d) Fuel pump timing incorrect e) Incorrect fuel f) Excessive engine wear	a) Service fuel injection pump b) Service or change injectors c) Reset clearance d) Reset timing e) Check fuel specification Overhaul engine
	5	Black Exhaust smoke	a) Faulty injection pump b) Worn/ dirty injectors	a) Service fuel injection pump b) Service or change injectors

		c) Air filter blocked d) Fuel pump timing incorrect e) Incorrect fuel f) Damaged or dirty turbocharger g) Excessive load h) Long running time on light load	c) Clean or replace filter d) Reset timing e) Check fuel specification f) Clean or replace turbocharger g) Reduce load as necessary h) Run on full load for one hour period
6	Blue/White exhaust smoke	a) Engine misfiring b) Excessive engine wear	a) See remedy under 2 b) Overhaul engine
7	Low lubricating oil pressure	a) Low oil level in sump b) Oil pressure gauge faulty c) Oil filter blocked d) Faulty relief valve e) Oil pump worn f) Excessive oil temp	a) Add lubricating oil to normal level b) Replace gauge c) Clean or replace filter d) Clean or replace valve e) Replace pump f) See problem 8 below
	High Engine temp	a) Low level of coolant b) Faulty thermostat c) Fan belt slipping d) Radiator matrix blocked	b) refill radiator and check for any leaks c) Check and replace if necessary d) Adjust tension of belt e) Clean out thoroughly

		e) Blockage in cooling system	f) Drain system, flush out refill
		f) Low level of lubricating oil g) Fuel injection pump incorrect h) Cylinder head gasket failed	g) Refill to correct level h) Reset timing i) Remove head and replace gasket

Step 6: Spare Parts, Tools and Technical Assistance

Facilitator should discuss requirements, availability and procurement for spare parts, tools, and technical assistance.
Tools - Routine maintenance requires a funnel to assist in fuelling and toping up the oil.
Spares Parts & Materials

- Lubricants – oil
- Filters - Oil, fuel and air
- Cotton waste for mopping up spills;

Supply Chain - Establish where the nearest store is that stocks spares for the diesel engine.

Spare	Name of Technical Assistant	Contact Details	Name & Contact of Supplier 2	Expected Cost per Unit on Delivery

Technical Assistance
Discuss who can provide technical assistance when it is required.

Component	Name of Technical Assistant	Contact Details	Name of Back up Contact	Contact Details for Back-up
Engine repair				
Electrician				
Water Quality				
e.t.c.				

Review

- What arrangements have been made to keep fuel safe and clean?
- What is the purpose of the Engine Log?

	• Who is authorised to service the engine?
Session Attachments	Attachment 1: Engine Log Attachment 2: Engine Service Form Attachment 3: Diagram of Lister TS3 Diesel Engine Attachment 4: Photo of 9KVa Perkins Generator Attachment 5: Preventative Maintenance of Diesel Engine

Table 45: Engine Log

Name of Water Supply		Engine Type		
State		GPS	Easting	Northing
County				
Payam				
Boma				

	At Start		During Operations		At End					
Date	Fuel Added (Litres)	Start Time	Voltage (Volts)	Current (Amps)	Time	Total Time (Hrs)	Kw-hrs (meter reading)	Water pumped (Meter Reading)	Comments Repairs Problems	Initials of Operator

Table 46: Engine Service Form

Engine Make: ____________________ Model: ____________________ Tel: ____________________

Date of Service: ____________________ Name of Mechanic: ____________________

Hours at Current Service: ____________________ Hours at Next Service: ____________________

CATEGORY	ITEM	CHECKED Tick if checked	WORK DONE	COMMENTS
LUBRICATION	Engine Oil			
	Oil Filter			
	Greasing			
FUEL SYSTEM	Fuel Filter			
	Injector/Fuel Pump (leakages)			
	Tank (leakages)			
	Fuel Lines (cracks, leaks)			
ENGINE	Belts			
	Air Filter			
	Plugs/Injectors			
ELECTRICALS	Battery			
COMMENT :				
Signature:				

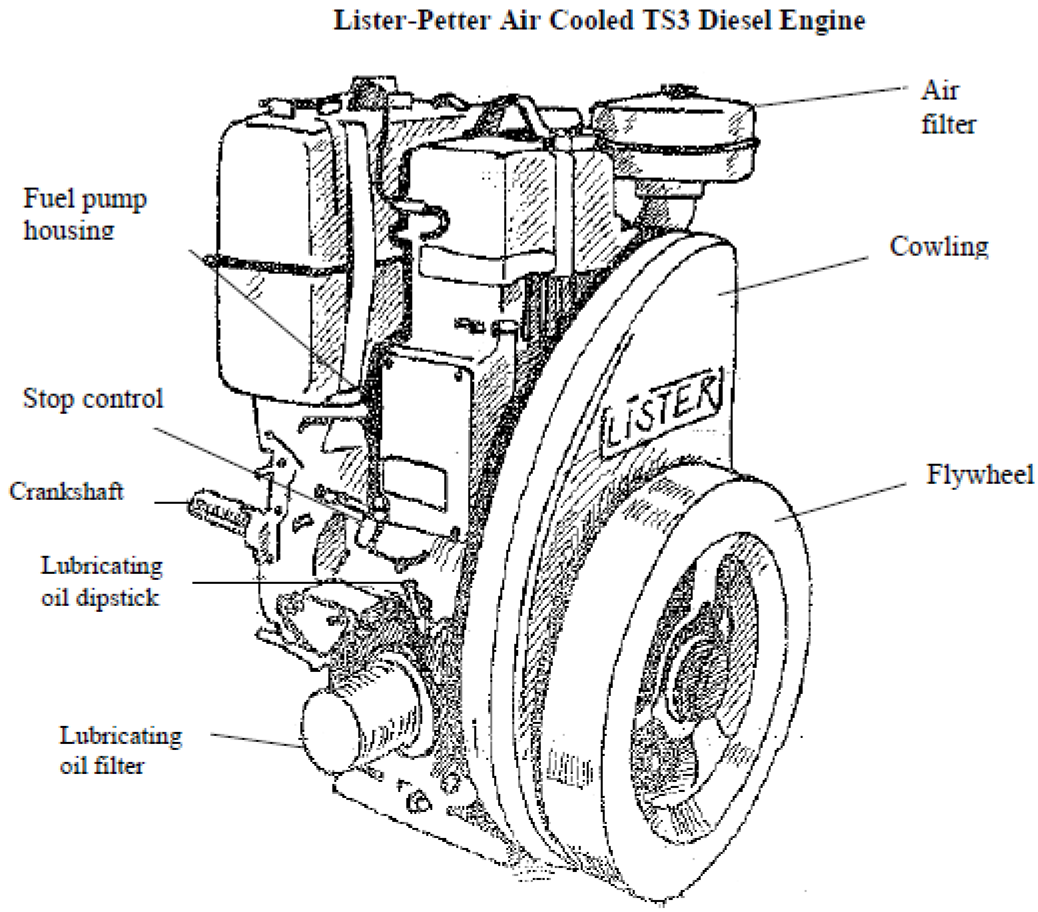


Figure 24: Diagram of Lister TS3 Diesel Engine

Figure 25: Photo of 9KVa Perkins Generator

Attachment 5: Schedule of Preventative Maintenance for Diesel Engines

Daily operation or every 8 hours (To be undertaken by operator/caretaker)

- Check fuel and engine oil levels, top up if necessary
- Check water level in radiator & top up if necessary and secure the cap
- Check tension of alternator drive belt, check battery condition/water level
- Check the lubricating oil pressure at the gauge
- Check for loose nuts and bolts, check and correct any leaks or engine damage
- In very dusty conditions clean air cleaner element, drain and clean dust bowl
- Check exhaust pipe
- Check foundation bolts

Every 100 hours or 3 months (To be carried out by skilled mechanics)

- As for daily services.
- Renew engine lubricating oil
- Renew engine oil filter
- Drain water from fuel filter and pre-filter
- Check the condition of the battery fitted
- When moderately dusty, empty bowl and clean or replace the air cleaner element
- Clean the compressor air filter
- Check and adjust idle speed

Every 200 – 250 hours or 6 months (To be carried out by skilled mechanics)

- As for previous servicing
- Change the engine oil and oil filter element
- Clean fuel strainer, fuel tank breather. Renew fuel filter canister
- Clean battery terminals

Every 400 hours or 12 months (To be carried out by skilled mechanics)

As for previous servicing

- Replace air cleaner element
- Renew fuel filter element
- Check concentration of coolant
- Check the battery charging system. Check alternator drive belt for wear, Check wiring harness & connections and tighten if required
- Check injectors for performance

After 600 hrs or 18 months (To be carried by skilled mechanics)

- As for 200 hour servicing and maintenance
- Renew coolant
- Renew alternator drive belt
- Tighten cylinder head
- Check and adjust valve clearances
- Check electrical system
- Check all nuts and bolts for tightness
- Check engine mountings

Introduction

General

Pumping machinery and pumping station are very important components in a water supply system. Pumping machinery is subjected to wear, tear, erosion and corrosion due to their nature of functioning and therefore are vulnerable for failures. Generally more number of failures or interruptions in water supply are attributed to pumping machinery than any other component. Therefore, correct operation and timely maintenance and upkeep of pumping stations and pumping machinery are of vital importance to ensure uninterrupted water supply. Sudden failures can be avoided by timely inspection, follow up actions on observations of inspection and planned periodical maintenance. Downtime can be reduced by maintaining inventory of fast moving spare parts. Efficiency of pumping machinery reduces due to normal wear and tear. Timely action for restoration of efficiency can keep energy bill within reasonable optimum limit. Proper record keeping is also very important.

Obviously due attention needs to be paid to all such aspects for efficient and reliable functioning of pumping machinery. This chapter discusses procedures for operation and maintenance and addresses pertinent issues involved in O&M of pumping machinery and associated electrical and mechanical equipment.

Components In Pumping Stations

The components in pumping station can be grouped as follows.

i. *Pumping machinery*
   - Pumps and other mechanical equipment, i.e. valves, pipe work, vacuum pumps
   - Motors, switchgears, cable, transformer and other electrical accessories

ii. *Ancillary Equipment*
   - Lifting equipment
   - Water hammer control device
   - Flowmeter
   - Diesel generating set

iii. *Pumping station*
   - Sump/intake/well/tubewell/borewell
   - Pump house
   - Screen
   - Penstock/gate

Types Of Pumps

Following types of pumps are used in water supply systems.

i. Centrifugal pumps
ii. Vertical turbine pumps
   - Oil lubricated
   - Self-water (pumped water) lubricated
   - Clear water lubricated
iii. Submersible pumps

- Vertical borewell type pump-motor set
- Monobloc open well type pump-motor set

iv. Jet pumps

v. Reciprocating pumps

Coverage In The Chapter

The chapter covers following aspects regarding operation and maintenance of components of pumping station and pumping machinery.

i. *Pumping Machinery*
- Operation including starting and stopping of pumps and associated electrical and mechanical equipment
- Preventive maintenance
- Trouble shooting
- Inventory of spares, oil and lubricants
- Tools and testing equipments
- Inspection and testing
- Record keeping

ii. *Ancillary equipment*
- Operation, maintenance and testing of
  - lifting equipment
  - water hammer (surge) control device

iii. *Pumping station*
- Maintenance of following,
  - Screen
  - Penstock/gate
  - Pump house
- Housekeeping
- Housekeeping

Intakes

General

An Intake is a device or structure placed in a surface water source to permit withdrawal of water from this source and its discharge into an intake conduit through which it will flow into the water works system. Types of intake structures consist of intake towers, submerged intakes, intake pipes or conduits, movable intakes, and shore intakes. Intake structures over the inlet ends of intake conduits are necessary to protect against wave action, floods, stoppage, navigation, pollution, and other interference with the proper functioning of the intake.

Intake towers are used for large waterworks drawing water from lakes, reservoirs and rivers in which there is either or both a wide fluctuation in water level or the desire to draw water at a depth that will give water of the best quality to avoid clogging or for other reasons.

Problems Of Operations

Some of the problems that may arise during the operation of Intakes are given below.
Necessary steps should be taken to set right the same.

i. Fluctuations in water level,
ii. Water withdrawal at various depths,
iii. Hydraulic surges, floods, floating debris, boats and barges,
iv. Withdrawal of water of the best available quality to avoid pollution, and to provide structural stability,
v. Operation of racks and screens to prevent entry of objects that might damage pumps and treatment facilities,
vi. Minimizing damage to aquatic life,
vii. Preservation of space for
   a) Equipment cleaning,
   b) Removal and repair of machinery,
   c) Storing, movement and feeding of chemicals.

Operation And Maintenance

i. Operating criteria, equipment manufacturer's operating instructions and standard operating procedures should be bound into a manual and used for reference by operators. If written references are not available for a particular facility, they should be prepared with the assistance of knowledgeable operators, engineers and manufacturers.
ii. Screens should be regularly inspected, maintained and cleaned.
iii. Mechanical or hydraulic jet cleaning devices should be used to clean the screens.
iv. Intake structures and related facilities should be inspected, operated and tested periodically at regular intervals.
v. Proper service and lubrication of intake facilities is important.
vi. Operation of Gates and Valves.
   Some of the causes of faulty operation are as under:
   - Settlement or shifting of supporting structures which could cause binding of gates and valves,
   - Worn, corroded, loose or broken parts,
   - Lack of use,
   - Lack of lubrication,
   - Vibration,
   - Improper operating procedures,
   - Design errors or deficiencies,
   - Failure of power source or circuit failure, and
   - Vandalism.

Record Keeping

The records to be maintained shall include the following aspects:

i. A history of operations and maintenance performed on Intake facilities.
ii. When and under what conditions, failure or malfunctions occur.

Safety

When working around Intake Structures proper safety procedure involving use of electrical and mechanical equipment and water safety should be observed.

Operation Of The Pumps

Important Points Of Operation

Important points as follows shall be observed while operating the pumps.

a) Dry running of the pumps should be avoided.
b) Centrifugal pumps have to be primed before starting.
c) Pumps should be operated only within the recommended range on the head-discharge characteristics of the pump.
    - If pump is operated at point away from duty point, the pump efficiency normally reduces.
    - Operation near the shut off should be avoided, as the operation near the shut off causes substantial recirculation within the pump, resulting in overheating of water in the casing and consequently, in overheating of the pump.
d) Voltage during operation of pump-motor set should be within + 10% of rated voltage. Similarly current should be below the rated current as per name plate on the motor.
e) Whether the delivery valve should be opened or closed at the time of starting should be decided by examining shape of the power-discharge characteristic of the pump. Pump of low and medium specific speeds draw lesser power at shut off head and power required increases from shut off to normal operating point. Hence in order to reduce starting load on motor, a pump of low or medium specific speed is started against closed delivery valve. Normally the pumps used in water supply schemes are of low and medium specific speeds. Hence, such pumps need to be started against closed delivery valve.
   The pumps of high specific speed draw more power at shut off. Such pumps should be started with the delivery valve open.
f) The delivery valve should be operated gradually to avoid sudden change in flow velocity which can cause water hammer pressures. It is also necessary to control opening of delivery valve during pipeline - filling period so that the head on the pump is within its operating range to avoid operation on low head and consequent overloading. This is particularly important during charging of the pumping main initially or after shutdown. As head increases the valve shall be gradually opened.
g) When the pumps are to be operated in parallel, the pumps should be started and stopped with a time lag between two pumps to restrict change of flow velocity to minimum and to restrict the dip in voltage in incoming feeder. The time lag should be adequate to allow to stabilize the head on the pump, as indicated by a pressure gauge.
h) When the pumps are to be operated in series, they should be started and stopped sequentially, but with minimum time lag. Any pump, next in sequence should be started immediately after the delivery valve of the previous pump is even partly opened. Due care should be taken to keep the air vent of the pump next in sequence open, before starting that pump.
i) The stuffing box should let a drip of leakage to ensure that no air is passing into the pump and that the packing is getting adequate water for cooling and lubrication. When the stuffing box is grease sealed, adequate refill of the grease should be maintained.
j) The running of the duty pumps and the standby should be scheduled so that no pump remains idle for long period and all pumps are in ready-to run condition. Similarly unequal running should be ensured so that all pumps do not wear equally and become due for overhaul simultaneously.
k) If any undue vibration or noise is noticed, the pump should be stopped immediately and cause for vibration or noise be checked and rectified.

l) Bypass valves of all reflux valve, sluice valve and butterfly valve shall be kept in closed position during normal operation of the pumps.
m) Frequent starting and stopping should be avoided as each start causes overloading of motor, starter, contactor and contacts. Though overloading lasts for a few seconds, it reduces life of the equipment.

Undesirable Operations

Following undesirable operations should be avoided.

i. *Operation at Higher Head*

The pump should never be operated at head higher than maximum recommended. Such operation results in excessive recirculation in the pump, overheating of the water and the pump. Another problem, which arises if pump is operated at a head higher than the recommended maximum head, is that the radial reaction on the pump shaft increases causing excessive unbalanced forces on the shaft which may cause failure of the pump shaft. As a useful guide, appropriate marking on pressure gauge be made.
Such operation is also inefficient as efficiency at higher head is normally low.

ii. *Operation at Lower Head*

If pump is operated at lower head than recommended minimum head, radial reaction on the pump shaft increases causing excessive unbalanced forces on shaft which may cause failure of the pump shaft. As useful guide, appropriate markings on both pressure gauge and ammeter be made. Such operation is also inefficient as efficiency at lower head is normally low.

iii. *Operation on Higher Suction Lift*

If pump is operated on higher suction lift than permissible value, pressure at the eye of impeller and suction side falls below vapour pressure. This results in flashing of water into vapour. These vapour bubbles during passage collapse resulting in cavitation in the pump, pitting on suction side of impeller and casing and excessive vibrations. In addition to mechanical damage due to pitting, discharge of the pump also reduces drastically.

iv. *Throttled operation*

At times if motor is continuously overloaded, the delivery valve is throttled to increase head on the pump and reduce power drawn from motor. Such operation results in inefficient running as energy is wasted in throttling. In such cases, it is preferable to reduce diameter of impeller which will reduce power drawn from motor.

v. *Operation with Strainer/Foot Valve Clogged*

If the strainer or foot valve is clogged, the friction loss in strainer increases to high magnitude which may result in pressure at the eye of the impeller falling below water vapour pressure, causing cavitation and pitting similar to operation on higher suction lift. The strainers and foot valves should be periodically cleaned particularly during Rainy season.

vi. *Operation of the Pump with Low Submergence*

Minimum submergence above the bell-mouth or foot valve is necessary so as to prevent air entry into the suction of the pump which gives rise to vortex phenomenon causing excessive vibration, overloading of bearings, reduction in discharge and efficiency. As a useful guide the lowest permissible water level be marked on water level indicator.

vii. Operation with Occurrence of Vortices

If vibration continues even after taking all precautions, vortex may be the cause. All parameters necessary for vortex-free operation should be checked.

Starting The Pumps

Checks before starting

Following points should be checked before starting the pump.

- Power is available in all 3 phases.
- Trip circuit for relays is in healthy state
- Check voltage in all 3 phases.
  The voltage in all phases should be almost same and within + 10% of rated voltage, as per permissible voltage variation.
- Check functioning of lubrication system specifically for oil lubricated and clear water lubricated VT pumps and oil lubricated bearings.
- Check stuffing box to ensure that it is packed properly.
- Check and ensure that the pump is free to rotate.
- Check overcurrent setting if the pump is not operated for a week or longer period.
- Before starting it shall be ensured that the water level in the sump/intake is above low water level and inflow from the source or preceding pumping station is adequate.

Starting and Operation of Pumps

Procedures for starting and operation of different types of pumps are as follows.

a) Centrifugal Pump (of low and medium specific speed)

i. To start a centrifugal pump, the suction pipes and the pump should be fully primed irrespective of the fact whether the pump is with positive (flooded) suction or suction lift. The centrifugal pump with positive suction can be primed by opening valve on suction side and letting out air from the casing by opening air vent. Centrifugal pump on suction lift necessitates close attention to prime the pump fully. To achieve this, the suction pipe and the pump casing must be filled with water and entire air in suction piping and the pump must be removed. If vacuum pump is provided, the pump can be primed by operating vacuum pump till steady stream of water is let out from delivery of vacuum pump. In absence of vacuum pump, priming can be done by pouring water in casing and evacuating air through air vent or by admitting water from pumping main by opening bypass of reflux valve and delivery valve. Check all joints in the suction pipe and fittings.

ii. Close the delivery valve and then loosen slightly.

iii. Switch on the motor, check that direction of rotation is correct. If the pump does not rotate, it should be switched off immediately.

iv. Check vacuum gauge if the pump operates on suction lift. If the pointer on gauge gradually rises and becomes steady the priming is proper.

v. Pressure gauge should be observed after starting the pump. If the pump is working correctly the delivery pressure gauge should rise steadily to shut off head.

vi. When the motor attains steady speed and pressure gauge becomes steady, the delivery valve should be gradually opened in steps to ensure that the head does not drop below recommended limit. (in the absence of recommendations, the limit shall be about 85% of duty head for centrifugal pump).

vii. Check that ammeter reading is less than rated motor current.

viii. Check for undue vibration and noise.

ix. When in operation for about 10-15 minutes, check the bearing temperature, stuffing box packing, and leakage through mechanical seal and observe vibrations, if any.
x. Voltage should be checked every half an hour and should be within limit.

b) Vertical Turbine Pump (of low and medium specific speed)

i. Close delivery valve, and then loosen slightly.
ii. If pump is oil-lubricated, check the oil in the oil tank and open the cock to ensure that oil is flowing at the rate of 2-4 drops per minute. If the pump is self-water-lubricated and length of column assembly is long (15 m or above), external water shall be admitted to wet and lubricate the line shaft bearings before starting the pump.
If the pump is external clear water lubricated, the clear water lubricating pump should be started before starting main pump.
iii. Open the air vent in discharge/delivery pipe.
iv. Switch on the motor and check correctness of direction of rotation. If the pump does not rotate, it should be switched off immediately.
v. Check that oil is flowing into the pump through the sight glass tube. The number of drops/min. should be as per manufacturer's recommendations (normally 2-4 drops/minute).
For clear water lubricated pump, check that lubricating clear water is passing into the column assembly.
vi. Check pressure gauge reading to ensure that pump has built up the required shut off head.
vii. When the motor attains steady speed and pressure gauge becomes steady, the delivery valve should be gradually opened in steps to ensure that the head does not drop below recommended limit. (In absence of recommendation, the limit shall about 75% of duty head for VT & submersible pump).
viii. If steady water stream is let out through air vent, close the air vent.
ix. Check that ammeter reading is less than rated motor current.
x. Check for undue vibration and noise.
xi. When in operation for about 10-15 minutes, check bearing temperature, stuffing box packing and observe vibration if any.
xii. Voltage should be checked every half an hour and should be within limit.

c) Submersible Pumps

Starting of a submersible pump is similar to vertical turbine pump except that steps ii, v, and xi are not applicable and since motor is not visible, correctness of direction of rotation is judged from pressure gauge reading which should indicate correct shut off head.

d) Jet Pump

The procedure for starting jet pumps is similar to centrifugal pump except that priming by vacuum pump is not possible. Priming needs to be done by filling the pump casing and suction line from external source or by pouring water.

e) *Vacuum Pump*

The procedure for starting vacuum pump is similar to centrifugal pump except that priming is not necessary and valves on both suction & delivery side of vacuum pump should be fully open.

f) *Reciprocating Pump*

The steps stipulated for centrifugal pump are equally applicable for reciprocating pump.
However exceptions as follows are applicable.

- The pump should be started against partially open delivery valve.
- The pump should never be started or operated against closed delivery valve.

Stopping The Pump

Stopping the Pump under normal condition

i. Steps to be followed for stopping a pump of low and medium specific speed are as follows:
ii. Close the delivery valve gradually (sudden or fast closing should not be resorted to, which can give rise to water hammer pressures).
iii. Switch off the motor.
iv. Open the air vent in case of V.T. and submersible pump.
v. Stop lubricating oil or clear water supply in case of oil lubricated or clear water lubricated VT pump as applicable.

Stopping after Power failure/Tripping

If power supply to the pumping station fails or trips, actions stated below should be immediately taken to ensure that the pumps do not restart automatically on resumption of power supply. Though no-volt release or undervolt relay is provided in starter and breaker, possibility of its malfunctioning and failure to open the circuit cannot be ruled out. In such eventuality, if the pumps start automatically on resumption of power supply, there will be sudden increase in flow velocity in the pumping main causing sudden rise in pressure due to water hammer which may prove disastrous to the pumping main. Secondly, due to sudden acceleration of flow in the pumping main from no-flow situation, acceleration head will be very high and the pumps shall operate near shut off region during acceleration period which may last for few minutes for long pumping main and cause overheating of the pump. Restarting of all pumps simultaneously shall also cause overloading of electrical system.

Hence, precautions are necessary to prevent auto-restarting on resumption on power.
Following procedure should be followed.

i. Close all delivery valves on delivery piping of pumps if necessary, manually as actuators can not be operated due to non-availability of power.
ii. Check and ensure that all breakers and starters are in open condition i.e. off-position.
iii. All switches and breakers shall be operated to open i.e. off-position.
iv. Open air vent in case of V.T. or submersible pump and close lubricating oil or clear water supply in case of oil lubricated or clear water lubricated V.T. pump.
v. Information about power failure should be given to all concerned, particularly to upstream pumping station to stop pumping so as to prevent overflow.

Preventive Maintenance Of Pumping Machinery

Lack of preventive and timely maintenance or poor maintenance can cause undue wear and tear of fast moving parts, and premature failure of the equipment. Such premature failure or breakdown causes immense hardship to the consumers and staff, and avoidable increase in repair cost. The shortcomings in maintenance can also result in increase in hydraulic and power losses and low efficiency. Inefficient running of the pump increases burden of power cost. Importance of preventive maintenance, therefore, need not be overstressed. Appropriate maintenance schedule and procedure need to be prescribed for all electrical and mechanical equipment based on manufacturers' recommendations, characteristics of the equipment, site and environment conditions i.e. temperature, humidity, dust condition, etc.
The maintenance schedule also need to be reviewed and revised in the light of experience and analysis of failures and breakdown at the pumping station. The preventive maintenance schedule shall detail the maintenance to be carried out at regular intervals i.e. daily, monthly, quarterly, half yearly, annually etc. or operation hours. The schedule shall also include inspections and tests to be performed at appropriate interval or periodicity.

General guidelines for maintenance schedules for pumps and associated electrical and mechanical equipment are enlisted below. The guidelines should not be considered as total, full-fledged and comprehensive as characteristics of equipment and site conditions differ from place to place. For example, in dust laden environment or places where occurrence of storms are frequent, blowing of dust in motor, renewal of oil and grease in bearing shall have to be done at lesser intervals than specified in general guideline.

Maintenance Of Pumps

Daily Observations and Maintenance

Daily Maintenance

- Clean the pump, motor and other accessories.
- Check coupling bushes/rubber spider.
- Check stuffing box, gland etc.

Routine observations of irregularities

i. The pump operator should be watchful and should take appropriate action on any irregularity noticed in the operation of the pumps. Particular attention should be paid to following irregularities.
ii. Changes in sound of running pump and motor
iii. Abrupt changes in bearing temperature.
iv. Oil leakage from bearings
v. Leakage from stuffing box or mechanical seal
vi. Changes in voltage
vii. Changes in current
viii. Changes in vacuum gauge and pressure gauge readings
ix. Sparks or leakage current in motor, starter, switch-gears, cable etc.
x. Overheating of motor, starter, switch gear, cable etc.

Record of operations and observations

A log book should be maintained to record the hourly observations, which should cover the following items.

i. Timings when the pumps are started, operated and stopped during 24 hours.
ii. Voltage in all three phases.
iii. Current drawn by each pump-motor set and total current drawn at the installation.
iv. Frequency.
v. Readings of vacuum and pressure gauges.
vi. Motor winding temperature.
vii. Bearing temperature for pump and motor.
viii. Water level in intake/sump.
ix. Flowmeter reading.
x. Daily PF over 24 hour’s duration.
xi. Any specific problem or event in the pumping installation or pumping system e.g. burst in pipeline, tripping or fault, power failure.

Monthly maintenance

i. Check free movement of the gland of the stuffing box; check gland packing and replace if necessary.
ii. Clean and apply oil to the gland bolts.
iii. Inspect the mechanical seal for wear and replacement if necessary.
iv. Check condition of bearing oil and replace or top up if necessary.

Quarterly maintenance

i. Check alignment of the pump and the drive. The pump and motor shall be decoupled while correcting alignment, and both pump and motor shafts shall be pushed to either side to eliminate effect of end play in bearings.
ii. Clean oil lubricated bearings and replenish with fresh oil. If bearings are grease lubricated, the condition of the grease should be checked and replaced/replenished to the correct quantity. An anti-friction bearing should have its housing so packed with grease that the void space in the bearing housing should be between one third to half. A fully packed housing will overheat the bearing and will result in reduction of life of the bearing.
iii. Tighten the foundation bolts and holding down bolts of pump and motor mounting on base plate or frame.
iv. Check vibration level with instruments if available; otherwise by observation.
v. Clean flow indicator, other instruments and appurtenances in the pump house.

Annual Inspections and Maintenance

A very thorough, critical inspection and maintenance should be performed once in a year.
Following items should be specifically attended.

i. Clean and flush bearings with kerosene and examine for flaws developed, if any, e.g. corrosion, wear and scratches. Check end play. Immediately after cleaning, the bearings should be coated with oil or grease to prevent ingress of dirt or moisture.
ii. Clean bearing housing and examine for flaws, e.g. wear, grooving etc. Change oil or grease in bearing housing.
iii. Examine shaft sleeves for wear or scour and necessary rectification. If shaft sleeves are not used, shaft at gland packings should be examined for wear.
iv. Check stuffing box, glands, lantern ring, mechanical seal and rectify if necessary.
v. Check clearances in wearing ring. Clearances at the wearing rings should be within the limits recommended by the manufacturer. Excessive clearance reduces discharge and efficiency of the pump. If the wear is only on one side, it is indicative of misalignment. The misalignment should be set right, and the causes of misalignment should be investigated. When the clearances have to be restored, general guidelines detailed in table 11.1 below shall be followed. Normally, if the clearance in wearing rings increase by about 100% for small pumps and 50-75% for large pumps the rings shall be renewed or replaced to restore to the original clearance. The tolerances given in the table are to be strictly followed. For example, while machining the internal diameter of the casing wearing ring of basic size, say 175 mm, the limits for machining would be 175.00 minimum and 175.05 maximum. For the corresponding outer diameter at the hub of the impeller or impeller ring, the basic size will be with a clearance of 0.4 mm, i.e. 174.60 mm and the machining limits will be 174.60 mm maximum and 174.55 minimum. Taking into consideration that part dismantling of the pump is involved in checking wearing ring clearance and as it is not advisable to dismantle vertical turbine pump every year, the frequency for checking wearing ring in case of V.T. pump shall be once in two years or earlier if discharge test indicates discharge reduction beyond limit of 5% - 7%.
vi. Check impeller hubs and vane tips for any pitting or erosion.
vii. Check interior of volute, casing and diffuser for pitting, erosion, and rough surface.
viii. All vital instruments i.e. pressure gauge, vacuum gauge, ammeter, voltmeter, wattmeters, frequency meter, tachometer, flowmeter etc. shall be calibrated.
ix. Conduct performance test of the pump for discharge, head and efficiency.

x. Measures for preventing ingress of flood water shall be examined. Ingress of flood water in sump, well, tubewell or borewell shall be strictly prevented. Seal cap shall be provided above tubewell/borewell.

xi. Check vibration level.

Table 47: Wearing Ring Diametric Clearance And Tolerance

Inside Diameter of wearing ring (mm)	Diameter Clearance (mm)	Machine Tolerance (mm)
Upto 100	0.3	0.050
101 – 150	0.35	
151 – 200	0.4	
201 – 300	0.45	0.075
301 – 500	0.5	
501 – 750	0.55	
751 – 1200	0.6	0.100
1200 – 2000	0.65	0.125

Overhaul of Pump

It is difficult to specify the periodicity or interval for overhaul in the form of period of service in months/years or operation hours, as deterioration of pump depends on nature of service, type of installation i.e. wetpit or drypit, quality of water handled, quality of material of construction, maintenance, experience with particular make & type of pump etc. However generally, following operational hours may be taken as broad guidelines for overhauling.

- Submersible pump - 5000 – 6000 hours
- Vertical turbine pump - 12000 hours
- Centrifugal pump - 15000 hours

Problems in long column Pipes in VT Pump

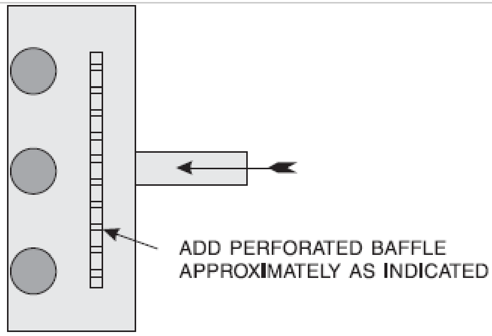
Very long column pipes in VT pump at river intake or intake well-constructed in impounded reservoir are required to be provided due to large fluctuations in water level from minimum water level in summer to high water level in monsoons. Such long column pipes (if length exceeds about 15 m) usually cause problem of fast wearing of line- shafts bearings in case of water lubricated pumps. Such longer suspended assembly is also more prone to rotation or swinging of column assembly due to vortices. Precautionary measure as follows may be taken

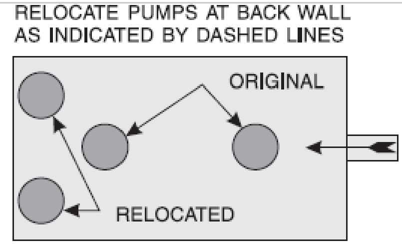
a) Prevention of premature wear of water lubricated bearings in column pipes

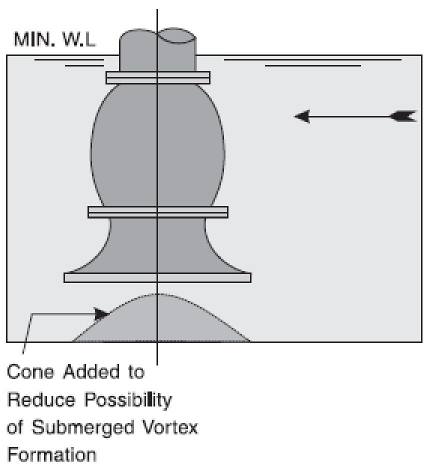
Water lubricated bearings usually are of rubber or neoprene and wear fast if dry running, occurs during starting of VT pumps. Therefore to avoid dry running water is admitted from external source (usually a tank near the pump provided for the purpose) into the column pipe for about 3-4 minutes so as to wet the bearing before starting the pump.

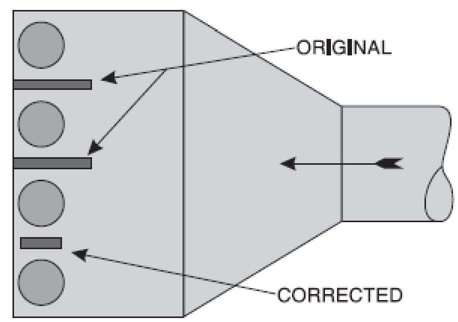
b) Preventing rotation or swinging in column assembly

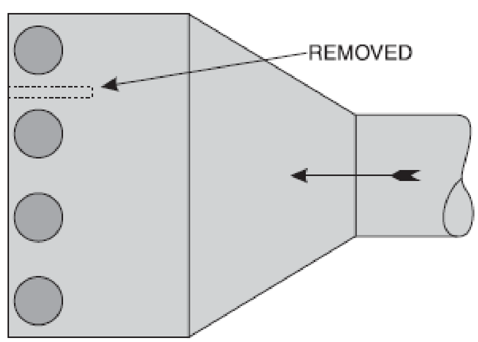
A cone as shown in the figure XXX (C) or splitter as shown in figure XXX (G) shall be provided underneath bellmouth.

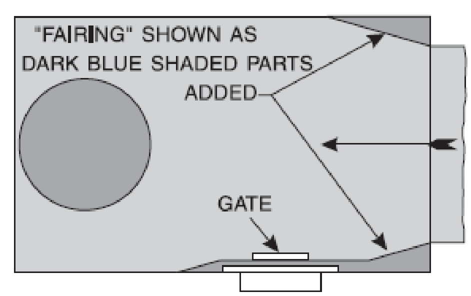

ADD PERFORATED BAFFLE
APPROXIMATELY AS INDICATED

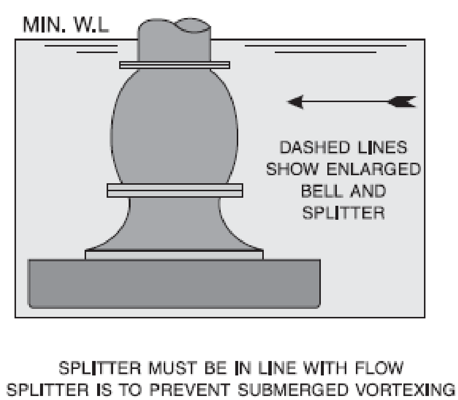

RELOCATE PUMPS AT BACK WALL
AS INDICATED BY DASHED LINES
ORIGINAL
RELOCATED

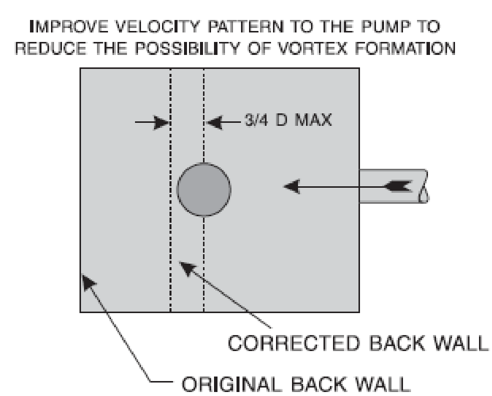

MIN. W.L
Cone Added to
Reduce Possibility
of Submerged Vortex
Formation


ORIGINAL
CORRECTED


REMOVED


"FAIRING" SHOWN AS
DARK BLUE SHADED PARTS
ADDED
GATE


MIN. W.L
DASHED LINES
SHOW ENLARGED
BELL AND
SPLITTER
SPLITTER MUST BE IN LINE WITH FLOW
SPLITTER IS TO PREVENT SUBMERGED VORTEXING


IMPROVE VELOCITY PATTERN TO THE PUMP TO
REDUCE THE POSSIBILITY OF VORTEX FORMATION
3/4 D MAX
CORRECTED BACK WALL
ORIGINAL BACK WALL

Under no circumstances the column assembly be tied or fixed at any point other than discharge head from which it is suspended, as such measure shall result in misalignment.

Maintenance Schedule For Motors

Daily Maintenance

i. Clean external surface of motor.
ii. Examine earth connections and motor leads.
iii. Check temperature of motor and check whether overheated. The permissible maximum temperature is above the level which can be comfortably felt by hand. Hence temperature observation should be taken with RTD or thermometer. (Note: In order to avoid opening up motors, a good practice is to observe the stator temperature under normal working conditions. Any increase not accounted for, by seasonal increase in ambient temperature, should be suspected).
iv. In case of oil ring lubricated bearing.
   - Examine bearings to check whether oil rings are working.
   - Note bearing temperature.
   - Add oil if necessary.

v. Check for any abnormal bearing noise.

Monthly Maintenance

i. Check belt tension. In case where this is excessive it should immediately be reduced.
ii. Blow dust from the motor.
iii. Examine oil in oil lubricated bearing for contamination by dust, grit, etc. (this can be judged from the colour of the oil).
iv. Check functioning and connections of anti-condensation heater (space heater).
v. Check insulation resistance by meggering.

Quarterly Maintenance

i. Clean oil lubricated bearings and replenish fresh oil. If bearings are grease lubricated, the condition of the grease should be checked and replaced/replenished to correct quantity. An anti-friction bearing should have its housing so packed with grease that the void space in the bearing housing should be between one third to half. A fully packed housing will overheat the bearing and will result in reduction of life of the bearing.
ii. Wipe brush holders and check contact faces of brushes of slip-ring motors. If contact face is not smooth or is irregular, file it for proper and full contact over slip rings.
iii. Check insulation resistance of the motor.
iv. Check tightness of cable gland, lug and connecting bolts.
v. Check and tighten foundation bolts and holding down bolts between motor and frame.
vi. Check vibration level with instrument if available; otherwise by observation.

Half Maintenance

i. Clean winding of motor, bake and varnish if necessary.
ii. In case of slip ring motors, check slip-rings for grooving or unusual wear, and polish with smooth polish paper if necessary.

Annual Inspections and Maintenance

i. Clean and flush bearings with kerosene and examine for flaws developed, if any, e.g. wear and scratches. Check end-play. Immediately after cleaning, the bearings should be coated with oil or grease to prevent ingress of dirt or moisture.
ii. Clean bearing housing and examine for flaws, e.g. wear, grooving etc. Change oil or grease in bearing housing.
iii. Blow out dust from windings of motors thoroughly with clean dry air. Make sure that the pressure is not so high as to damage the insulation.
iv. Clean and varnish dirty and oily windings. Revarnish motors subjected to severe operating and environmental conditions e.g., operation in dust-laden environment, polluted atmosphere etc.
v. Check condition of stator, stamping, insulation, terminal box, fan etc
vi. Check insulation resistance to earth and between phases of motors windings, control gear and wiring.
vii. Check air gaps.
viii. Check resistance of earth connections.

History Sheet

Similar to history sheet of pump, history sheet of motor should be maintained. The history sheet should contain all important particulars, records of periodical maintenance, repairs, inspections and tests. It shall generally include the following:

i. Details of motor, rating, model, class of duty, class of insulation, efficiency curve, type test result and type test certificate etc.
ii. Date of installation and commissioning.
iii. Addresses of manufacturer & dealer with phone & fax number and e-mail addresses.
iv. Brief details of monthly, quarterly, half yearly and annual maintenance and observations of inspections about insulation level, air gap etc.
v. Details of breakdown, repairs with fault diagnosis.
vi. Running hours at the time of major repairs

Valves

Following 5 types of valves are generally used in pumping installation

i. Foot valve.
ii. Sluice valve.
iii. Knife gate valve.
iv. Reflux (non-return) valve.
v. Butterfly valve.

Maintenance as follows shall be carried out.

a) Foot Valve

- Clean foot valve once in 1-3 months depending on ingress of floating matters.
- Clean flap of the foot valve once in 2 months to ensure leakproof operation.
- Inspect the valve thoroughly once in a year. Check for leakage through foot valve after priming and observing level in volute casing.

b) Sluice valve and Knife gate valve

- Check gland packing of the valve at least once in a month. It should be ensured that packings inside the stuffing box are in good trim and impregnated with grease.
- It may be necessary to change the packing as often as necessary to ensure that the leakage is within limit.
- Grease should be applied to reduction gears and grease lubricated thrust bearing once in three months. Check tight closure of the valve once in 3 months.
- A valve normally kept open or closed should be operated once every three months to full travel of gate and any jamming developed due to long disuse shall be freed.
- Inspect the valve thoroughly for flaws in guide channel, guide lugs, spindle, spindle nut, stuffing box etc. once in a year.
- Important DON'T for valve is that it should never be operated with oversize Hand-wheel or cap or spanner as this practice may result in rounding of square top and hand-wheel or cap or spanner may eventually slip.
- An important DON'T for valve is that it should never be operated under throttled i.e. partially open condition, since such operation may result in undue chatter, wear and failure of valve spindle.

c) Reflux (non-return) valve

- Check proper operation of hinged door and tight closure under no-flow condition once in 3 months.
- The valve shall be thoroughly inspected annually. Particular attention should be paid to hinges and pins and soundness of hinged door.
- Condition of dampening arrangement should be thoroughly examined once in year and necessary maintenance and rectification as per manufactures' instructions shall be carried out.
- In case of dampening arrangement, check for oil leakage and replace oil once in a year.

d) Butterfly valve

- Check seal ring and tight shut-off once in 3 months.
- Lubricate gearing arrangement and bearing once in 3 months.
- Inspect the valve thoroughly including complete operations once in a year.
- Change oil or grease in gearing arrangement once in a year.

e) General

- Operate bypass valve wherever provided once in 3 months.
- Flange adapter/dismantling joint provided with valve shall be loosened and retightened once in 6 months to avoid sticking.

Valve Actuators

Quarterly maintenance

- Declutch and operate manual hand-wheel.
- Check oil level and top up if required.
- Re-grease the grease lubricated bearing and gear trains as applicable.
- Check insulation resistance of the motor.
- Check for undue noise and vibration and take necessary rectification measures.
- Tighten limit switch cams and check for setting and readjust if necessary.

Annual Inspections and maintenance

- Examine all components and wiring thoroughly and rectify as necessary.
- Change oil or grease in gear box and thrust bearing.
- Check condition of gears & replace gears if teeth are worn out.

L.T. Starters, Breakers And Panel

Note: Circuit diagram of starter/breaker should be pasted on door of switch gear and additional copy should be kept on record.

i. *Daily*

- Clean the external surface.
- Check for any spark or leakage current.
- Check for overheating.

ii. *Monthly*

- Blow the dust and clean internal components in the panel, breaker and starter.
- Check and tighten all connections of cable, wires, jumpers and bus-bars. All carbon deposits shall be cleaned.
- Check relay setting.

iii. *Quarterly*

- Check all connections as per circuit diagram.
- Check fixed and moving contacts and clean with smooth polish paper, if necessary.
- Check oil level and condition of oil in oil tank. Replace the oil if carbon deposit in suspension is observed or colour is black.
- Check insulation resistance.
- Check condition of insulators.

iv. *Yearly*

- Check and carry out servicing of all components, thoroughly clean and reassemble.
- Calibrate voltmeter, ammeter, frequency meter etc.

H.T. Breakers, Contactors And Protection Relays

Note: Circuit diagram of breaker/relay circuit should be pasted on door of switch gear and additional copy should be kept on record.

Maintenance schedule specified for L.T. breakers is also applicable to H.T. breakers and contactors. In addition, following important points shall be attended for H.T. breakers and contactors.

i. *Monthly*

- Check spring charging mechanism and manual cranking arrangement for operation.
- Clean all exposed insulators.
- Check trip circuit and alarm circuit.
- Check opening & closing timing of breaker.

ii. Quarterly

- Check control circuits including connections in marshalling boxes of breakers and transformer.
- Check oil level in MOCB/LOCB/HT OCB and top up with tested oil.

iii. Yearly/ Two yearly

- Testing of protection relay with D.C. injection shall be carried out once in a year.
- Servicing of HT breaker and contactor shall be carried out once in 2-3 years.
- Check dielectric strength of oil in breaker and replace if necessary.
- Check male & female contacts for any pitting and measure contact resistance.

Capacitors

Pre-requisites for satisfactory functioning of capacitors

Ensure following points:

i. A capacitor should be firmly fixed to a base.
ii. Cable lugs of appropriate size should be used.
iii. Two spanners should be used to tighten or loosen capacitor terminals. The lower nut should be held by one spanner and the upper nut should be held by the another spanner to avoid damage to or breakage of terminal bushings and leakage of oil.
iv. To avoid damage to the bushing, a cable gland should always be used and it should be firmly fixed to the cable-entry hole.
v. The capacitor should always be earthed appropriately at the earthing terminal to avoid accidental leakage of the charge.
vi. There should be a clearance of at least 75 mm on all sides for every capacitor unit to enable cooler running and maximum thermal stability. Ensure good ventilation and avoid proximity to any heat source.
vii. While making a bank, the bus bar connecting the capacitors should never be mounted directly on the capacitor terminals. It should be indirectly connected through flexible leads so that the capacitor bushings do not get unduly stressed.
viii. Ensure that the cables, fuses and switchgear are of adequate ratings.

Operation and maintenance of capacitors

i. The supply voltage at the capacitor bus should always be near about the rated voltage. The fluctuations should not exceed + 10% of the rated voltage of the capacitor.
ii. Frequent switching of the capacitor should be avoided. There should always be an interval of about 60 seconds between any two switching operations.
iii. The discharge resistance efficiency should be assessed periodically by sensing, if shorting is required to discharge the capacitor even after one minute of switching off.
iv. If the discharge resistance fails to bring down the voltage to 50V in one minute, it needs to be replaced.
v. Leakage or breakage should be rectified immediately. Care should be taken that no appreciable quantity of impregnant has leaked out.
vi. Before physically handling the capacitor, the capacitor terminals shall be shorted one minute after disconnection from the supply to ensure total discharging of the capacitor.
vii. Replace capacitor if bulging is observed.

Transformer And Transformer Substation

Maintenance schedule as follows shall be applicable for transformer and sub-station equipments e.g. lightening arrestor, A.B. switch, D.O. or horn gap fuse, sub-station earthing system etc.

Daily Observation and maintenance

i. Check winding temperature and oil temperature in transformer and record. (For large transformers above 1000 kV, the temperature should be recorded hourly).
ii. Check leakages through CT/PT unit, transformer tank and HT/LT bushings.
iii. Check colour of silica gel. If silica gel is of pink colour, change the same by spare charge and reactivate old charge for reuse.

Monthly maintenance

i. Check oil level in transformer tank and top up if required.
ii. Check relay contacts, cable termination, connections in marshalling box etc.
iii. Check operation of AB switch and DO fuse assembly.
iv. Clean radiators free from dust and scales.
v. Pour 3-4 buckets (6 to 8 buckets in summer) of water in earth pit. *The frequency of watering shall be increased to once in a week in summer season.* The water for earthing shall preferably contain small amount of salt in solution.
vi. Inspect lightning arrestor and HT/LT bushing for cracks and dirt.

Quarterly maintenance

i. Check dielectric strength of transformer oil and change or filter if necessary.
ii. Check insulation resistance of all equipments in sub-station, continuity of earthings and earth leads.
iii. Check operation of tap changing switch.

Before the seasonal rains and after

i. Check insulation resistance of transformer.
ii. Test transformer oil for dielectric strength, sludge etc. If necessary, filtration of oil shall be carried out before rains.
iii. Oil shall be tested for dielectric strength after rains.

Half Yearly Maintenance

i. Check dielectric strength of transformer oil in CT/PT and filter or change oil if necessary.
ii. Check contact faces of AB switch and DO/HG fuse; apply petroleum jelly or grease to moving components of AB switch.

Annual Inspection and Half Yearly Maintenance

i. Measure resistance of earth pit. Resistance shall not exceed 1 ohm.
ii. Check bus bar connections, clean contact faces, change rusted nut bolts.
iii. Calibrate the protection relay for functioning. Check relay setting and correct if necessary.
iv. Ensure that sub-station area is not water-logged. If required necessary earth fillings with metal spreading at top shall be carried out once in a year.
v. Check drainage arrangement to prevent water logging in substation area and cable trenches.
vi. Test transformer oil for acidity test.

D.C. battery

i. Maintenance schedule as under shall be applicable for D.C. Batteries.
ii. *Daily:* Check voltage and specific gravity of the batteries and battery supply for the tripping circuit.
iii. *Monthly:* Check the battery charging & fuses and clean contact faces.
iv. *Monthly:* Apply petroleum jelly or grease to battery terminals.

Lifting Equipment

Relevant points in the maintenance schedule as follows shall be applicable for lifting equipment, depending on the type of lifting equipment i.e. chain pulley block, monorail (travelling trolley and chain pulley block), manually operated overhead crane and electrically operated travelling crane.

i. Quarterly:

- Check oil level in gear box and top up if required.
- Check for undue noise and vibration.
- Lubricate bearings and gear trains as applicable.
- Check insulation resistance of motors.

ii. Half yearly:

- Clean limit switches.
- Clean all electrical contacts.

iii. Yearly:

- Change oil in gear box.
- Conduct load test of crane for rated load or at least for maximum load required to be handled. All fast moving components which are likely to wear should be thoroughly inspected once in a year and if necessary shall be replaced.

Water Hammer Control Devices

Maintenance requirements of water hammer devices depends on type of water hammer control device, nature of its functioning, water quality etc. Type of water hammer control devices used in water pumping installations are as follows:

- Surge tank
- One-way surge tank
- Air vessel (air chamber)
- Zero velocity valve and air cushion valve.
- Surge anticipation valve (surge suppressor)
- Pressure relief valve.

General guidelines for maintenance of different types of water hammer control devices are as follows:

Surge Tank and one-way surge tank

- *Quarterly:* Water level gauge or sight tube provided shall be inspected, any jam rectified, all cocks and sight tube flushed and cleaned.
- *Yearly:* The tank shall be drained and cleaned once in a year or earlier if frequency of ingress of foreign matter is high.
- *Valve maintenance:* Maintenance of butterfly valve, sluice valve and reflux valve shall be attended as specified for valves on pump delivery.
- *Painting:* Painting of tanks shall be carried out once in 2 years.

Air Vessel

- *Daily:*

➢ Check air-water interface level in sight glass tube.

The air water level should be within range marked by upper and lower levels and shall be preferably at middle.

➢ Check pressure in air receiver at interval of every 2 hours.

- *Quarterly:*

➢ Sight glass tube and cock shall be flushed.
➢ All wiring connections shall be checked and properly reconnected.
➢ Contacts of level control system and pressure switches in air supply system shall be cleaned.

- *Yearly:*

➢ The air vessel and air receiver shall be drained, cleaned and dried.
➢ Internal surface shall be examined for any corrosion etc. and any such spot cleaned by rough polish paper and spot-painted.
➢ Probe heads of level control system shall be thoroughly checked and cleaned.

- *Accessories:*

➢ Maintenance of panel, valves and air compressor etc. shall be carried out as specified for respective appurtenances.

Zero Velocity Valve and Cushion Valve

Foreign matters entangled in valve shall be removed by opening all handholes and internal components of the valves including ports, disk, stem, springs, passages, seat faces etc. should be thoroughly cleaned and checked once in 6 months for raw water and once in a year for clear water application.

Surge Anticipation valves

Pilot valves and tubes shall be flushed and cleaned every month.

Pressure Relief valve

The spring shall be checked and freed from jam every month.

Air Compressor

i. *Daily:*

➢ Clean external surface.
➢ Check oil level and top up if necessary.

ii. *Monthly:*

➢ Clean oil filter
➢ Clean air filter

iii. *Quarterly:*

➢ Check condition of oil and change if dirty.
➢ Check grease in bearing housing and replenish/change if necessary.
➢ Check condition of oil in air filter and change if dirty.

iv. *Half yearly:*

- ➢ Change oil.
- ➢ Change oil filter element.
- ➢ Thoroughly clean air filter.
- ➢ Clean bearing and bearing housing and change grease/oil.

v. *Yearly:*

- ➢ Thoroughly check all components, piping valve etc. and rectify if necessary.

Maintenance Of Pumping Station

Maintenance as follows shall be carried out for screens, penstock/gate, and sump/intake/well and pump house including civil works.

Screens

i. Screen should be cleaned at a frequency depending on ingress load of floating matters. The frequency in monsoon season shall be more than that in fair season.
However, cleaning frequency should be at least once in a week, or, if head loss in screen exceeds 0.20m.

ii. Care should be taken to remove and dump the screening far away from the pump house.

iii. Lubricate wheels and axle of wheel burrows.

iv. The screen, catch tray and screen handling arrangement shall be thoroughly inspected once in six months and any item broken, eroded, corroded shall be rectified.

Sump/Intake Well

i. All foreign floating matters in the sump/intake shall be manually removed at least once in a month and shall be disposed off away from pump house.

ii. Desilting of intake/sump shall be carried out once in year preferably after monsoon.

iii. Care should be taken to dump the removed silt away from pump house.

iv. It is generally observed that reptiles like snakes, fish, etc. enter intake particularly in monsoon. The intake should be disinfected.

v. The sump/intake should be fully dewatered and inspected once in a year.

vi. It is advisable to undertake leakage test of sump once in a year. For this purpose, the sump shall be filled to FSL and drop in water level for reasonably long duration (2-3 hours) should be observed. If leakage is beyond limit, rectification work shall be taken.

Pump House

i. The pump house should be cleaned daily. Good house keeping and cleanliness are necessary for pleasant environment.

ii. Entire pump house, superstructure and sub-structure shall be adequately illuminated and well ventilated. Poor lighting, stale air etc. create unpleasant environment and have an adverse effect on will of the staff to work.

iii. Wooden flooring and M.S. grating wherever damaged should be repaired on priority.

iv. It is observed that at many places, roof leaks badly and at times the leakage water drips on the panel/motor which is dangerous and can cause short circuit and electric accidents. All such leakages should be rectified on priority.

v. All facilities in sub-structure i.e. stair case, floors, walkways etc. should be cleaned daily.

vi. Painting of civil works should be carried out at least once in two years.

Predictive Maintenance

Predictive maintenance is the term used to examine and predict likely failure of components. As this requires experience, anticipation, good judgment and expertise and involves costs for repairs for predicted failures, it can be adopted at important, vital and large pumping stations.

Pumps And Bearings

Some factual evidence i.e. declining of pump performance, excessive noise or bearing temperature, increase of vibration can indicate that the pump probably needs to be overhauled or bearing need to be replaced.

Efforts should be made to rectify noise and vibration level by critical study and adopting measures for rectifications. If noise or vibration still persists, the pump should be dismantled and thoroughly checked.

If significant reduction in discharge is suspected, performance test at site shall be conducted with calibrated instruments and the results of the tests are compared with initial results of new pump. After fully ascertaining that the performance has considerably declined, decision to overhaul may be taken.

In some installations particularly if raw water is corrosive or contains grit or sand, the pump may become prematurely due for overhaul due to deterioration caused by corrosion or erosion.
In such cases, the decision for overhaul should be based on circumstantial evidence i.e. previous history. As a long term solution, the manufacturer should be consulted for use of better material of construction for affected components.

Electrical Equipment

Weakening of insulation and failure of winding can be predicted by measuring insulation resistance and judging trend of weakening of insulation. The predictive maintenance test is recommended for following components of electrical machinery.

i. Motor winding and insulation … Quarterly
ii. Transformer winding and insulation … Annual

For condition monitoring of motors polarization index shall be checked. The polarization index is ratio of meggar value after 10 minutes and meggar value after1 minute. The measurement should be taken with help of motorized meggar. For a healthy motor from insulation resistance point of view, the value of PI shall be more than 1.25.

Electrical Equipment

Facilities as follows should be provided for maintenance, inspection and repairs in the pumping installation.

- Adequate stock of consumables and lubricants
- Adequate stock of spare parts
- Tools and testing instruments
- Lifting equipment
- Ventilated and illuminated adequate space for repairs

Consumables And Lubricants

Adequate stock of gland packing, belts, gaskets, lubricating oil, greases, transformer oil, insulation tape, sealing compound, emery paste etc. shall be maintained. The consumables and lubricants shall be of proper quality and grade. Quantity shall be decided depending on consumption and period required to procure and replenish the stock.

Spare parts

Adequate stock of spare parts should be maintained to avoid downtime due to non-availability of spares. Generally spares required for one-two years maintenance as per list below shall be kept in stock. The list should not be considered as full-fledged and comprehensive and should be updated and revised in light of manufacturers' recommendations and previous history of repairs undertaken.

- Set of wearing rings
- Shaft sleeves
- Bearings
- Gland packings and gaskets
- Coupling bushes and bolts and spiders
- Line shaft
- Pump shaft
- Shaft enclosing tube
- Tube tensioning plate
- Impeller
- Gland nut
- Lantern ring
- Coupling for line shaft
- Carbon brushes
- Slip ring unit
- Fixed and moving contacts
- Line shaft bearings
- Lugs
- Gland for cable termination
- Fluorescent tubes and lamps
- Fuses
- Rotating assembly of pump (for large pumping installation)

Tools And Testing Equipment

The pumping installation should be equipped with all necessary tools, testing instruments and special tools required for repairs and testing. Their quantity and special tools depend on size and importance of installation. Generally following tools and testing instruments shall be provided.

Tools

- Double ended spanner set and ring spanner set.
- Box spanner set
- Hammers (of various sizes and functions)
- Screw driver set
- Chisel
- Nose plier, cutting plier
- Flies of various sizes and smooth/rough surfaces
- Adjustable spanner
- Pipe wrenches
- Bearing puller
- Torque wrench
- Clamps for column pipes, tube and line shaft.
- Specials tools such as grinder, blower, drilling machine.
- Tap and die set.
- Bench vice
- Special tools for breakers

- Crimpling tool
- Heating stove for heating sleeves.

b) Test instruments

- Insulation tester
- Tongue tester
- AVO meter
- Test lamp
- Earth resistance tester
- Wattmeter, CT and PT
- Dial gauge
- Tachometer

Lifting And Handling Material Aids

Following lifting and material handling aids shall be kept in the pump house.

- Chains
- Wire rope
- Manila rope
- Chain pulley block and tripod.
- Other lifting equipment
- Hand cart
- Ladder

Space

A well ventilated and illuminated adequate space shall be earmarked for repairs. Minimum facilities such as work table, bench-vice etc. shall be provided.

Trouble Shooting of Pumps and Electricals

Trouble shooting check charts for the following equipments are enlisted below.

- Pumps (Centrifugal, jet, VT, submersible, vacuum, reciprocating).
- Electric motor
- Capacitors
- Starters, breakers and control circuits
- Panels
- Cables
- Transformer
- Batteries
- Air compressor

Trouble Shooting For Centrifugal/Submersible Pumps

Trouble & Causes

Trouble	Possible Causes (numbers as per the list below)	List of causes
• Pump does not deliver water. (water not delivered to not completely filled with water.)	1,2,3,5,6,9,15,18,21,23,28,29,31,33,40,41,42	1. Pump not fully primed i.e pump or suction pipe discharging end i.e. reservoir/WTP. 2. Pressure at eye of impeller has fallen below vapor pressure Causing cavitation (check for clogging on suction side. If not clogging is observed take action against Sr. 3)
• Insufficient discharge delivered	2,3,4,5,6,7,8,10,13,16,18,20,21,23, 27,28,30,31,33,39,40,41	3. Suction lifts too high(Reduce suction lift after calculating permissible suction lift from NPSHAR
		4.
• Insufficient pressure developed	2,3,4,21,23,24,26,27,33,39	5. Excessive amount of air in liquid
• Pump losses prime after starting	4,5,6,7,10,16,17,18	6. Air pockets in suction line (Check whether any point in the suction line is above center line of pump and if so, lower the line.
• Pump requires excessive power.	22,25,28,33,37,38,49,53,54,55,56,58	7. Air locks into pump through stuffing boxes or mechanical seals
• Stuffing box leaks excessively	34,36,44,45,46,47,48,50,51,52	8. Net opening area of foot valves less. 9. Foot valve/Strainer partially or fully clogged or silted up.
• Gland packing has short life	11,12,34,36,44,45,46,47,48,49,50,51,52	10. Section bell mount or foot valve insufficiently submerged. (Lower the inlet for adequate submergence for vortex-free operation as 11. Water seal pipe clogged
• Bearing has short life	17,20,32,34,35,36,37,39,41,44,48,51,54,55 ,57,58,59,60,62,63	12. Seal cage improperly in stuffing box, preventing sealing, fluid from entering space to form seal
Pump vibrates or noisy at all flows	10,17,19,20,22,23,33,34,35,36,37,38,40,41 ,43,45,46,47,48,51, 52,53,55,56,57,58, 59,60,61,62,63,65	13. Circular motion in suspended suction pipe observed (the problem indicates occurrence

Pump vibrates or noisy at low flows	1,2,3,9,20,21,27,39	14. Foot valves leak 15. Flap of foot valve jammed
Pump vibrates or noisy at high flows	25,28	16. Concentric taper in suction line causing air-pocket (Replace with eccentric taper)
Pump oscillates axially	38	17. Occurrence of vortex in intake, sump or well (Check whether all parameters for vortex-free in-take parameters are satisfied)
Couplings fail	34,36,38,60,62	18. Casing not air-tight and therefore breathing in
Pumps overheat and or seizes	1,2,3,11,12,17,20,26,27,31,34,36,37,38,44, 45,46,47,48,50,53, 54,55,56,57,58	19. Short bend/elbow on suction side.
		20. Inadequate clearance below suction bell mouth. (Raise bell mouth to achieve clearance for vortex-free operation.
• Pump rotates in reverse direction on shut-down or after power failure or tripping.	14,64	21. Speed too low for pump driven by diesel engine 22. Speed too high for pump driven by diesel engine 23. Wrong direction of rotation 24. Total head of system higher than design of the pump 25. Total head of system lower than design of the pump 26. Static head of system higher than pump design head 27. Pump characteristic unsuitable for parallel operation of the pumps 28. Burst of leakage in pumping main 29. Pumping main partially or fully clogged 30. Air trapped in pumping 31. Malfunctioning of line valve causing partial or full closure 32. Capacity of thrust bearing inadequate 33. Foreign matter in impeller 34. Misalignment 35. Foundations not rigid or broken/loose foundation bolts or supporting structural member RCC/structural steel beams) not rigid (Dismantle existing foundation supporting RCC/ structural member beams) 36. Pump impeller shaft bent. 37. Rotating part rubbing on stationary part 38. Pump shaft bearing (bush bearing or antifriction bearing) worn.

		39. Wearing rings worn 40. Impeller damaged 41. Impeller locking pin or collate loose 42. Pump shaft or transmission shaft broken. 43. Transmission shaft bent 44. Shaft or shaft sleeves worn or scored at the packing. 45. Gland packing improperly installed. 46. Incorrect type of gland packing for operation conditions. 47. Shaft running off center because of worn out bearing or misalignment 48. Rotor out of balance, causing vibration. 49. Gland tight, resulting in no flow of liquid to lubricate gland. 50. Failure to provide cooling liquid of stuffing boxes. 51. Excessive clearance at the bottom of stuffing box between shaft and casing, causing interior packing to be forced into pump 52. Dirt or grit in sealing liquid leading to scoring of the shaft or shaft sleeve 53. Excessive thrust caused by mechanical failure inside the pump or by the failure of the hydraulic balancing device if any. 54. Excessive grease or highly viscous oil anti-friction bearing housing or lack of cooling causing excessive bearing temperature 55. Lack of lubrication causing over-heating and bearing or transmission shaft bearing. 56. Improper installation of anti-friction bearing (damage during assembly, incorrect assembly of stacked bearings, use of unmatched bearings as a pair etc.) 57. Dirt in bearings 58. Rusting of bearings from water in housing 59. Mechanical seal worn out 60. Coupling bushes or rubber spider worn out or wear in coupling 61. Base plate or frame not properly levelled 62. Coupling imbalances 63. Bearing loose on shaft or in housing 64. Reflux valve (NRV) does not close tight closure during shut down or after power or tripping 65. Critical speed close to normal speed of pump.

Trouble Shooting Delivery Pipes, Header And NRV

S/No	Trouble	Cause	Remedy
	Hot bearings	• Bent or sprung shaft.	• Straighten or replace shaft.
		• Excessive belt pull.	• Decrease belt tension
		• Misalignment	• Correct coupling alignment.
		• Bent or damaged oil rings	• Replace or repair oil rings
		• Oil too heavy or too light.	• Use recommended oil. Use of oil of too light grade is likely to cause the bearings to seize.
		• Insufficient oil level	• Fill reservoir to proper level when motor is at rest.
		• Badly worn bearings	• Replace bearings.
		• Bearing loose on shaft or in bearing housing	• Remetal shaft/housing or replace shaft or bearing housing
		• Insufficient grease	• Maintain proper quantity of grease in bearing.
		• Deterioration of grease or lubricant contaminated	• Remove old grease, wash bearings thoroughly with kerosene and replace with new grease.
		• Excessive lubricant	• Reduce quantity of grease. Bearing should not be more than two-third filled.
		• Overloaded bearing	• Check alignment, side thrust and end thrust.
		• Broken ball or rough races.	• Clean housing thoroughly and replace bearing.
	Motor dirty	• Ventilation passage blocked. Windings coated with fine dust or lint (dust may be cement, saw dust, rock dust, grain dust and the like).	• Dismantle entire motor and clean all the windings and parts by blowing off dusts, and if necessary, varnish
		• Bearing and brackets coated with fine dusts/cement	• Clean and wash with cleaning solvent
		• Rotor winding coated with fine dusts/cement	• Clean and ploisn slip ring. • Clean rotor and varnish.
	Motor stalls	• Motor overloaded	• Check any excessive rubbing or clogging in pump.

		• Low voltage	• Correct voltage to rated value.
		• Open circuit	• Fuses blown, check over-loads relay, starter and push button
		• Incorrect control resistance of wound motor	• Check and correct sequence; Replace broken resistors
		• Mechanical locking in bearings or at air gap.	• Dismantle and check bearings. Check whether any foreign matter has entered air gap
	Motor does not start	• No supply of voltage or single phasing or open circuit or voltage too low	• Start on no-load by decoupling. Check for cause for over-loading.
		• Starter or switch/breaker contacts improper	• Examine starter and switch/breaker for bad contact or open circuit. Make sure that brushes of the slip-ring motor are making good contact with rings.
		Initial starting torque of the load is high	If or squirrel cage type and with auto-transformer starter, change to a higher tap. If of a lower slip ring, lower the starting resistance.
		Rotor defective	Check for broken rings
		Poor stator coil connection	Remove end shields, check end connections.
		Mechanical locking in bearings or air gap.	Dismantle and repair. Clean air gap if checked.
	Motor runs and then stops	Power supply system faulty bearings or at air gap	Check for loose connections or single phasing switches, breakers, starter, bush-bars and conductor.
		Overloaded replay trips	Examine over-loaded relay setting. Ensure that the relay is set correctly to about 140 - 150% of load current. Check whether clashpot is filled with correct quantity of grade of oil. Consult manufacture whether suitable for design duty and load.

		Voltage too low at motor terminals because of line drop.	Check voltage, change tapping on transformer.
		Improper connection.	Check that all brushes are ridings on rings. Check secondary connections. Leave no lead poorly connected.
		Broken rotor bars.	Look at cracks near the rings.
	Motor takes too long to accelerate	Excess loading	Reduce load. (Note that if motor is driving a heavy load or starting up a long line of shafting, acceleration time will be more).
		Time setting of starter not correct.	Check whether timer setting of star – delta or autotransformer starter is less that acceleration time required for the torque of driven equipment.
		Defective squirrel cage rotor	Replace with new rotor.
		Applied voltage too low	Correct the voltage by changing tap on transformer. If voltage is still low, take up the matter to power supply authority.
	Wrong rotation	Wrong sequence of phases	Inter-change connections of two leads at motor or at switchboard for two phases.
	Motor overheats while running	Check for overload	If over-loaded, check and rectify cause for over loading. Overloading may be due to system fault, e.g. if pipeline bursts, the pump may be operating at low head causing overload of motor. Vortices in sump also may cause overload
		End shields may be clogged with dust, preventing proper ventilation of motor.	Blow off dust from the end shields
		Motor may have one phase open.	Check to make sure that all leads are well connected.
		Unbalanced terminal voltage	Check for faulty leads, connections from transformer.
		Weak insulation	Check insulation resistance, examine and revarnish or change insulation

		High or low voltage	Check voltage of motor and correct it to the extent possible
		Rotor rubs on rotor bore	Replace worn out bearings. Check for trues running of the shaft and rotor.
	Motor vibrates after connections have been made	Motor misaligned. Weak foundations or holding down bolts loose.	Realign. Strengthen base plate/foundation; tighten holding down bolts.
		Coupling out of balance	Balance coupling.
		Driven equipment unbalanced.	Balance rotating elements of driven equipment on dynamic balancing machine.
		Defective ball or roller bearings.	Replace bearings.
		Bearings not in line	Line up properly
		Rotor unbalanced	Rebalance rotor on dynamic balancing machine.
		Single phasing	Check for open circuit in all phase.
		Resonance from supporting structure or foundations or vibration of adjoining equipment	Seek consultation from expert.
	Unbalanced line current on polyphaser motor during normal operation	Unbalanced terminal voltage	Check from contacts or circuit in all phases.
		Poor rotor contacts in control wound rotor resistance.	Check control devices
		Brushes not in proper position in proper position in wound rotor	See brushes are properly seated
	Scrapping noise	Fan rubbing air shield or striking insulation.	Check for cause and rectify
		Loose on bed plate	Tighten holding down bolts
	Magnetic noise	Air gap not uniform	Check and correct bracket fits or bearing.
		Rotor imbalance	Rebalance on dynamic balancing machine
		Stator stamping loose	Retighten
		Loose bearings	Correct or replace bearings
	Motor sparking at slip rings	Motor may be overloaded	Reduce the load

		Brushes may not be of correct quality and may not be sticking in the holders	Use brushes of the grade recommended and fit properly in the brush holder
		Slip rings dirty or rough	Clean the slip rings and maintain smooth glossy appearance and free from oil and dirt.
		Slip rings may be ridged or out of turness	Turn and grind the slip rings in a lathe to a smooth finish.
	Leakage of oil or grease on winding	Thrust bearing oil seal damaged	Clean the spilled oil on winding. Replace oil seal.
		Excessive oil, grease in bearing	Reduce quality to correct extent. Grease should be filled up to maximum half space in bearing housing.

Trouble Shooting For Capacitors

S/No.	Trouble	Cause	Remedy
1.	• Leakage of heclor[8]	• Leaking weld & soldiers	• Repair by soldiers
		• Broken insulators	• Replace insulators
2.	• Overheating of unit	• Poor ventilators	• Arrange for circulation of air either by re-installing in a cooler and ventilated place or arrange for proper ventilation.
	•	• Over-voltage	• Reduce voltage if possible, otherwise switch off capacitors
3.	• Current below normal value	• Low voltage	• Correct Voltage
	•	• Element fuses blown	• Replace capacitor
	•	• Loose connections	• Tighten carefully
4.	• Abnormal budging	• Gas formation due to internal arcing	• Replace capacitor
5.	• Cracking sound	• Partial internal faults	• Replace capacitor
6.	• HRC Fuse blowing	• Short, external to the units.	• Check and remove the short
	•	• Over-current due to over voltage and harmonics	• Reduce voltage and eliminate harmonics
	•	• Short circuited unit	• Replace capacitor
	•	• kVAR rating higher	• Replace with bank of appropriate LVAR
7.	Capacitor not discharging	Discharge resistance low	Correct or replace the discharge resistance
8.	Unbalanced current	Insulation or di-electric failure	Replace capacitor unit

[8] Leakage of Heclor from terminals, insulators or lid e.t.c. is not a serious trouble. After cleaning, the nuts should be tightened carefully, araldite shall be a applied if necessary and the capacitor should be put into circuit. If the leakage still continues, refer the matter to manufacture.

Trouble Shooting For Starters, Breakers And Control Of Circuits

S. No.	Trouble	Cause	Remedy
1.	• Starter/breaker not switching on	• Non availability of power supply to starter/breaker	• Check the supply
		• Overcurrent relay operated	• Reset the relay
		• Relay reset not operating	• Clean and reset relay
		• Castle lock is not locked properly	• Remove lock and lock it properly
2.	• Starter/breaker not holding on ON-Position.	• Relay contacts are not contacting properly	• Check and clean the contacts
		• Latch or cam worn out	• Re-adjust the latch and cam.
3.	• Starter/breaker tripping within short duration due operation of over-current relay	• Over-current relay setting incorrect	• Check and reset to 140-150% of normal load current.
		• Moderate short circuit on outgoing side	• Check and remove cause for the short circuit
		• No or less oil in the dashpot	• Fill oil up to level mark
		• Dashpot oil not of proper grade	• Check and use oil of correct grade.
			• Check for short circuit or earth fault.
			• Examine cause of over-load and rectify.
		• Loose connection	• Clean and tighten
4.	• Starter/breaker not tripping after over-current or short circuit fault occurs.	• Lack of lubrication to mechanism.	• Lubricate hinge pins and the mechanism
		• Mechanism out of adjustment	• Adjust all mechanical devices i.e. toggle stops, buffers, spring as per manufacturer’s instructions

		• Failure of latching device	• Examine surface, clean and adjust latch. If worn or corroded, replace it.
		• Mechanical binding	• Replace over-current relay (and heater, if provided)
		• Relay previously damaged by short circuit.	• Replace over-current relay and heater.
		• Heater assembled incorrectly	• Review installation instructions and correctly install the heater assembly.
		• Relay not operating due to:	•
		• -Blown fuse	• -Replace fuse
		• -Loose or broken wire	• -Repair faulty wiring, ensure that all screws are tight
		• -Relay contacts damaged or dirty.	• -Replace damaged contacts.
		• -Damaged trip coil.	• -Check and repair/replace.
5	• Overheating	• Poor condition of contacts	• Clean and polish contacts
		• Contacts out of proper alignment	• Align the contacts
		• Contacts burnt or pitted	• Clean the contacts with smooth polish paper or if badly burnt/pitted, replace contacts. (Contacts shall be cleaned with smooth polish paper to preserve faces. File should not be used)
		• Loose power connection	• Tighten the connection
		• Sustained overcurrent or short circuit/earth fault	• Check cause and rectify
		• Poor ventilation at location of starter/breaker	• Improve ventilation
6.	• Overheating of auto transformer unit	• Winding design improper	• Rewind
		• Transformer oil condition poor	• Check voltage condition. • Check momentary voltage dip during starting. Low

			voltage prevents magnet sealing. • Check coil voltage rating.
		• Poor contact in control circuit	• Check push button station, (stop button contacts), auxiliary relay contacts and test with lamp.
			• Check for loose connections in control circuits.
		• Defective or incorrect coil	• Replace coil. Rating should be compatible for system.
8.	• Contacts welding	• Abnormal inrush or current	• Check for grounds and shorts in system as well as other compatible for system nominal.
		• Low voltage preventing magnet from sealing	• Check for grounds and shorts in system as well as other components such as circuit breaker.
		• Low voltage preventing magnet from sealing	• Check and correct voltage
		• Short circuit	• Remove short circuit fault and ensure that fuse or circuit breaker rating is correct.
9.	• Short push bottom and/or over-heating of contacts	• Filing or dressing	• Do not file silver tips. Rough spots or discoloration will not harm tips or impair their efficiency.
		• Interrupting excessively high current	• Check for short circuit, earth fault or excessive motor current.
		• Discolored contacts caused by insufficient contact pressure, loose connections etc.	• Replace contact springs, check contact for deformation or damage. Clean and tighten connections.
		• Short circuit	• Remove fault & check fuse or carefully rating whether correct.
		• Dirt or foreign matter on contact surface.	• Clean with carbon tetrachloride
10.	• Coil open circuit	• Mechanical damage	• Examine and replace carefully. Do not handle coil by leads.

		• Burnt out coil due to over voltage or defect.	• Replace coil
11.	• Magnet and other mechanical parts worn out/broken	• Too much cycling • Dust and dirt or mechanical abuse.	• Replace part and correct the cause of damage
12.	• Noisy magnet (humming)	• Defective coil	• Replace coil
		• Magnet faces not mating correctly	• Replace magnet assembly. Hum may be reduced by removing magnet armature and rotating through 180^0
		• Dirt oil or foreign matter on magnet faces	• Clean magnet faces with carbon tetrachloride
13.	• Failure to pick-up and/or seal	• Low voltage	• Check system voltage and voltage dips during starting.
		• Coil open or shortened	• Replace coil
		• Wrong coil	• Check coil voltage rating which must include system nominal voltage and frequency.
		• Mechanical obstruction	•
		•	• With power off, check for free movement of contact and armature assembly. Remove foreign objects or replace contactor
		• Poor contact in control circuit.	• Check and correct.
15	• Failure to drop out	• Gummy substance on pole faces in mechanism	• Clean with Carbon tetrachloride
		• Voltage not removed from control circuit	• Check control circuit
		• Worn or rusted parts causing binding e.g. coil guides, linkages	• Replace contactor
		• Residual magnetism due to lack of air gap in magnetic path.	• Replace contactor

		• Improper mounting of starter	• Review installations and mount property
15	• Failure to reset	• Broken mechanism worn parts, corrosion dirt etc.	• Replace over-current relay and heater
16	• Open or welded control circuit contacts in over current relay.	• Short circuit in control circuit too large protecting fuses.	• Rectify circuit in general. Fuses over 10A rating should not be used.
		• Misapplication, handling too heavy current.	• Check rating and rectify
17	• Insufficient oil in breaker/starter (if oil cooled).	• Leakage of oil.	• Locate point of leakage and rectify.
	• Oil dirty	• Carbonization of moisture from the atmosphere	• Clean inside of tank and all internal parts
		• Condensation of moisture from the atmosphere	•

Trouble Shooting For Panels

S. No.	Trouble	Cause	Remedy
1.	Over-heating	• Bush-bar capacity inadequate	• Check and provide additional bars in combination with existing bush-bars or replace bush-bars
		• Loose connection	• Improper ventilation
		• Improper ventilation	• Improper ventilation
			• Replace the insulator

Trouble Shooting For Cables

S. No.	Trouble	Cause	Remedy
1.	• Overheating	• Cable size inadequate	• Provide a cable in parallel to existing cable or higher size cable • Increase clearance between cable
2.	• Insulation burning	• Improper termination in lug termination	• Check size of lug and correct. • Check whether only few strands of cable are inserted in lug. Insert all higher strands using a new or higher size lug

Trouble Shooting For Transformer

S. No.		Trouble shooting procedure	Cause	Remedy
1.	Abnormal noise	• Listen to the noise at various points of the transformer and find the exact location by means of a solid piece of wood or insulating materials placed on body of transformer tank at various points. This helps in from the inside of determining whether the noise originated from the inside of the transformer or is an external one.	a. External Noise: A loose fixing bolt/nut of the transformer b. Noise originating small transformer, the transformer. In case of old transformer, possibly due to the windings having become slightly slack.	a. Tighten the fixing bolts and nuts such other loose metallic parts b. In the case of such facilities are vailable open the transformer and take up any slackness by placing shim of insulated boards. In case of big tarsnformers it will be necessary to manufacture or repair the transformer.
2.	High Temperature	• The temperature rise of the transformer during 10-24 hours of	a) Transformer is overloaded. b) Transformer room is not properly ventilated.	a) Reduce the load to rated load. b) Improve ventilation of the transformer room to achieve effective air cooling

		operation is observed. The input current oil temperature are noted down at intervals of half an hour and tabulated.		
		•	c) Dielectric strength of transformer oil low	c) Filter transformer oil and improve dielectric strength to 40kV minimum.
		•	d) Certain turns in the winding are short circuited.	d) Major repairs are necessary and should be taken up in consultation with an experienced electrical engineer.
		• The transformer becomes hot in a relatively short period; transformer oil escapes from the conservator or there is even appearance of gas. In the case of built-in buchloz relay, accumulation of inflammable gas accompanied by the alarm signal of the relay.	The transformer has major defect	Take action for major repairs in consultation with an experienced Electrical Engineer and transformer repairer.
		• Abnormal heating of the terminal	Poor termination either inside or outside the transformer	a) External contacts should be checked up and put in order especially in the aluminum bars. b) If heating persists, action for major repairs should be taken in consultation with an experienced Electrical Engineer

3.	Tripping of circuit breaker for blowing fuses		a) Short circuit in the windings. b) Damage in the insulation of the winding or of the terminal.	Action for najor repairs should be taken in consultation with an experienced Electrical Engineer and transformer repairer.
4.	Buchloz relay contains only air		Due to leakage, the transformer has lost so much oil that even conservator and Buchloz relay is drained off	a) Locate the leakage, switch off the transformer leakage socket and weld the transformer tank or replace the packing. b) Fill with dry oil till the oil level indicator. All terminals should be properly cleaned before switching on.
5.	Frequent change of siligel colour		a) Breather leakage	a) Replace packing
			b) Breather oil level low	b) Check oil seal. c) Top up oil level.
			c) Absorption of moisture	d) Moisture to be removed completely.
6.	Oil leak at joints/bushing/drain valve		a) Defective packing	a) Replace packing
			b) Loose packing	b) Tighten properly
			c) Uneven surface	c) Check and correct it
			d) Brushing cracked	d) Replacing with washer.
			e) Drain, valve not fully tight	e) Tighten valve washer.
7	Low insulation resistance		a. Moisture absorption by wining.	a) Heat the windings, by operating transformer on no-load, and check whether insulation resistance improves. If no improvement is observed after operation for 5-6 hours, filter the oil.
			b. Contaminated oil	b) Replace with proper oil

			c. Presence of sludge	c) Filter or replace with oil.
8.	Water inside tank		Defects of joints	Rectify the defect
			Moisture condensation	Drain water and dry the moistures from winding.
			Oil with water when topping up	Heat the winding on load. Recheck dielectric strength and filter if necessary.
9.	Over-heating of cable ends and cable terminals		Loose connections	Check and tighten the connections
10.	Neutral ground conductor (earth strip) burnt		Loose connections	Replace grounding conductor.

Trouble Shooting For Batteries

Battery troubles revealed in the service may be due to inadequate maintenance, incorrect operation and incorrect charging. Many battery troubles can be traced to charging source, under-charging or excessive overcharging eventually leads to battery trouble.

S. No.	Trouble	Cause	Remedy
1.	Readings of specific gravity and voltage very erratic even after equalizing charge for at least 48 hours.	• Battery life over	• Check the following: -Age of battery -Capacity -Appearance of plates -Depth of sediments below plates.
2.	Several cells showing low charge voltage at the end of extended	• Internal short circuit	• Open cells and examine for damage or displaced separators, lead particles between plates or buckled plates
3.	Battery over-heads	• Poor contacts or badly welded joints	• Clean and tighten all bolted connections, reweld doubtful welded joints.
4.	Battery damp and dirty, wood trays deteriorated	• Poor contacts or badly welded joints	• Keep battery dry and clean. Do not overtop when adding water. Clear away all traces of acid and old sealing. Compound from cell lids.
5.	Hydrometer test (at 800F) shows less than 1.200 specific gravity	•	• Battery should be re-charged. Give high rate discharge test for capacity. If cell test OK recharge and adjust gravity of all cells uniformly. Check operation and setting of voltage regulator, make a thorough check of electrical system for circuits, loose connection, corroded terminals e.t.c.

TROUBLE SHOOTING FOR AIR COMPRESSOR

S. No.	Trouble	Cause	Remedy
1.	Compressor does not start	• Dirty contacts	• Clean the contacts on all switches and controls
		• Loose electrical connections or faulty firing	• Tighten connections. Check wiring and rewire if necessary
2.	Compressor noisy	• Loose or misaligned coupling	• Check alignment & tightness
		• Insufficient clearance between piston and valve plate.	• Replace worn out parts
		• Motor or compressor bearing worn out.	• Replace bearing
		• Loose foundation bolts or hold down bolts	• Check alignment & tension
		• Improper support or isolation of piping.	• Tighten bolts
3.	Pipe rattle	• Inadequately supported piping or loose pipe connections	• Support pipes or check pipe connections
		• No muffler in discharge line or muffler improperly located	• Install or move muffler closer to compressor
4.	Compressor will not load	• Low oil pressure	• See Item 5
		Capacity control valve struck open	Repair or replace
		Unloader element struck	Repair
5.	Oil pressure lower than normal or no oil pressure	Faulty oil gauge	Check and replace
		Defective oil pressure regulator	Replace or repair
		Clogged oil suction strainer	Clean
		Broken or worn oil pump	Replace pump assembly
		Worn compressor bearings	Replace

General Safety Aspects

i. Following safety precautions should be observed while working in a pump house.
ii. No electric live part shall be kept exposed. Particular care should be taken not to keep the motor terminals, starter door, panel door etc. in open condition.
iii. Guard for pump – motor coupling and for extended shaft shall be provided.
iv. Top cover of the VHS (vertical hollow shaft) motor shall not be unnecessarily kept in dismantled condition. iv) Helmet, gumboots, hand gloves, torch and emergency lamp etc. shall be provided to the workers.
v. Shock proof rubber matting shall be kept in front of panel and starters.
vi. Discharging devices shall also be provided to work safely on HT side of transformer.
vii. Fire-fighting equipment suitable for electrical fire shall be provided. The fire extinguisher shall be thoroughly checked and recharged once in a year.
viii. Damaged wooden flooring, damaged grating etc. shall be repaired on priority.
ix. Safety railing shall be provided above all openings, unwalled edges of flooring and all such places vulnerable for falling or slipping of staff.
x. First aid box shall be kept at visible and accessible place. The first aid box shall be checked once in a month and all used items shall be replenished.
xi. Staff shall be trained in the following aspects to enhance safety awareness and skills to handle safety aspects.
    - Fire fighting
    - Safety procedures and practices in electrical work
    - First aid (general)
    - First aid for electric shock.

Safety Procedures & Practical In Electrical Work

General guidelines and precautions as follows should be observed for safe working in electrical installations.

Work on Low and medium Voltage Mains and Apparatus

1. Unless a person is authorized to work on live low and medium voltage mains and apparatus, all mains and apparatus to be worked upon shall be isolated from all sources of supply, before starting the work, proved dead, earthed and short-circuited.
2. For earthing and short-circuiting, only recognized methods should be used. Measures such as removing fuses shall be taken against the inadvertent energizing of the mains and apparatus.
3. Only competent, experienced and authorised persons shall work on live mains and apparatus, and such persons should take all safety measures as required
4. Warning boards shall be attached on or adjacent to the live apparatus and at the limits of the zone in which work may be carried out.
5. Immediately before starting work, rubber hand gloves shall be thoroughly examined to see whether they are in sound condition. Under no circumstances shall a person work with unsound hand gloves, mats, stools, platforms or other accessories and safety devices.

Work on High Voltage System in Transformer Station

All high voltage mains and apparatus shall be regarded as alive and a source of danger and treated accordingly unless it is positively known to be dead and earthed.

No person shall work on high voltage mains or apparatus unless covered by a permit-towork and after proving the mains dead except for the purpose of connecting the testing apparatus, etc. which is specially designed for connecting to the live parts. Incoming high voltage power supply shall be disconnected by opening AB switch/GOD. As additional precaution, the DO fuses or HG fuses shall be disconnected. Breaker on HV side shall be kept in open (off) position.

General Precautions in Electrical Precautions

It is always necessary to observe the following rules as precautionary measures in electrical installations.

i. Try to avoid work on live mains which should be switched off before working.
ii. If it is not possible to switch off the mains, make sure before working that your hands or feet are not wet and insulated footwear and rubber hand gloves are worn.
iii. Place yourself in a safe and secure position to avoid slipping, stumbling or moving backward against live conductors or apparatus. Do not rely for protection upon the care assumed to be exercised by others.
iv. In the event of near approach of a lightning storm, all outdoor work on electrical system should be stopped.
v. Make a habit of being cautious. Be on the lookout for danger notice plates, danger flags, warning boards and signals etc. Warn others when they seem to be in danger near live conductor or apparatus.
vi. Never speak to any person working upon live mains or apparatus, unless the person doing the work is aware of your presence and that you are working on electrical system.
vii. In order to rescue a person who has got an electric shock, if there is no other insulator available for rescuing, use your feet rather than hands.
viii. When attending electrical work, be sure that the floor is covered with rubber mat. Concrete floors are dangerously conductive.
ix. When working on high voltage try to keep your left hand in the pocket i.e. avoid your left hand to get in contact with any live conductor or metallic casing of an apparatus or metal pole or cross arms.
x. Do not work in such a place where your head is liable to touch the live mains.

First Aid For Electrical Shock

Standard printed instructions for first aid against electric shock shall be framed and displayed at prominently visible and accessible location. In most of the cases the electric shock due to accidents is momentary and the contact with the live wire is imperfect. In such cases breathing stops momentarily, but due to the shock, the victim becomes unconscious, and heart beats become weak. The most urgent and immediate care for the victim is that he should be given immediate artificial respiration in the manner detailed below, and artificial respiration should be continued till the victims starts breathing normally. It should be borne in mind if the artificial respiration is stopped just after the victims recovers, he is liable to become unconscious again. In some cases the artificial respiration need to be continued for 6 to 8 minutes.

Artificial Respiration

At the time of accident due to electric shock, proceed as follows.

i. When any one gets a shock, the first and foremost duty of the observer is to break the contact of the live mains and body either by switching off the main supply, or the body should be rolled away with dry wooden stick. If a stick etc. is not at hand, a dry piece of cloth should be used. Detach the body from the live mains, or if that is also not available, the loose cloth such as coat or shirt of the victim should be pulled without touching his body.

ii. See if the operator's clothes are smoldering; extinguish the spark first.

iii. Check up if the patient is breathing or not. If he is not breathing, immediately start artificial respiration as detained below until medical aid arrives.

iv. Lay the patient so that no pressure on the lungs of the patient is exerted to facilitate artificial respiration.

Method – I

Lay the patient as shown in Fig. 11.2. Kneel over the patient's back, and place both the hands on the patient's thin portion of the back near the lowest rib in such a manner that the fingers

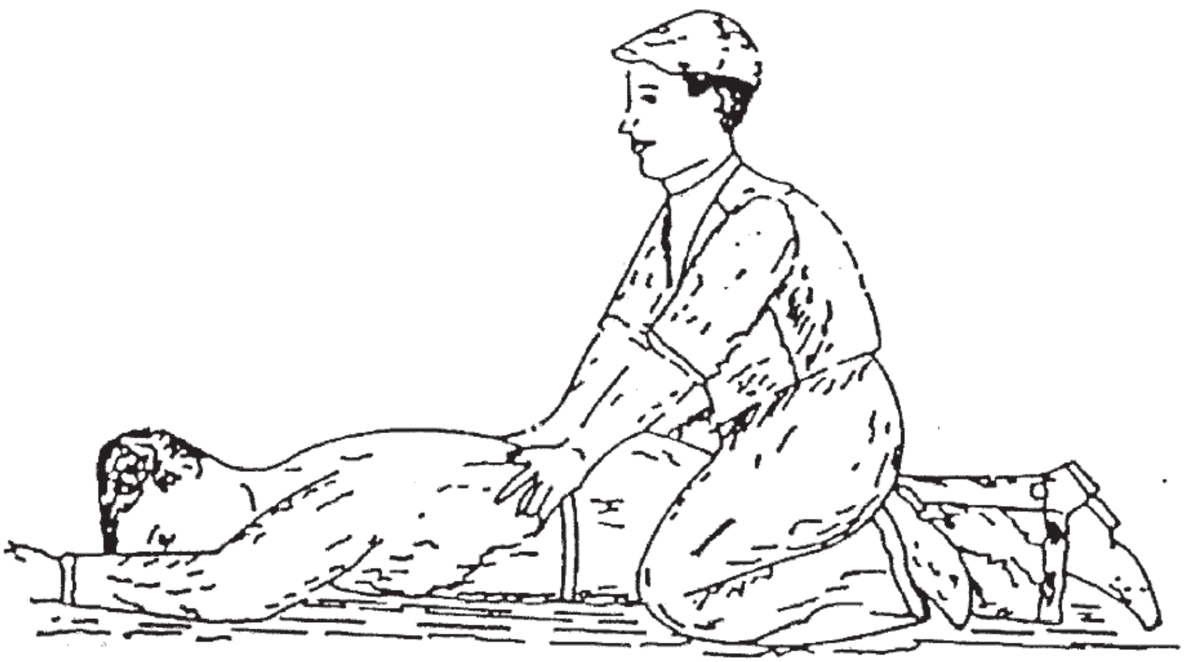


Figure 26: Artificial Respiration

remain spread on the sides and the two thumbs almost touch each other and are parallel to spine. Now press gradually and slowly for about 3 seconds by leaning your hands forward as shown in Fig.1 . The patient should be kept warm. Now relax the pressure slowly and come to the original kneeling position for about 2 seconds as represented in Fig. X. Repeat the process for about 12 to 15 times in a minute so as to expand and contract lungs of the patient to initiate breathing. The process should be continued with great patience and in no case undue force should be used.

Method-II

When the patient has got burns etc. on his chest or anywhere on front side, then the patient should not be laid as in Fig. 1. Appropriate position of laying in such case is on back as shown Fig 1 with a pillow or rolled cloth, mat, bedsheet under his shoulders. The clothes of the patient shall be immediately loosened before starting the process of artificial respiration.

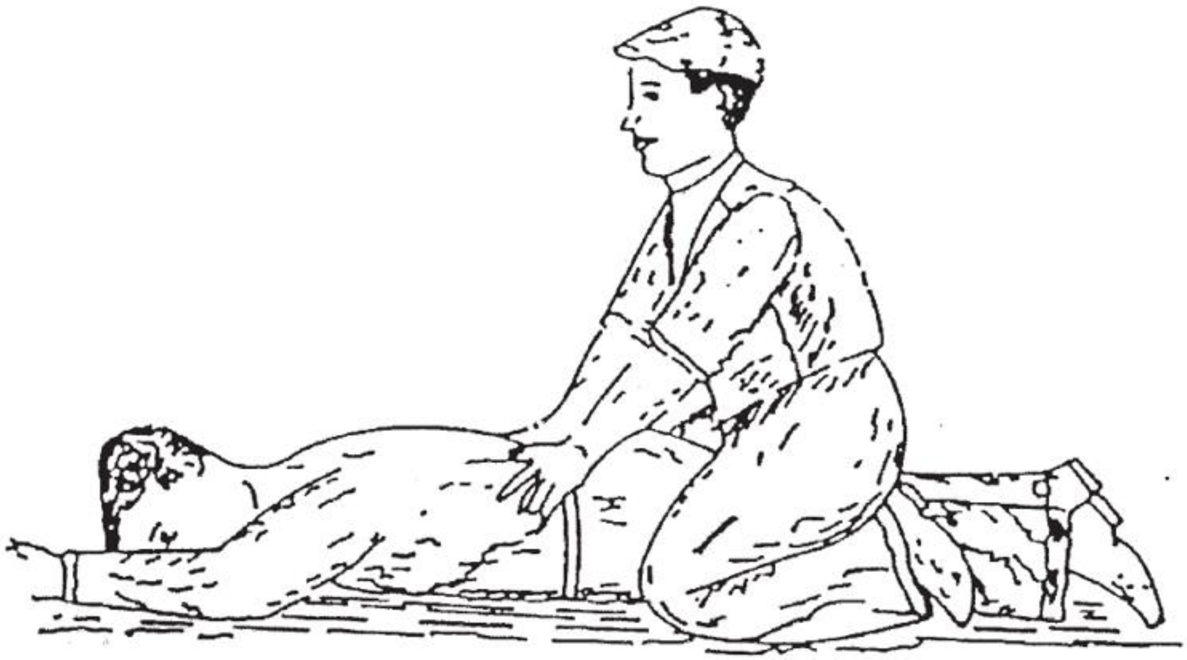


Figure 27: Artificial Respiration

Hold the patient just below the elbow and draw his hand over his head until they are horizontal. Keep them in that position for about two seconds. Now bring the patient’s hands on to his sides kneeling over the patient’s hands so as to compress them down as shown in Fig. 5. After 2 seconds repeat the process again.

Management Indicators

The results of actions by managers at the strategic, tactical and operational level are measured by management/performance indicators. These indicators represent a situation, an event or a change brought about by an action aimed at achieving a target set by the agency. These indicators allows the management to set targets, monitor the O&M, evaluate the performance of the agency and take necessary decisions and corrective actions.

Limitations

The performance monitoring indicators mentioned here are only indicative and the concepts and procedures suggested herein need to be adjusted as appropriate to suit specific problems of each agency. The performance indicators mentioned herein may supplement but not replace any existing performance indicators. Performance monitoring indicators have to be prepared for individual schemes on the basis of an exhaustive assessment of the water supply service under review. Suggested performance indicators of O&M are given in the **Annexure**. Each agency has to choose the relevant indicators and then generate the data for MIS required to assess the appropriate indicators.

How to use Indicators

The performance indictors and the information generated thereon can be the basis for the decision making process involving determining targets, deciding priorities, drafting schedules of O&M, assigning responsibilities and in distribution of human, material and financial resources. In the planning process these indicators provide basis for preparing long term, medium term or short-term plans with appropriate finances allocated in the budgets. These performance indicators provide a measure of what has been achieved so that the results can be evaluated and disparities corrected. Based on the results the targets and indicators need to be changed so as to be nearer to reality. Some of the uses of these indicators are :

i. Maintenance information can be used to assess changes in conditions of installations and equipment and identify potential problems such as weaknesses of structure, reliability of equipment or obsolete equipment and also determine how long the facilities can function usefully.
ii. The maintenance activities can be reformulated to achieve maximum yield at minimum cost.
iii. The data can be used for the preparation of budget. The best justification for the next year's budget is an accurate record of previous year's activities, costs, workload, growth and production. Similarly the records on use of spares and materials and performance of equipment can be used to document the importance of the programme and get adequate financial support.
iv. The trend in the agency's workload can indicate where the workload has increased or where the performance has deteriorated requiring more staff.
v. The need for new equipment can also be justified while preparing budget. Age is not necessarily the only factor for replacing the equipment. Record on production, use and cost of maintenance to keep the equipment operational may also substantiate the need for replacement.
vi. The review shall bring out need for buying new equipment. Additional equipment (including safety equipment) may become necessary from a review of the performance either due to hiring of staff or the need for developing of equipment for specific purpose.
vii. vii) The review will provide an assessment of what spares, and consumables are required for the next year/future.

viii. The review can also bring out the need for economy, for hiring external specialized agency or hiring additional staff for attending to routine or breakdown maintenance or repair work.

ix. The indicators can be used to measure productivity, reduction in breakdowns or frequency of breakdowns linked to productivity levels so as to achieve reasonable level of maintenance with minimum cost.

Each agency has to choose appropriate methods of evaluating effectiveness in achieving the O&M objectives.

Computerized MIS

With the advancement of the Information Technology in this millennium, there is a need to adopt a methodology to align the information strategy with the business strategy of the organization to derive maximum benefits of computerization. A computerized system is a more sophisticated method of providing useful information in different formats to different levels within the organization for discharging duties in a more efficient way. Computers are good at rapid and accurate calculation, manipulation, storage, and retrieval but less good at unexpected or qualitative work or where genuine judgement is required. It has been suggested that computers can be used to best advantage for processing information, which has the following characteristics.

Financial Management Information System

Financial Accounting

- Payroll
- Revenue Management
- General Ledger
- Accounting
- Funds

Project Management Information System

Engineering Planning and Design
Construction
Contracts and Monitoring

Human Management Information System

Manpower planning and Recruitment
Personnel Development and Training

Material Management Information System

Purchasing
Inventory Control

Operation Management Information System

Operation
Maintenance

Marketing Management Information System

Customer Information
Demand Forecasting
Market planning

Reporting

- Operational control level - Handling transactions, process data, preparing detailed reports of various activities, lists, documents, schedules, summary.
- Management control level - obtaining operations data, sorting, analysing and Prioritising, Modifying all information to the requirements for higher level, planning, scheduling, identifying out-of control situations, making decisions, reporting
- Strategic planner level - response to the queries, projections with regard to objectives, resources, and policies of organisation.

Formats Of Reporting

Various reports to be generated and their exact formats will have to be decided by the authorities concerned so that the MIS together with norms that have been set up will clearly highlight the performance indicators. Some of the following type of information in water industry is suggested for strategic planners level.

Financial Management Information System

Monthly capital budget progress details
Annual Billings, Collections, O&M expenditure, Surplus/Deficit

Operation And Maintenance Information System

- Daily reservoir levels, rainfall details, quantity available at source, quantity treated and consumed.
- Weekly % samples with residual chlorine more than 0.2 ppm.
- Weekly pending complaints.
- Fortnightly report on details of new connections.
- Daily status report on mobile water supply.
- Monthly % of unaccounted for water.

Human Management Information System

- Monthly report on staffing and salary.

Projects Planning And Contracts Information System

- Physical and financial status report on ongoing project works.
- Monthly report on contract works awarded.

Material Information System

- Monthly inventory status report.
- Quarterly report on suppliers' performance.

Marketing Information System

- Monthly demand forecasting and market planning.

ANNEXURE

S/No.	Indicator	Method of Calculation	Remarks
1	Coverage of area with water supply	Area with water supply/Total	Identify areas to be provided water supply in the future plans
2	Index of population covered of main by service (%)	Length of streets with water pipelines/total length of streets	Is extension of main required
3	Percent covered by service	Population served/total population	How to serve the unserved population?
4	Service level	Quantity of water produced per day/population served	
4.1	Index of population served by public taps (%)	Population served by public taps/total population	
4.1	Average population served by one public tap	Population served by public taps/number of public taps	
	Index of water distributed or measured (%)	Quantity measured or distributed/quantity produced	
5	Index of water distributed through public taps (unmeasured %)	Quantity of water supplied through public taps/total quantity of water	
6	Water not accounted for	Water bills/water produced	
7	Staff productivity	Number of connection/ Number of Staff	
8	Operational costs per staff	Total O&M cost/Staff number	
9	Operational cost per connection	Total O&M cost/number of connections	
10	Operational cost per KL of water produced	O&M Cost/quantity of water produced in KL	
11	Production cost	Cost of production/quantity of water produced in KL	
12	Distribution cost	Distribution cost/quantity of water produced in KL	
13	Index of use of production or / treatment capacity	Quantity of water produced installed capacity	
14	Index of use of transmission line capacity	Quantity of water transmitted/	
15	Index of use of pumping station capacity	Quantity of water pumped per day/installed capacity	
16	Index of use of reservoir capacity	Average quantity of water distributed/available storage capacity of reservoirs	
17	Index of use of energy at Energy at treatment plant	consumed per day/ quantity of water pumped per day i.e KW/KL pumped	Is there a need for an energy audit by an external agency?

18	Index of use of energy at Energy treatment plant	Energy consumer per day/ quantity of water treated per day i.e. KW/KL treated	
19	Index of use of Coagulant at treatment plant	Coagulant consumed per day/ Quantity of water treated per day (mg/L)	
20	Index of treatment losses	Treated water produced/raw water received	
21	Index of water quality at treatment plant	Percent samples with greater than permissible turbidity	
22	Index of unwholesome samples in distribution system	Percent unwholesome samples	
23	Index of disinfection at treatment plant	Percent samples with less than desired residual chlorine	
24	Index of use of chlorine at treatment plant	Chlorine consumed per day/ quantity of water treated per day (mg/L)	
25	Index of power failures pumping at stations	Hours of pumping lost/ 24 hours or designed pumping hours	
26	Index of other failures at pumping stations	Hours of pumping lost due to reasons other than power failure/24 hours or designed pumping hours	
27	Index of failure of pumping mains	Hours of pumping lost due to transmission line defects/ 24 hours or designed pumping hours	
28	Mean time between failure of pumping equipment	Average of time interval between two successive failures of pumping equipment in a year	
29	Mean time between failure of pumping mains	Average of time interval between two successive failures of pumping mains in a year	
30	Index of failures		
30.1	Power	Power failures/total failures	
30.2	Pumping equipment	Equipment failures/Total failures	Is the equipment reliable or obsolete
30.2	Pumping main	Pumping main failure/Total failures	

31	Index of works done by outsiders		
32	Distribution system (Zone wise)	Number of breakdown orders works Is it economical carried out by compared to specialised agency	works Is it economical agency's own staff?
34	Distribution system (Zone wise)		
34.1	Index of supply timings	Actual hours of water distributed in a day/required distribution hours	
34.2	Storage ratio	Quality of water distributed/ quantity of storage	
34.3	Residual chlorine	Percent samples with less than desired residual Chlorine	
34.4	Bacteriological quality		
	Storage reservoirs cleaning	Actual number of times cleaned/required number of times to be cleaned	
34.5	Level of maintenance of pipe lines		
35	Number of Leaks reported per day	Number of leaks/km of distribution system	
35.1	Index of Leaks attended per day	Leaks attended per day/Leaks reported per day	
35.2	Number of cross connections reported per thousand connections	Number of cross connections reported/number of connections (in thousands)	
35.2	Index of Leaks attended per day	Leaks attended per day/Leaks reported per day	
35.3	Number of points with negative pressures		
36	Consumer connections		
36.1	Total number		
36.2	Domestic (%)		
36.3	Commercial (%)		
36.4	Industrial/bulk (%)		
36.5	Unauthorised connections		
37	Water audit		
37.1	Index of water distributed	Water distributed/water received at the reservoir	
37.2	Index of Billing	Water billed/water distributed	
37.3	Index of domestic supply (%)	Total domestic supply/total distributed	
37.4	Index of commercial supply (%)	Total commercial supply/total distributed	
37.5	Index of Industrial supply (%)	Total Industrial supply/total	

		distributed	
37.6	Functioning of consumer meters	Number of meters non unctional/number of meters	Is there a need to change over to accurate and reliable meters?
37.7	Connections with large consumption	Number of connections	Identify those
38	Financial Indices		
38.1	O&M cost as per capita/per connection	Total O&M Cost/population served or no. of connections	
38.2	Cost of production of water/KL	Total O&M cost/Quantity of water produced	
38.3	Energy costs as percent of Energy cost/O&M cost	Energy cost/O&M cost	Are the energy costs O&M cost going up?
38.4	Spares cost or repairs and replacement costs as percent of O&M cost	Repairs & replacement cost/ O&M cost	
38.5	Consumables cost as percent of O&M cost	Cost of consumables/O&M cost	
38.6	Staff costs as percent of O&M cost	Staff cost/O&M cost	
38.7	Operating ratio for the previous year	Operating revenue/ operating expenses	Identify the reasons for fewer ratios. Is there a need for revision of tariff?
38.8	Current year's operating ratio (as on date of review)	Operating revenue for the year/operating expenses	Identify reasons for shortfall
38.9	Ratio of revenue demanded	Bills served or revenue demanded/budgeted demand	Identify reasons for shortfall
38.10	Ratio of consumer connections No. of consumer connections Billed	No. of consumer connections billed for whom bills are served/ total number of connections	Identify if bills are not served for those connections with large (?) consumption
38.11	Ratio of revenue collected	Revenue collected/bills raised	If the connections with large (?) sums due who have not paid their bills
38.12	Status of disconnection notices	Number of notices served/ number of defaulters	Identify whether disconnection notices are served for connections with large sums due (?)
39	Safety Record		
39.1	Number of accidents per Km or connection	Total number of accidents/	
39.2	Percent fatal accidents	Number of fatal accidents/	

		total accidents	
40	Consumer satisfaction		
40.1	Number of consumer meets organized at section level	Number	
40.2	Number of consumer complaints per thousand connections	Number of consumer complaints received per day/ Number of connections in thousands	
40.3	Consumer complaints attended poor quality)	Average Number of consumer (no water/inadequate pressure/ complaints (weekly or monthly) /number of connections	
40.4	Ratio of consumer complaints attended	Number of complaints received/number of complaints attended on the same day	
40.5	Ratio of unattended complaints (spilled over to next day)	Number of complaints left unattended on the same day/ number of complaints received	

Emergency/Disaster Planning

Disaster Mitigation Management

Any event, natural or man-made, which disrupts a water supply system, can be termed as an emergency. The disasters that may affect a water supply system may vary but the effects are similar. Such disasters occur suddenly. There is no warning and there is no time to plan out how to meet the situation on the spot. It is therefore essential that an advance plan be prepared to meet such exigencies.

Emergency Events

Planning for all types of disasters is not possible. Past experience of emergencies in the system as well as of other systems is very useful in drawing up an emergency plan. We can identify emergencies that are likely to occur; units likely to be affected and steps taken in the past.
Some of the events or emergencies that may arise are:

- Power failure.
- Storms and flooding.
- Epidemics.
- Fire.
- Earthquakes and landslides.
- Explosions.
- Breakdown of water supply system units like pumping burst mains etc.
- Strikes by workmen.
- Sabotage or vandalism.
- Water supply Bioterrorism.

Structure of The Plan

In the preparation of an emergency plan, the following steps should be taken:

1. Consider the whole water supply system and break it up into subsystems from the source upto the consumer's end. Necessary maps, drawings etc. must be included as part of the plan.
2. List the units in each sub-system.
3. Find out what kind of emergency can occur either on the whole subsystem or on the individual units.
4. Plan to prevent such emergencies.
5. Simulate the effects of each emergency on the sub-system or units.
6. Prepare a plan for action for each emergency like meeting water demand through alternative sources, re-routing of supply, rotational supply, supply through tankers etc.
   The person in charge of each problem area must know the system and be equipped with the necessary plans, materials, personnel etc.
7. Prepare a plan for repairing, restoring the normal supply. The operators, supervisors, workmen must be trained and made aware of the different kinds of work to be taken.
   This would include knowledge of location of valves, electrical connections to different parts and units of the system. Absence of trained personnel to make critical decisions and carry out orders is often a critical issue.
8. List all agencies, authorities with whom coordinations is necessary, like the State administration, fire department, police etc. with telephone numbers, addresses and names of the persons to be contacted.
9. List all suppliers of equipment, materials, contractors who have to be contacted with names, telephones numbers and addresses.
10. Identify the headquarters for control and instructions. Proper communication facilities are very essential between the control room and various site units.

11. Make provision for medical care, lodging, food etc. for the staff who will be on round the clock duty. This is more necessary when the location of the disaster is far away like transmission mains, intakes etc.
12. Adequate transport arrangements are necessary. List of vehicles that can be required within the organisation as well as from other departments should be maintained with details of the officers to be contacted.

The considerations to be taken in planning for emergencies would include:

a) The minimum water required for survival for a person could be 3 to 5 litres per day, whereas the desirable would be about 15-30 l/p/d. For Health centres, it could be 40-60 l/patient per day for inpatients and 5 l/p/day for outpatients. Other demands for good sanitation and hygiene may be estimated. If the emergency is long drawn out, other demands will have to be considered. The figures will depend on local conditions.
b) Ground water through hand or motive pumps, ponds, lakes etc.
c) Disinfection through chlorine compounds is a widely used technique. Emergency stocks and sources of supply must be planned for.
d) Proper security like armed guards etc. may be necessary. If treated water supply is available at convenient distances, use of tankers and transport through tanks can be arranged easily and offers flexibility.

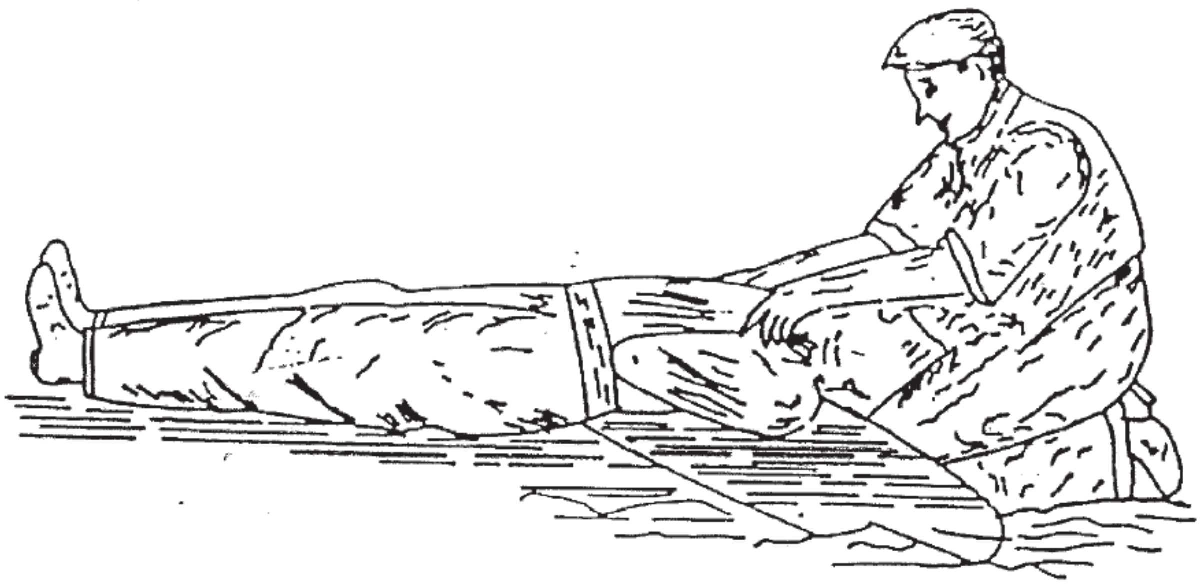
The action plan must include:

- Immediate measures to sustain life.
- Intermediate measures.
- Long term measures.

Threat Of Bioterrorism

In the recent past, bio-terrorism has assumed importance. Water supply facilities are identified as a potential target. Determination of contamination of water before it reaches the consumer is difficult, as laboratory tests are time consuming. However the following precautions can be taken:

1. Increased security measures and more diligent monitoring for pathogens and chemical toxins.
2. Residual chlorine in the storage or service reservoir is a defence against contamination.
   Chlorine may not be effective against chemical toxins but it can be effective against some biological toxins and pathogens. Cholera and the botulin toxin that causes botulism can be inactivated by chlorine. However, resistance of many biological agents like plague and brucellosis to chlorine is unknown.
3. Besides tanks, pipelines are also vulnerable, especially where water supply is intermittent. Contaminants can be injected in the pipelines. Monitoring a vast network of pipe is difficult and residual chlorine again is a safeguard.
4. Ensure that all tanks, manholes are covered and under security surveillance. The size of a water utility system may be the best defence. It will require a large quantity of contaminant to poison a reservoir or tank to cause death or debilitation to someone consuming a glass of water. Calculations can be made to determine the quantity of known toxins like potassium cyanide and others required for poisoning the tank or reservoir. Huge quantities of toxin will be required and it will show the logistics of obtaining and administering the volume of toxin required for contaminating the reservoir or tank. This will be a quick check when rumours are spread about poisoning of water at a reservoir or tank. Also using an animal as a guinea pig who can be fed with the alleged poisoned water can also be a check.
5. Detection of chemical and biological agents that are a threat to water supply is now receiving emphasis. Fast on-site tests utilising DNA analysis for pathogens such as anthrax have been developed. There is need to keep abreast of such developments.



If operator has got burns only, the same should be dressed properly. Oil should never be used on the burns. After burns are dressed properly, he may feel better. It is important to note that the one who has received electric shock is liable to get an attack of hyperstatic pneumonia. So it is necessary to keep him warm for at least a day.

Desirable Environment And Amenities Installation

Environment and cleanliness have tremendous impact on willingness or unwillingness of the workers. In order to maintain working environment following guidelines shall be followed.

- Maintain cleanliness in the installation and surrounding. Cleanliness causes pleasant atmosphere for work.
- Appearance of equipment, furniture and walls etc. should be improved by painting, polishing etc. at about 2 years interval.
- The color selected shall be sober and eye-pleasing.
- Good housekeeping is must for sustaining pleasant environment.
- High noise is major irritant and should be kept within limit, by reducing or isolating the noise emitting sources.

Following amenities shall be provided at installations.

- Dress-changing room and locker facilities.
- Clean toilet and running water supply.
- Drinking water facilities.
- Chairs etc. to rest during work.

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