



Department of Public Health Engineering (DPHE)

**TRAINING ON WATER QUALITY
MONITORING AND SURVEILLANCE
(URBAN AND RURAL)**

**Training Division
Department of Public Health Engineering, Mohakhali, Dhaka
January-2024**

Manual Compilation/Preparation

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Emergency Basis (EMCRP)

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Preface

Providing emergency services like water supply, sanitation, and healthcare is unbelievably challenging in any disaster or crisis. The Rohingya refugee influx in Cox's Bazar is a good example of these challenges. Supplying water, sanitation facilities, proper waste management and health promotion in the densely populated refugee camps is a tremendous task. This immense population strain on Ukhia and Teknaf upazilas significantly threatens the natural environment, socio-economic stability and quality of life, hindering overall development in Cox's Bazar.

To address this, the Department of Public Health Engineering (DPHE) is implementing the Emergency Multi-Sector Rohingya Crisis Response Project (EMCRP) across Cox's Bazar, encompassing the Rohingya camps and the two sub-districts with World Bank funding. This project includes various activities, such as building climate-resilient safe water supplies, implementing drainage systems, establishing sanitation systems, managing wastewater, handling solid waste, and promoting social and gender-inclusive hygiene practices.

To effectively manage the EMCRP's activities and achieve its goals, nine training manuals have been developed covering various relevant topics. These manuals aim to enhance the knowledge and skills of officials, employees, and stakeholders of DPHE involved in the project, including the project office, consultants, implementing agencies, and operation and maintenance organizations. This manual, "Training on Water Quality Monitoring and Surveillance (Urban and Rural)," plays a key role in equipping trainees with essential knowledge about water quality, its importance, relevant guidelines and standards, the need for monitoring and surveillance, and how to apply this knowledge in their daily work. Special attention has been given to make the training course engaging and interactive through various activities and exercises.

I want to express my sincere gratitude to the honorable Chief Engineer, DPHE for involving the Training Division, DPHE and providing overall guidance and to the Project Director of EMCRP for providing invaluable support and assistance in preparing this manual. The following individuals have played a direct or indirect role in the preparation of this training manual: Mr. A K M Ibrahim, Short-term Consultant, EMCRP. I hope that this manual will not only be instrumental in successfully implementing the EMCRP project but will also serve as a comprehensive resource for DPHE officials in the future.



Ruksana Parvin
Executive Engineer
Training Division
Public Health Engineering Department

Forward

In August 2017, a large number of Rohingya refugees forcibly displaced from Myanmar entered the coastal district of Cox's Bazar in Bangladesh, creating one of the world's largest refugee crises. As of today, nearly 1.1 million displaced Rohingya refugees still reside in temporary camps in the two upazilas of Ukhia and Teknaf, under Cox's bazar district in Bangladesh, creating one of the world's largest refugee crises. This influx tripled the local population, placing immense strain on the already weak infrastructure and limited access to basic services. The area is also prone to natural disasters like cyclones and floods.

The World Bank, analyzing initial humanitarian efforts coordinated its ongoing assistance with long-term initiatives for the Rohingya. As part of this, the Department of Public Health Engineering (DPHE) is currently implementing the "Emergency Multi-Sector Refugee Crisis Response Project (EMCRP)" to provide safe water, sanitation, and hygiene facilities to the displaced Rohingya population.

Nine training manuals have been developed on topics like water quality monitoring, sanitation system design and waste management to equip officials, employees, consultants, and implementing organizations involved in the EMCRP. These manuals aim to enhance their knowledge and skills in delivering safe water supply, sanitation services, hygiene promotion, and waste management to the displaced Rohingya population.

I hope these manuals will play a crucial role in strengthening the skills of all concerned. This manual is one of the nine and is intended for DPHE officials. I envision it being used in future training courses for DPHE officials from other projects and potentially even incorporated into the department's regular training program.

I express my gratitude to all those who have played a direct or indirect role in the preparation of the training manuals by providing valuable opinions and suggestions. I congratulate and thank all colleagues including the Project Director of the EMCRP project of the Public Health Engineering Department, the Training Division, and the Short-Term Consultant, EMCRP for their cooperation in finalizing and preparing these manuals.



Engineer Md. Sarwar Hossain
Chief Engineer
Public Health Engineering Department

Acknowledgment

The Rohingya people have been fleeing persecution in Myanmar's Rakhine State since August 2017, entering Bangladesh's Cox's Bazar district. The Bangladesh government has provided them with temporary shelter in the Ukhiya and Teknaf upazilas of Cox's Bazar, on a completely humanitarian basis. The presence of this large displaced Rohingya population has turned the Rohingya camps in Cox's Bazar into one of the most densely populated areas in the world, and meeting the basic needs of the population has become a major challenge. As a result, the development of Cox's Bazar district is being hampered and the quality of life of the local people is at risk.

To address this crisis, the Government of Bangladesh, with the support of the World Bank, is implementing the "Emergency Multi-Sector Refugee Crisis Response Project (EMCRP)", funded by the World Bank, to provide safe water, sanitation, and hygiene facilities to the displaced Rohingya population.

In order to improve the knowledge and skills of the officials, employees, and stakeholders of the Department of Public Health Engineering (DPHE), consultants, implementing, and management and maintenance organizations involved in the implementation and management of these activities, nine training manuals have been prepared on various relevant topics.

The training manual on "Water Quality Monitoring and Surveillance" is part of this effort. This training manual includes a detailed discussion of the relevant topics, a plan for managing the sessions, and various necessary materials (learning and reference materials/reading materials). I firmly believe that this manual will improve the quality of water supply and sanitation activities under the project and will accelerate the project activities.

I would like to express my gratitude to all those who have contributed to the enrichment of the manual through their valuable time, opinions, and suggestions. I would like to express my gratitude to Mr. Md. Sarwar Hossain, the Honorable Chief Engineer of the Department of Public Health Engineering, , for his overall cooperation in preparing the manual by providing overall guidance. I am grateful to the World Bank authorities for their overall cooperation in project management through the original and additional funding of the project. I would also like to express my special thanks to Training Division for developing the manual.

I hope that through this training manual, all concerned with the said work will be properly informed about all matters and will acquire the necessary skills.



Mohammad Abdul Kaiyum

Project Director

Multi-Sector Project to Address the Rohingya Crisis on an Emergency Basis

Department of Public Health Engineering

Useful Information and Tips for Preparation for the Trainers

Registration: Trainees will register in the training room by providing their names, titles, and work areas in the designated book.

Opening: The training will be inaugurated in any formal or informal way. The entire training course will be conducted in a participatory manner, and it is therefore advisable to follow a participatory method during the opening phase.

Duration: This training is for two days. Each session lasts 60 minutes.

Tips:

- Trainers will gain a full understanding of the content and training process of each session before the training begins. It is important to note that the trainers should read the manual carefully to gain a full understanding of the content and training process. Otherwise, it will not be possible to conduct the training properly;
- When choosing the venue for the training, make sure that the training room is well-ventilated and has enough light and space for trainees to sit and move around;
- Collect or prepare in advance the materials mentioned for presentation in various sessions, such as multimedia, video, manuals, and session plans, so that there are no problems in conducting the training;
- Select methods and materials that are aimed at the quality of education of the participants. Since methods and materials with pictures help trainees remember the content, they should be used whenever possible.
- If possible, the knowledge of the trainees before and after the training can be checked.
- Collect or prepare the other materials needed for conducting the training, such as VIP cards, markers, scotch tape, push pins, and name cards for trainees, before organizing the training.
- During the training session, make sure that the training is not one-way and that all trainees participate actively. Allow trainees to express their own experiences and opinions. This will make the training much more realistic and participatory.

- Give equal attention to all trainees and give equal importance to everyone's opinions. No one should feel that you are paying special attention to someone or giving more importance to someone's opinion. This can discourage others.
- Do not give any statements or examples that hurt the self-esteem of trainees or make them feel embarrassed during the discussion of any topic. In addition, do not ask anyone directly if it is not necessary. This can also make trainees feel embarrassed.
- Always keep in mind that the discussion is relevant. If any discussion goes off-topic, bring it back to the topic.
- Try to keep the training environment open and lively. For this, entertainment can be presented during the discussion breaks during the training.
- Mention at the beginning of each session what the topic of discussion is so that trainees can easily understand what topic is being discussed and understand the continuity of the discussion.
- At the end of each session, review the summary of the discussed topics and conclude.
- Do not discuss or use examples during the training that could create a negative impression about any individual, group, or area.

Water Quality- A General Overview

(1st day, 1st Session)

Introduction Session	<ul style="list-style-type: none"> ○ Mutual acquaintance/Knowing each other of the participants ○ Description of training objectives ○ Expectations from that session ○ Pre-training Assessment
Purpose of the Session	<p>At the end of this session</p> <ul style="list-style-type: none"> ○ The Training personnel and participants get to know each other, ○ The Participant will be able to explain training objectives, ○ A learning environment will be created, ○ Coordination between expectations and topics can be achieved.
Duration	1 hour
Training Materials	White Board, White Board Marker, Flip Chart Board, Flip Chart Paper, Flip Chart Marker, Multimedia Projector, Screen, Duster, Manual.
Overall objective of the Training	<p>At the end of the Training, the Participants can be able to</p> <ul style="list-style-type: none"> ○ Define water quality and its importance ○ Identify the key factors that affect water quality ○ Explain the purpose and importance of drinking water quality standards and guidelines
Specific Objectives of Training	<p>After completing the training, the Participants can have clear idea on</p> <ul style="list-style-type: none"> ○ Water Quality, Importance of Water Quality, Factors Affecting Water Quality, Significance of Drinking Water Quality. ○ Drinking Water Quality and Sustainable Development Goals (SDGs), ○ Challenges in Ensuring Access to Safe Drinking Water, Necessity of Standards and Guidelines for Effective Monitoring and Surveillance. ○ They also can be able to know Water Quality Standards VS. Guidelines, Some Examples of DWQ Standards, what are the Steps for setting standards, etc.

Schedule of Training

Session	Content	Time
1st Day		
	Registration	8:30 AM - 9:00 AM
	Training Norms and Ice-Breaking	9:00 AM - 9:30 AM
	Inaugural Session	9:30 AM - 10:00 AM
	Tea and Snacks	10:00 AM - 10:30 AM
Session 1	Water Quality- A General Overview	10:30 AM - 11:30 AM
Session 2	WHO Drinking Water Quality Guideline and Bangladesh Standards	11:30 AM - 01:00 AM
Namaj and Lunch		1:00 PM - 2:00 PM
Session 3	Drinking Water Quality Monitoring for Urban and Rural Areas	2:00 PM - 3:00 PM
Session 4	Drinking Water Quality Surveillance for Urban and Rural Areas	3:00 PM - 4:00 PM
Session 5	Water Quality Parameters	4:00 PM - 5:00 PM
2nd Day		
Session 1	Wrap-up of Previous Day Discussions	9:00 PM - 9:30 PM
Session 2	Standardizing Quality Control: A Step-by-Step Guide to Validation, Verification, and Documentation	9:30 PM - 10:30 PM
Tea and Snacks		10:30 AM - 11:00 AM
Session 3	Sanitation Inspection	11:00 AM - 12:00 AM
Session 4	Group Work	12:00 AM - 01:00 PM
Namaj and Lunch		1:00 PM - 2:00 PM
Session 5	Group Work	2:00 PM - 3:00 PM
Session 6	Group Work Presentation	3:00 PM - 4:00 PM
Closing		

Water Quality- A General Overview

(1st day, 1st Session)

Introduction

Water, the elixir of life, sustains all living beings and maintains the delicate balance of our environment. However, the quality of this precious resource directly impacts our health and well-being. This presentation focuses on the critical aspects of drinking water quality, exploring its importance, the factors that influence it, and the devastating consequences of compromised water quality. Establishing stringent drinking water quality standards and guidelines is essential for ensuring that our drinking water is safe and clean. These standards provide a framework for effective monitoring and surveillance, ensuring that the collected data guides us toward providing communities with wholesome drinking water.

Importance of Water Quality

Water, the foundation of life, plays a crucial role in ensuring our well-being and prosperity. Clean and safe drinking water is essential for human health, agricultural productivity, industrial processes, and maintaining healthy aquatic ecosystems. Contaminated water can pose a serious threat to human health, causing diseases like cholera, dysentery, and hepatitis. Poor water quality can also hinder agricultural production, leading to reduced yields and disrupting ecosystems. Industries rely on water for various processes, and water pollution can affect product quality, increase operational costs, and damage a company's reputation. Aquatic ecosystems, from freshwater rivers and lakes to marine environments, depend on balanced water quality to thrive. Disruptions in water quality can lead to the decline of aquatic species, loss of biodiversity, and disruptions in ecosystem services that benefit human society.

Factors Affecting Water Quality

The quality of our water is influenced by both natural forces and human actions. Natural factors like geology, climate, and hydrology play a role in shaping water quality. Geology affects the composition of water by dissolving minerals, metals, and other substances from rocks and soil. Climate impacts water temperature, rainfall patterns, and the occurrence of extreme weather events, all of which can influence water quality. Hydrology, the study of water movement, distribution, and quality on Earth, is crucial for understanding water quality and developing effective management strategies.

Human activities also have a significant impact on water quality. Agriculture, industry, and urbanization are major sources of water pollution. Agricultural runoff can introduce excessive nutrients into water bodies, leading to excessive plant growth and harmful algal blooms. Industrial discharges can release heavy metals, chemicals, and other pollutants

into water systems. Urbanization can result in increased impervious surfaces, such as roads and buildings, which contribute to stormwater runoff carrying pollutants into waterways.

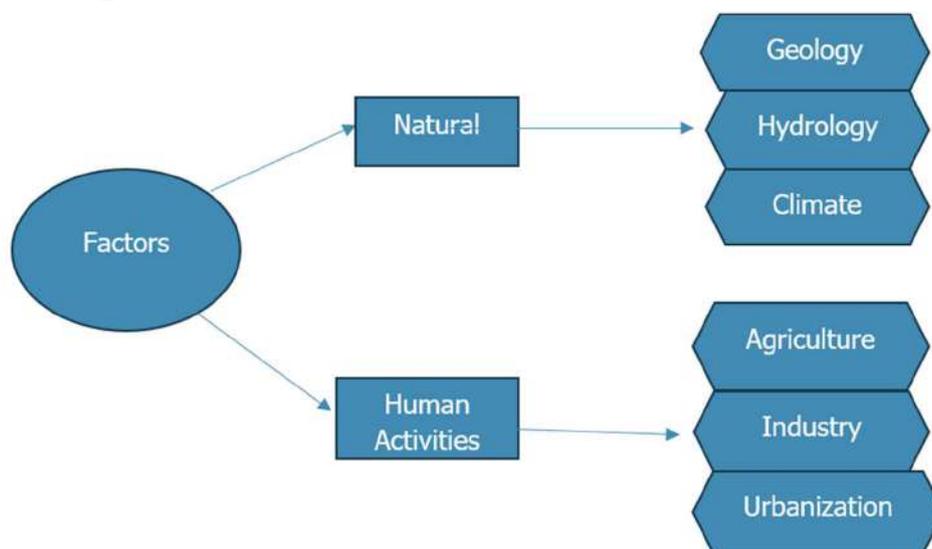


FIGURE-1: FACTORS AFFECTING WATER QUALITY

Understanding both natural and human factors that affect water quality is essential for developing effective strategies to protect and manage our water resources.

Consequences of Poor Water Quality

Poor water quality can have serious consequences, including:

- **Waterborne diseases:** Dirty water can spread diseases like cholera, dysentery, typhoid and hepatitis. These diseases can be fatal, especially for children and older adults.
- **Harm to aquatic life:** Polluted water bodies can damage aquatic life and biodiversity. For example, too many nutrients in the water can lead to harmful algal blooms, which can use up all the oxygen in the water and suffocate fish and other aquatic creatures.
- **Economic losses:** The cost of cleaning up polluted water for drinking and household use, agriculture, and industry goes up a lot. Tourism and recreation businesses can also suffer when polluted water bodies become unpleasant and unsafe.
- **Social conflicts:** Poor water quality can lead to conflicts over who gets access to clean water, making existing social tensions worse.

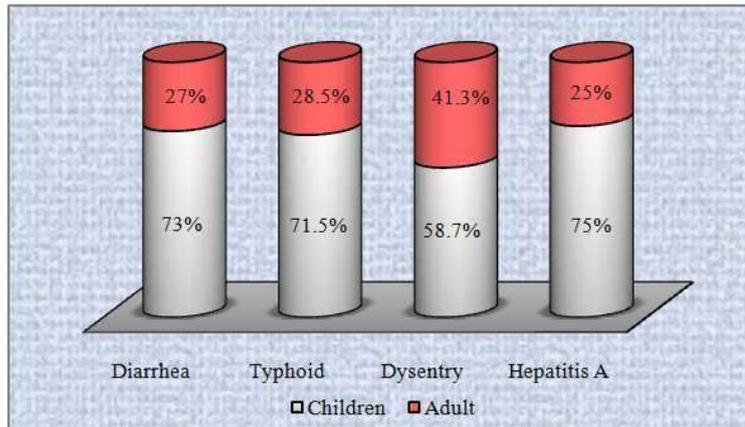


FIGURE-2: PREVALENCE OF WATER BORNE DISEASES IN OLD DHAKA

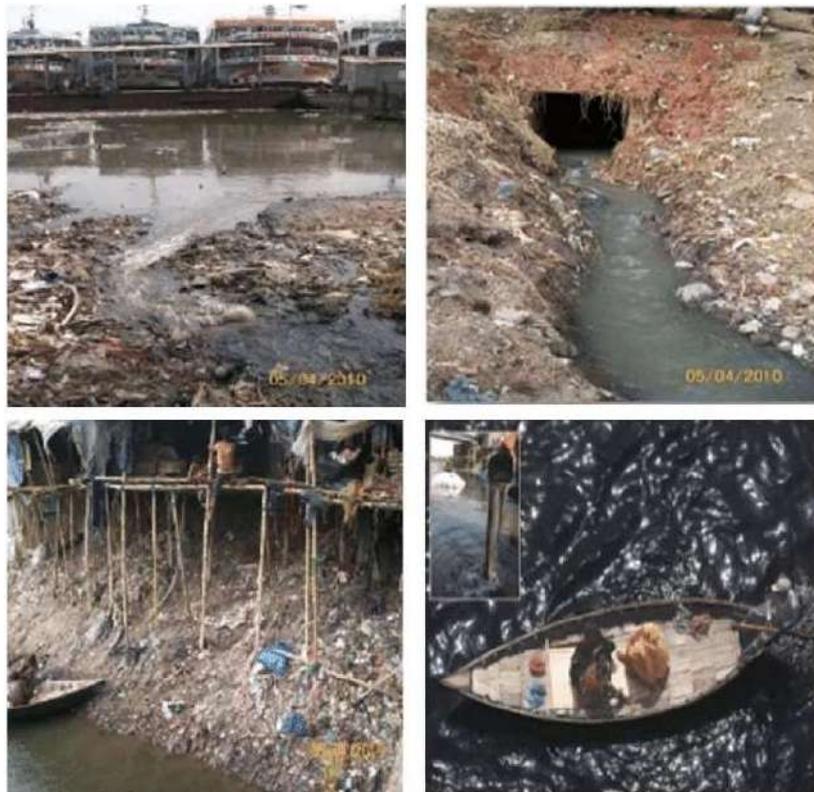


FIGURE-3: AQUATIC LIFE IN DANGER

Significance of Drinking Water Quality

Clean and safe drinking water is a basic human right and essential for a healthy society. It is crucial for proper nutrition, hygiene, and disease prevention. Contaminated drinking water can cause a variety of waterborne diseases, such as cholera, dysentery, typhoid, and hepatitis. These diseases can lead to high death rates, especially among vulnerable populations such as children and the elderly.



Key facts

- In 2021, over 2 billion people live in water-stressed countries, which is expected to be exacerbated in some regions as result of climate change and population growth (1).
- In 2022, globally, at least 1.7 billion people use a drinking water source contaminated with faeces. Microbial contamination of drinking-water as a result of contamination with faeces poses the greatest risk to drinking-water safety.
- Safe and sufficient water facilitates the practice of hygiene, which is a key measure to prevent not only diarrhoeal diseases, but acute respiratory infections and numerous neglected tropical diseases.
- Microbiologically contaminated drinking water can transmit diseases such as diarrhoea, cholera, dysentery, typhoid and polio and is estimated to cause approximately 505 000 diarrhoeal deaths each year.
- In 2022, 73% of the global population (6 billion people) used a safely managed drinking-water service – that is, one located on premises, available when needed, and free from contamination.

FIGURE-4: KEY FACTS ON WATER

Poor drinking water quality also has broader societal impacts. It can lead to impaired public health systems, decreased productivity due to illness, and increased healthcare costs.

Therefore, ensuring access to safe and clean drinking water is essential for sustainable development and an effective public health strategy.

Drinking Water Quality and Sustainable Development Goals (SDGs):

Drinking water quality is a critical aspect of the United Nations Sustainable Development Goals (SDGs), which aim to address various social, economic, and environmental challenges by 2030. Ensuring access to safe and clean drinking water is essential for achieving several of these goals.

Drinking water quality not only affects public health but also plays a role in many aspects of sustainable development. It contributes to achieving several SDGs by promoting health, protecting the environment, encouraging responsible consumption, and improving

community well-being. Access to safe and clean drinking water is a fundamental step toward realizing the broader vision of sustainable development outlined in the SDGs.

Here are some SDG targets related to water quality:



FIGURE 5: SDG 6 AND OTHER SDGS

SDG-6: Clean Water and Sanitation:

Target 6.1: By 2030, everyone should have access to safe, affordable, and equitable drinking water.

Target 6.3: By 2030, water quality should be improved by reducing pollution, eliminating waste dumping and minimizing the release of hazardous chemicals and materials.

SDG 3: Good Health and Well-Being:

Safe and clean drinking water is essential for preventing waterborne diseases and protecting public health. Access to clean water helps reduce child mortality, improve maternal health, and combat diseases like cholera, diarrhoea and dysentery.

SDG 11: Sustainable Cities and Communities:

Target 11.1: By 2030, everyone should have access to adequate, safe, and affordable housing and basic services, and slums should be upgraded.

Effective water quality management in urban areas contributes to improved living conditions and reduces health risks associated with an inadequate water supply.

SDG 17: Partnerships for the Goals:

Collaboration between governments, international organizations, civil society, and private sector stakeholders is crucial for achieving SDG 6 and related drinking water quality targets.

Challenges in Ensuring Access to Safe Drinking Water:

Access to safe and clean drinking water is a fundamental human right and essential for public health and well-being. However, ensuring the quality of drinking water remains a significant challenge around the world. Various factors contribute to this ongoing issue, including:

- 1. Contamination from natural and human sources:** Water sources can be contaminated by both natural processes and human activities. Natural sources of contamination include geological factors that release minerals and metals into water and biological factors such as algae blooms that can produce harmful toxins. Human activities that contribute to water contamination include industrial waste disposal, agricultural runoff, and improper sanitation practices.
- 2. Infrastructure limitations and aging systems:** In many parts of the world, aging and inadequate water infrastructure pose a major challenge to maintaining water quality. Leaking pipes, outdated treatment facilities, and insufficient distribution networks can all contribute to contamination and reduce access to safe drinking water.
- 3. Inadequate monitoring and surveillance:** Effective monitoring and surveillance of water quality are crucial for identifying and addressing contamination issues promptly. However, many regions lack the resources and expertise to conduct comprehensive water quality testing and tracking.
- 4. Financial constraints and resource scarcity:** Ensuring safe drinking water requires significant investments in infrastructure, treatment technologies, and monitoring systems.

Financial constraints, particularly in developing countries, often hinder the implementation of necessary improvements.

5. Climate change and extreme weather events: Climate change is exacerbating water quality issues by increasing the frequency and intensity of extreme weather events such as floods and droughts. These events can lead to increased contamination, disruptions in water treatment, and reduced water availability.

Addressing these challenges requires a multi-pronged approach that includes:

Strengthening water governance and regulations: Implementing robust water quality standards, enforcing regulations, and promoting sustainable water management practices are essential.

Investing in infrastructure and technology: Upgrading water infrastructure, implementing advanced treatment technologies, and expanding distribution networks are crucial for improving water quality.

Enhancing monitoring and surveillance: Expanding water quality testing programs, establishing real-time monitoring systems, and strengthening data management are essential for effective surveillance.

Promoting public awareness and education: Raising public awareness about water quality issues, encouraging water conservation practices, and fostering community engagement can contribute to improved water management.

International cooperation and partnerships: Sharing best practices, providing technical assistance, and fostering collaboration among countries are vital for addressing global water quality challenges.

Ensuring safe drinking water for all requires a concerted effort from governments, international organizations, civil society, and the private sector. By addressing the challenges and implementing effective strategies, we can move towards a world where everyone has access to safe and clean drinking water.

Necessity of Standards and Guidelines for Effective Monitoring and Surveillance:

Drinking water quality standards and guidelines help us check if our water is safe to drink. They help us in the following ways:

Spotting problems early: By setting limits for how much certain substances can be in our water, standards help us find problems quickly before they make us sick.

Ensuring consistent quality: Standards make sure that everyone's drinking water is checked the same way and that it meets the same safety levels.

Focusing on what's important: Standards help us focus on the things in our water that matter most for our health.

Communicating clearly: When we report on water quality using standards, it's easier for people to understand how safe their water is.

Setting goals for improvement: Standards give us a target to aim for when we want to make our drinking water even safer.

In short, drinking water quality standards are essential for making sure our water is safe and healthy to drink and consume.

Water Quality Standards VS. Guidelines:

Water quality standards and guidelines are both important tools for managing and ensuring the safety of water resources, but they have distinct purposes and applications. The key differences between water quality standards and guidelines:

Definition:

Water Quality Standards: Standards are legally binding and regulatory limits set by government agencies or regulatory bodies. They define the maximum allowable concentrations of specific contaminants or parameters in water for various uses, such as drinking water, recreational water, and ecosystem health.

Water Quality Guidelines: Guidelines are non-binding recommendations or advisory values provided by organizations, experts, or agencies. They offer suggested concentration ranges for contaminants in water and serve as references for informed decision-making.

Legal Status:

Water Quality Standards: Standards have legal authority and are enforceable by law. Violating these standards can lead to regulatory actions, fines, and penalties.

Water Quality Guidelines: Guidelines are not legally enforceable. While they provide guidance for best practices, their implementation is voluntary.

Purpose:

Water Quality Standards: Standards are designed to protect human health by setting strict limits for contaminants.

Water Quality Guidelines: Guidelines offer recommendations to aid in decision-making related to water quality management. They provide a basis for understanding potential risks and planning actions.

Accountability:

Water Quality Standards: Compliance with standards is mandatory, and regulatory authorities enforce adherence through monitoring, inspections, and enforcement actions.

Water Quality Guidelines: Adherence to guidelines is voluntary, and there is no legal obligation to follow them. They serve as references for stakeholders to make informed decisions.

Sources:

Water Quality Standards: Standards are typically established by government agencies or regulatory bodies with legal authority to regulate water quality.

Water Quality Guidelines: Guidelines can be developed by various organizations, including environmental agencies, research institutions, international bodies, and expert panels.

Examples of DWQ Standards

Several well-known and widely accepted water quality standards have been established by different countries and regions worldwide. These standards provide guidelines for assessing and maintaining the safety of water resources and serve as the basis for water quality monitoring and surveillance. Here are a few examples:

Safe Drinking Water Act (SDWA): The U.S. Environmental Protection Agency (EPA) sets standards for drinking water quality under the SDWA. It includes Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs) for various contaminants.

Japanese Drinking Water Standards: Japan has established water quality standards for various parameters, including microbial indicators and chemical contaminants.

Bureau of Indian Standards (BIS): BIS sets standards for drinking water quality in India, including permissible limits for chemical and microbial parameters.

China National Standards (GB): China has established national standards for drinking water quality that cover a range of parameters and contaminants.

South African National Standards (SANS): SANS sets standards for drinking water quality in South Africa, addressing chemical, microbial, and physical parameters.

Examples of DWQ Guidelines

Several well-known guidelines have been established by different countries and organizations. These guidelines serve as the basis for water quality monitoring and surveillance.

Canadian Drinking Water Quality Guidelines: Health Canada provides guidelines for safe drinking water quality, including maximum allowable concentrations for contaminants.

WHO Drinking Water Quality Guidelines: The WHO offers international guidance on drinking water quality, setting permissible limits for various parameters to protect public health.

Australian Drinking Water Guidelines: These guidelines provide recommendations for the quality of drinking water and set limits for chemical, microbial, and physical parameters.

Steps for setting standards

The process of setting drinking water quality standards and guidelines involves a combination of scientific research and evidence, risk assessment, public health considerations, regulatory decisions, public input, and feasibility considerations. Different governments and organizations follow a similar general approach, but specific considerations can vary based on regional conditions, available resources, and public health priorities. The ultimate goal is to provide safe and clean drinking water that protects public health and ensures the well-being of communities.

A few key steps are shown below.

- **Identification of Parameters:**

The first step is to identify the parameters and contaminants that should be monitored in drinking water. This is based on scientific research, historical data, emerging contaminants, and potential risks to human health and the environment.

- **Review of Existing Guidelines:**

Governments often review existing national and international drinking water quality guidelines, such as those provided by the World Health Organization (WHO), to determine the most up-to-date and scientifically sound standards.

- **Risk Assessment:**

A thorough risk assessment is conducted to evaluate the potential health risks associated with exposure to different contaminants. This involves assessing toxicity, exposure pathways, dose-response relationships, and vulnerable population groups.

- **Setting Maximum Allowable Concentrations:**

Based on risk assessment, governments set maximum allowable concentrations (also known as Maximum Contaminant Levels or MCLs) for each parameter. These concentrations are chosen to protect public health by minimizing risks to consumers, especially the most sensitive individuals.

- **Establishing Treatment Goals:**

Some standards include goals that are more stringent than the MCLs. These represent an ideal level at which no adverse health effects are expected.

- **Multiple Lines of Defence:**

Drinking water quality standards often incorporate multiple lines of defence, such as source water protection, treatment processes, distribution system maintenance, and monitoring, to ensure safe drinking water from the source to tap.

- **Scientific Review and Consultation:**

Proposed standards are subject to scientific review and often involve consultation with experts in fields such as toxicology, epidemiology, chemistry, and engineering.

- **Public Participation:**

Public input is essential in the setting of drinking water quality standards. Governments often seek feedback from stakeholders, including communities, health professionals, environmental groups, and industries.

- **Economic and Feasibility Considerations:**

Governments consider the feasibility of implementing the proposed standards, taking into account available resources, technology, infrastructure, and associated costs.

- **Legislative Approval and Implementation:**

Once established, the standards may require legislative approval before becoming legally binding. Implementation plans and monitoring programs are developed to ensure compliance.

- **Periodic Review and Updates:**

Drinking water quality standards are periodically reviewed and updated based on new scientific research, emerging contaminants, changing health concerns, and advancements in treatment technology.

Conclusion

Water quality is a critical aspect of public health and environmental protection. Understanding the factors that affect water quality and the importance of drinking water quality standards is essential for ensuring that our water is safe to drink and that aquatic ecosystems flourish.

Water quality is influenced by a combination of natural factors, such as geology, climate, and hydrology, as well as human activities, including agriculture, industry, and urbanization. These factors can introduce pollutants into water, making it unsafe for human consumption and harming aquatic life.

Drinking water quality standards are essential for protecting public health by setting limits on the levels of contaminants that can be present in drinking water. These standards provide a framework for monitoring and surveillance of water quality, ensuring that the water we drink is safe and clean.

By understanding water quality and drinking water quality standards, we can make informed decisions about how to protect our water resources and ensure that everyone has access to safe and clean drinking water. We can also advocate for policies and practices that promote sustainable water management and protect our environment.

All of us should remember, water is a precious resource that we must all work together to protect. By taking action to improve water quality, we can safeguard the health of our communities and our planet for future generations.

WHO Drinking Water Quality Guideline and Bangladesh Standards

(1st Day, 2nd Session)

Introduction of the Session	<ul style="list-style-type: none"> ○ Mutual acquaintance/Knowing each other ○ Description of training objectives ○ Expectations from that session ○ Pre-training Assessment
Purpose of the Session	<p>At the end of this session:</p> <ul style="list-style-type: none"> ○ The Training personnel and participants get to know each other, ○ The Participant will be able to explain training objectives, ○ A learning environment will be created, ○ Coordination between expectations and topics can be achieved.
Duration	1 hour
Training Materials	White Board, White Board Marker, Flip Chart Board, Flip Chart Paper, Flip Chart Marker, Multimedia Projector, Screen, Duster, Manual.
Overall objective of the Training	<p>At the end of the Training, the Participants can be able to</p> <ul style="list-style-type: none"> ○ Describe the key principles of the WHO Drinking Water Quality Guidelines ○ Explain the requirements of the Bangladesh Standards for Drinking Water Quality ○ Communicate effectively with stakeholders about drinking water quality
Specific Objectives of Training	<p>After completing the training, the Participants can have a clear idea on</p> <ul style="list-style-type: none"> ○ WHO Water Quality Guideline. ○ Key Components of the WHO Guideline, Microbiological Parameters, Chemical Parameters, Radiological Parameters, and Aesthetic (Acceptability) Parameters ○ Risk Assessment and Management, ○ ECR 1997, Standards for Raw Water Quality for Inland Surface Water, and Treated Water Quality.

WHO Drinking Water Quality Guideline and Bangladesh Standards

(1st Day, 2nd Session)

Introduction

Access to clean and safe drinking water is a fundamental human right and a vital factor in maintaining public health. Recognizing the critical importance of safe water, the World Health Organization (WHO) has played a pivotal role in establishing guidelines that set the standards for drinking water quality worldwide. The WHO Drinking Water Quality Guidelines, last updated in 2004, serve as a comprehensive reference for governments, policymakers, and public health professionals striving to ensure that communities have access to water that is free from harmful contaminants.

The WHO Drinking Water Quality Guidelines (DWQGs) were first introduced in 1984 and have undergone several revisions to reflect scientific advancements and emerging challenges. The 2004 version of the guidelines represents a significant milestone, providing an evidence-based framework to address a wide range of potential contaminants that can affect water quality.

One of the notable strengths of the WHO DWQGs is their global applicability. Recognizing that water quality challenges vary across regions; the guidelines provide a flexible framework that can be adapted to different contexts. They empower countries and regions to develop their own standards based on local circumstances, while still adhering to the core principles of safeguarding public health.

Key Components of the Guideline

The WHO DWQGs (2004) are structured to cover various aspects of water quality, from microbiological parameters to chemical substances. Some of the key components include:

Microbiological Quality: The guidelines emphasize the importance of controlling microbial contaminants such as bacteria, viruses, and protozoa in drinking water. These

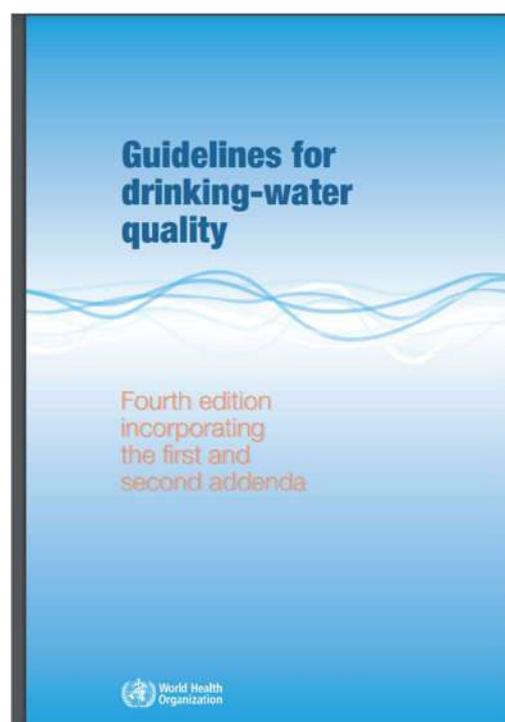


FIGURE-5: WHO DRINKING WATER QUALITY GUIDELINE 4TH EDITION

contaminants can cause waterborne diseases, making their control essential for public health.

Chemical Quality: The guidelines address a diverse range of chemical contaminants, including heavy metals, pesticides, organic chemicals, and naturally occurring substances. Limits for these contaminants are set based on rigorous scientific evaluations of their potential health impacts.

Radiological Quality: The guidelines assist and guide managing radioactive substances in drinking water, including natural radionuclides and those arising from human activities.

Aesthetic Quality: While not directly affecting health, the guidelines also address aesthetic qualities such as taste, odor, and color, ensuring that water is acceptable to consumers.

Microbiological Parameters

Coliform bacteria are a group of bacteria that are commonly found in the environment and in the intestines of humans and animals. Most coliform bacteria are harmless, but some can cause disease. Escherichia coli (E. coli) is a type of coliform bacteria that can cause a variety of illnesses, including diarrhea, urinary tract infections, and food poisoning.

E. coli is a good indicator of fecal contamination in water. If E. coli is found in drinking water, it means that there is a risk that other harmful bacteria may also be present. Drinking water that is contaminated with E. coli can cause serious illness, especially in children and the elderly.



FIGURE 7: MICROBES IN DRINKING WATER

Enteric pathogens are a group of microorganisms that can cause infections of the gastrointestinal tract. These infections can range from mild to severe, and can even be

fatal in some cases. Enteric pathogens can be transmitted through a variety of ways, including contaminated food and water, contact with feces or vomitus, contact with animals or their environment, poor hygiene practices, etc.

The following diagram shows the names of different types of enteric bacteria and viruses present in the water and diseases associated with these pathogens.

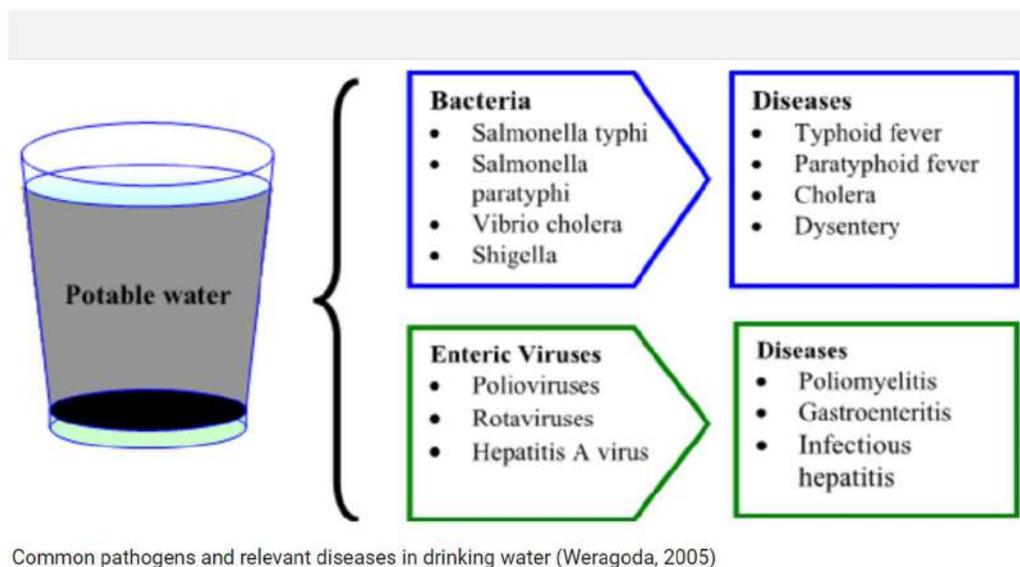


FIGURE 8: PATHOGENS AND RELEVANT DISEASES IN DRINKING WATER

Coliform Bacteria:

- Absence of total and fecal coliform in a 100 mL sample of water intended for drinking.
- Absence in a 100 mL sample of water intended for drinking.

Enteric Pathogens:

- Water quality targets for pathogens are not typically developed.
- Monitoring finished water for pathogens is not considered feasible or cost-effective.
- A tolerable level of risk is associated with the presence of pathogens typically less than 1 organism per 10,000 to 100,000 litres of water.

Chemical Parameters

A few chemical contaminants have been shown to cause adverse health in humans as a consequence of prolonged exposure to drinking water. Guideline values have been established only based on health concerns.

Arsenic: Arsenic is a toxic metal that can occur naturally in groundwater, posing serious health risks even at low concentrations. Maximum allowable concentration of 0.01 mg/L (10 µg/L) to protect against chronic health effects.



FIGURE-6: CHEMICAL PARAMETERS TESTING

Lead: Lead can leach into drinking water from pipes and plumbing fixtures, leading to developmental and neurological issues. Maximum allowable concentration of 0.01 mg/L (10 µg/L) to minimize exposure due to plumbing systems.

Nitrate and Nitrite: Elevated nitrate levels in water can lead to methemoglobinemia, or "blue baby syndrome," in infants. Maximum allowable concentration of 50 mg/L as nitrate (NO₃⁻) to prevent methemoglobinemia in infants.

Fluoride: Fluoride is important for dental health, but excessive levels can cause dental and skeletal fluorosis. Maximum allowable concentration of 1.5 mg/L to prevent dental fluorosis.

Chlorine and Disinfection Byproducts: Chlorine is commonly used for disinfection, but its byproducts can pose health risks at elevated levels. Chlorine residuals are used to ensure adequate disinfection, and specific guidelines are provided for disinfection byproducts.

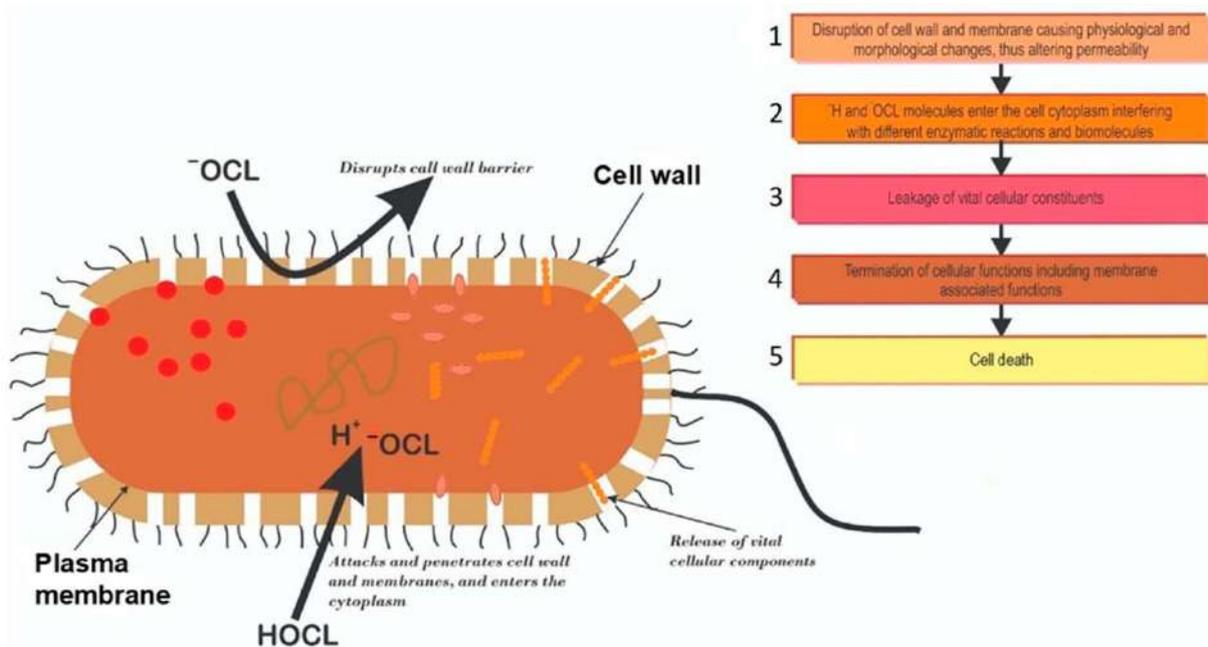


FIGURE-7: CHLORINE DISINFECTION

Pesticides and Herbicides: Various chemical compounds from agricultural activities can contaminate water sources. Maximum allowable concentrations for various pesticides, including individual and total concentrations

Heavy Metals: Other heavy metals like cadmium, mercury, and chromium can also be present in water sources due to industrial activities. Specific guideline values for heavy metals like cadmium, chromium, copper, iron, mercury, and others.

Organic Chemicals: Organic pollutants, including industrial chemicals, solvents, and pharmaceuticals, can find their way into water. Specific guideline values for various organic chemicals, including solvents and industrial pollutants.

Radiological Parameters

Drinking water may contain radioactive substances that could present a risk to human health. The risks are normally small compared with the risks from microorganisms and chemicals that may be present in the drinking water.

Radon: Radon is a radioactive gas that can dissolve in groundwater and pose a risk when released into indoor air. The recommended reference level of 100 Bq/L (becquerels per liter) for radon-222 in drinking water.

Radioactive Nuclides: Naturally occurring and human-made radioactive substances can be present in water sources. Guidelines are provided for specific radioactive isotopes, including gross alpha and beta activity.

Aesthetic (Acceptability) Parameters

Providing drinking water that is both safe and aesthetically pleasing (in terms of appearance, taste, and odor) is a top priority. If consumers find their drinking water to be aesthetically unacceptable, they may lose confidence in it and resort to using water from sources that are less safe but more aesthetically pleasing.

Taste, Odor, and Color:

While not directly harmful to health, water with unpleasant taste, odor, or color can affect consumer acceptance.

No specific guideline values, but recommendations for minimizing aesthetic issues.

Turbidity:



Turbidity refers to the cloudiness of water caused by suspended particles. High turbidity can interfere with disinfection processes and indicate potential contamination.

The recommended maximum allowable concentration of 5 NTU (Nephelometric Turbidity Units) to ensure effective disinfection and filtration.

In a nutshell, the physical, biological, chemical, and radiological parameters in drinking water can be shown in the following diagram.

Risk Assessment and Management

A fundamental principle underlying the WHO DWQGs is the risk assessment and management approach. The guidelines emphasize evaluating contaminants' potential risks based on their concentrations in water and their potential health effects. This approach ensures that regulatory efforts are focused on mitigating risks that could have the most significant impact on public health.

ECR 1997

The government of Bangladesh issued the Environment Conservation Rule (ECR) 1997 to protect the environment. This rule includes a set of standard values for different parameters to ensure potable and safe water for the people. This is the first standard for drinking water quality issued by the government.

After twenty years of issuance of Environment Conservation Rule 1997, the Bangladesh Government published the Environment Conservation Rule 2023 vide Bangladesh Gazette dated 5th March 2023. The government promulgated this rule under the powers given in the Environment Conservation Act, of 1995. It has been implemented immediately after issuance. By promulgating this, the Environment Conservation Rules, 1997 have been repealed.

Environmental Standards

Rule 31 says about the determination of environmental standards for different environmental elements including water quality. Rule 31 says that the standards of water shall be determined as per Schedule 2 and the standards of other environmental elements shall be determined as per the provisions of the relevant rules.

In Schedule 2, there are a few tables for water quality standards for different uses of water. The first table, Table ka describes surface water quality for different purposes. This table has two parts. Part 1 is for inland surface water while the second part is for coastal surface water. Table Kha says about the standard values for different parameters for potable and drinking water.

Water Quality Standards

The water quality standards described in the ECR 2023 are an important part of Bangladesh's efforts to protect the environment and ensure the safety of drinking water. The ECR 2023 standards are based on the latest scientific evidence and are in line with international standards. The government is committed to enforcing the ECR 2023

standards and ensuring that all Bangladeshis have access to safe and clean drinking water.

As said earlier, the first part of Table Ka describes the requisite raw water quality standard for using inland surface water for different six purposes. Among these six purposes, two are for drinking water. First, the standard values of some parameters are mentioned for determining the source of fresh water for supply only by disinfection. Then row 3 specifies the standard values of several parameters for determining the source of fresh water for supply through the conventional treatment process.

Table Kha describes standard values for 55 parameters for drinking water. These 55 parameters cover microbiological parameters (e.g., *Escherichia coli*, total coliforms), chemical parameters (e.g., arsenic, fluoride, nitrate), and aesthetic acceptability parameters (e.g., color, turbidity, taste, odor).

Raw Water Quality for Inland Surface Water

According to the ECR 2023, the following are the raw water quality standards for using inland surface water for drinking purposes with disinfection only:

- **Chemical parameters:**
 - Nitrate-N: 7 mg/l (milligrams per liter)
 - Ammonia-N: 0.1 mg/l (milligrams per liter)
 - Phosphate-P: 0.1 mg/l (milligrams per liter)
 - Total Chromium: 0.02 mg/l (milligrams per liter)
 - Lead (Pb): 0.02 mg/l (milligrams per liter)
 - Mercury (Hg): 0.001 mg/l (milligrams per liter)
 - Total Dissolved Solids (TDS): 1000 mg/l (milligrams per liter)
 - BOD: ≤ 2 mg/l (milligrams per liter)
 - DO: ≥ 6 mg/l (milligrams per liter)
 - COD: 10 mg/l (milligrams per liter)
- **Physical Parameters:**
 - pH: 6.5-8.5
- **Microbiological Parameters**
 - Total Coliform: ≤ 100 cfu/100 milliliters

However, when water is supplied through conventional purification processes, some relaxation in raw water quality has been made. Under such a case, the following are the

raw water quality standards for using inland surface water for drinking purposes according to the ECR 2023. :

- **Chemical parameters:**

- Nitrate-N: 7 mg/l (milligrams per liter)
- Ammonia-N: 0.3 mg/l (milligrams per liter)
- Phosphate-P: 0.5 mg/l (milligrams per liter)
- Total Chromium: 0.02 mg/l (milligrams per liter)
- Lead (Pb): 0.03 mg/l (milligrams per liter)
- Mercury (Hg): 0.001 mg/l (milligrams per liter)
- Total Dissolved Solids (TDS): 1000 mg/l (milligrams per liter)
- BOD: ≤ 3 mg/l (milligrams per liter)
- DO: ≥ 5 mg/l (milligrams per liter)
- COD: 25 mg/l (milligrams per liter)

- **Physical Parameters:**

- pH: 6-9

- **Microbiological Parameters**

- Total Coliform: $\leq 5,000$ cfu/100 milliliters

Treated Water Quality

The Drinking Water Quality Standards described in the Environment Conservation Rule (ECR) 2023 of Bangladesh are based on the World Health Organization (WHO) Guidelines for Drinking Water Quality. These standards cover 59 parameters that comprise microbiological, chemical, radiological, and aesthetic acceptability parameters. A few of those parameters are shown below. :

Microbiological parameters:

- Escherichia coli (E. coli): Not detectable in any sample of 100 ml of water.
- Total coliforms: Not detectable in more than 10% of samples of 100 ml of water.

Chemical parameters:

- Arsenic: 50 $\mu\text{g/l}$ (micrograms per liter)
- Fluoride: 1.0 mg/l (milligrams per liter)
- Nitrate: 50 mg/l (milligrams per liter)
- Total dissolved solids (TDS): 1000 mg/l (milligrams per liter)
- Ammonia: 1.5 mg/l (milligrams per liter)
- Chloride: 250 mg/l (milligrams per liter). For coastal areas, it is 1000 mg/l

- Iron: 0.3-1 mg/l (milligrams per liter)

Aesthetic Acceptability Parameters:

- Color: Not more than 15 Hazen units
- Turbidity: Not more than 5 Nephelometric turbidity units (NTU)
- Taste and odor: Unobjectionable

Radioactive Parameters

- Total alpha Radiation: 0.1 bq/l (Becquerel per liter)
- Total alpha Radiation: 1.0 bq/l (Becquerel per liter)

It is important to note that these standards are the maximum allowable limits for the specified parameters. The lower the concentration of these parameters in drinking water, the safer the water is to consume.

Conclusions

There are no differences between the drinking water quality standards stated in the Environment Conservation Rule (ECR) 1997 and ECR 2023 in Bangladesh. Though it was expected that the drinking water quality standard in ECR 2023 would be more stringent, but the drinking water quality standards in both versions of the ECR are the same.

(খ) সুপের পানির মানমাত্রা

ক্রমিক নং	স্থিতিমাণ	একক	মানমাত্রা
(১)	(২)	(৩)	(৪)
১।	ফিকাল কলিফর্ম (Fecal Coliform)	সি.এফ.ইউ./১০০মি. লি.	০
২।	সার্বিক কলিফর্ম (Total Coliform)	সি.এফ.ইউ./১০০মি. লি.	০
৩।	রেসিডুয়াল ক্লোরিন (Free Residual Chlorine)	মি.গ্রা./লি.	০.২০
৪।	নাইট্রেট (NO ₃)	মি.গ্রা./লি.	৪৫
৫।	আর্সেনিক (As)	মি.গ্রা./লি.	০.০৫
৬।	টারবিডিটি (Turbidity)	এনটিইউ	৫
৭।	অ্যালুমিনিয়াম (Al)	মি.গ্রা./লি.	০.২০
৮।	অ্যামোনিয়া (NH ₃)	মি.গ্রা./লি.	১.৫০
৯।	বেরিয়াম (Ba)	মি.গ্রা./লি.	০.৭০
১০।	বেনজিন (C ₆ H ₆)	মি.গ্রা./লি.	০.০১
১১।	বোরন (B)	মি.গ্রা./লি.	১.০
১২।	ক্যাডমিয়াম (Cd)	মি.গ্রা./লি.	০.০০৩
১৩।	ক্যালশিয়াম (Ca)	মি.গ্রা./লি.	৭৫
১৪।	ক্লোরাইড (Chloride)	মি.গ্রা./লি.	২৫০*
১৫।	কার্বনটেট্রা ক্লোরাইড (CCl ₄)	মি.গ্রা./লি.	০.০০৫
১৬।	১,১ ডাইক্লোরো ইথেন (১,১ C ₂ H ₄ Cl ₂)	মি.গ্রা./লি.	০.০৩
১৭।	১,২ ডাইক্লোরো ইথেন (১,২ C ₂ H ₄ Cl ₂)	মি.গ্রা./লি.	০.০৩
১৮।	ট্রাইক্লোরো ইথেন (C ₂ H ₃ Cl ₃)	মি.গ্রা./লি.	০.০৪
১৯।	ট্রাইক্লোরো ইথেন (C ₂ H ₂ Cl ₄)	মি.গ্রা./লি.	০.০২
২০।	পেন্টাক্লোরো ফেনোল (Pentachlorophenol)	মি.গ্রা./লি.	০.০০২
২১।	২,৪,৬ ট্রাইক্লোরো ফেনোল (২,৪,৬ Trichlorophenol)	মি.গ্রা./লি.	০.২০
২২।	ক্লোরোফর্ম (CHCl ₃)	মি.গ্রা./লি.	০.০২

ক্রমিক নং	স্থিতিমাপ	একক	মানমাত্রা
(১)	(২)	(৩)	(৪)
২৩।	সার্বিক ক্রোমিয়াম (Total Cr)	মি.গ্রা./লি.	০.০৫
২৪।	বর্ণ (Color)	হেজেন একক	১৫
২৫।	কপার (Cu)	মি.গ্রা./লি.	১.৫
২৬।	সায়ানাইড (CN)	মি.গ্রা./লি.	০.০৫
২৭।	ফ্লোরাইড (Fluoride)	মি.গ্রা./লি.	১.০
২৮।	খরতা CaCO ₃ হিসাবে (Hardness as CaCO ₃)	মি.গ্রা./লি.	৫০০
২৯।	লৌহ (Fe)	মি.গ্রা./লি.	০.৩-১.০
৩০।	সার্বিক জেলডাল নাইট্রোজেন (Total Kjeldahl Nitrogen)	মি.গ্রা./লি.	১.০
৩১।	লেড (Pb)	মি.গ্রা./লি.	০.০১
৩২।	ম্যাগনেশিয়াম (Mg)	মি.গ্রা./লি.	৩০-৩৫
৩৩।	ম্যাংগানিজ (Mn)	মি.গ্রা./লি.	০.৪
৩৪।	মার্কুরি (Hg)	মি.গ্রা./লি.	০.০০১
৩৫।	নিকেল (Ni)	মি.গ্রা./লি.	০.০৫
৩৬।	নাইট্রাইট (NO ₂)	মি.গ্রা./লি.	১.০
৩৭।	গন্ধ (Odor)	-	গন্ধহীন
৩৮।	তৈল ও গ্রিঞ্জ (Oil & Grease)	মি.গ্রা./লি.	০.০১
৩৯।	পিএইচ (pH)	-	৬.৫-৮.৫
৪০।	ফিনোল যৌগাদি (Phenols)	মি.গ্রা./লি.	০.০০২
৪১।	পটাশিয়াম (K)	"	১২
৪২।	শেজক্রিয় বস্তুসমূহ সার্বিক আলফা বিকিরণ	বিকিউ/লি.	০.১
৪৩।	সার্বিক বিটা বিকিরণ	বিকিউ/লি.	১.০
৪৪।	সেলিনিয়াম (Se)	মি.গ্রা./লি.	০.০১
৪৫।	সিলভার (Ag)	মি.গ্রা./লি.	০.০২
৪৬।	সোডিয়াম (Na)	মি.গ্রা./লি.	২০০

ক্রমিক নং	স্থিতিসাপ	একক	মানসীমা
(১)	(২)	(৩)	(৪)
৪৭।	প্রলম্বিত কঠিন বস্তু কণা (SS)	মি.গ্রা./লি.	১০
৪৮।	সালফাইড, হাইড্রোজেন সালফাইড হিসাবে (Sulfide as H ₂ S)	মি.গ্রা./লি.	০.০৫
৪৯।	সালফেট (SO ₄ ⁻²)	মি.গ্রা./লি.	২৫০
৫০।	সার্বিক দ্রবীভূত দ্রব্য (TDS)	মি.গ্রা./লি.	১০০০
৫১।	উষ্ণতা (Temperature)	ডিগ্রি সেন্টিগ্রেড	২০-৩০
৫২।	টিন (Sn)	মি.গ্রা./লি.	২.০
৫৩।	জিংক (Zn)	মি.গ্রা./লি.	৫.০
৫৪।	আলড্রিন ও ডাই আলড্রিন (Aldrin/Dieldrin)	মাইক্রোগ্রা./লি.	০.০৩
৫৫।	অ্যানায়নিক ডিটারজেন্ট (Anionic detergents)	মি.গ্রা./লি.	০.২

নোট:

*সমুদ্র উপকূলীয় এলাকায় ১০০০ মি.গ্রা./লি.

Drinking Water Quality Monitoring for Urban and Rural Areas

(1st day, 3rd Session)

Introduction of the Session	<ul style="list-style-type: none"> ○ Mutual acquaintance/Knowing each other of the participants ○ Description of training objectives ○ Expectation from that session ○ Pre-training Assessment
Purpose of the Session	<p>At the end of this session</p> <ul style="list-style-type: none"> ○ The Training related personnel and participant get to know each other, ○ The Participant will be able to explain training objectives, ○ A learning environment will be created, ○ Coordination between expectations and topics can be achieved.
Duration	1 hour
Training Materials	White Board, White Board Marker, Flip Chart Board, Flip Chart Paper, Flip Chart Marker, Multimedia Projector, Screen, Duster, Manual.
Overall objective of the Training	<p>At the end of the Training, the Participants can be able to</p> <ul style="list-style-type: none"> ○ Have a clear understanding of drinking water quality monitoring, ○ They can have an idea of factors that need to be considered while developing and designing such monitoring programs. ○ The participants will be able to develop and design such monitoring programs.
Specific Objectives of Training	<p>After completing the training, the Participants can have a clear idea on</p> <ul style="list-style-type: none"> ○ Importance of the Water being safe, ○ Importance of Water Quality Monitoring, How to Prepare a Monitoring Plan Program, Objectives of Monitoring Programs, ○ Urban and Rural Water Quality Monitoring, Similarities in and Differences Urban and Rural Water Quality Monitoring ○ Water Quality Monitoring in Bangladesh Context.

Drinking Water Quality Monitoring for Urban and Rural Areas

(1st day, 3rd Session)

Introduction



To run a water supply system properly, it is essential to ensure adequate operation and maintenance. But that is not enough to ensure sustainable and safe use of water supply. The sustainability of a water supply depends on water quality and a few other important factors such as water conservation, protection of source, climate change adaptability, etc. Testing of water at the source or at the consumption point once

at the time of commissioning and a few times irregularly cannot ensure a sustainable and safe water supply. For that, well-established water quality monitoring is required.

Water quality monitoring is the act of observing, tracking, and recording water quality over time. It is the process of measuring and evaluating the physical, chemical, and biological characteristics of drinking water to determine whether it is safe for human consumption. Drinking water quality monitoring is typically conducted by government agencies and water utilities. However, private companies and individuals can also monitor their own drinking water quality. There are a variety of different methods and technologies that can be used to monitor drinking water quality, depending on the specific pollutants of concern.

Monitoring, as a practical activity, provides the essential information which is required for an assessment of water quality. However, assessments require additional information, such as an understanding of the hydrodynamics of a water body, information on geochemical, atmospheric, and anthropogenic influences, and the correct approaches for analysis and interpretation of the data generated during monitoring.

Importance

Monitoring is essential to protect public health, ensure the health and well-being of individuals and communities, and ensure that drinking water meets all applicable standards and regulations. Monitoring these sources of water helps safeguard public health, support effective water treatment, and promote sustainable water use. By providing accurate data, monitoring empowers communities, regulatory agencies, and water providers to work together to secure access to safe and clean water for all.

Water quality monitoring is the foundation on which water quality management is based. Monitoring provides the information that permits rational decisions to be made on the following:

- Describing water resources and identifying actual and emerging problems of water pollution.
- Formulating plans and setting priorities for water quality management.
- Developing and implementing water quality management programs.
- Evaluating the effectiveness of management actions.

Preparing a Monitoring Plan Programs

The design of a monitoring program should be based on clear and well-thought-out aims and objectives and should ensure, as far as possible, that the planned monitoring activities are practicable and that the objectives of the program will be met. The monitoring plans should be fully documented and should include the following information:

- Objectives of monitoring
- Parameters to be monitored;
- Sampling or assessment location and frequency;
- Sampling or assessment methods and equipment;
- Schedules for sampling or assessment;
- Methods for quality assurance and validation of results;
- Requirements for checking and interpreting results;
- Responsibilities and necessary qualifications of staff;
- Documentation and management of records,

Among the above issues, parameters to be monitored, sampling or assessment location and frequency, sampling or assessment methods and equipment, and schedule for sampling or assessment will be discussed in a separate session. Methods for quality assurance and validation of results, requirements for checking and interpreting results; responsibilities and necessary qualifications of staff, and documentation and management of records will be discussed in another session. These issues for both water quality monitoring and surveillance purposes are the same.

Objectives of Monitoring

The objectives of a water quality monitoring program must be clearly stated and recorded. The very act of writing them down generally results in careful consideration being given to the possible options. Written objectives help to avoid misunderstandings by project participants, are an effective way of communicating with sponsors, and provide assurance that the monitoring program has been systematically planned. They are also important when the program is evaluated to determine whether or not the objectives are being met.

To help with the establishment of objectives, the following questions might be addressed:

- Why is monitoring going to be conducted? Is it for basic information, planning and policy information, management and operational information, regulation and compliance, resource assessment, or other purposes?
- What information is required on water quality for various uses? Which variables should be measured, at what frequency, and in response to which natural or man-made events?
- What is practical in terms of the human and financial resources available for monitoring? There is little point in setting unrealistic objectives.
- Who is responsible for the different elements of monitoring?
- Who is going to use the monitoring data and what are they intending to do with the information? Will it support management decisions, ensure compliance with standards, identify priorities for action, provide early warning of future problems, or detect gaps in current knowledge?

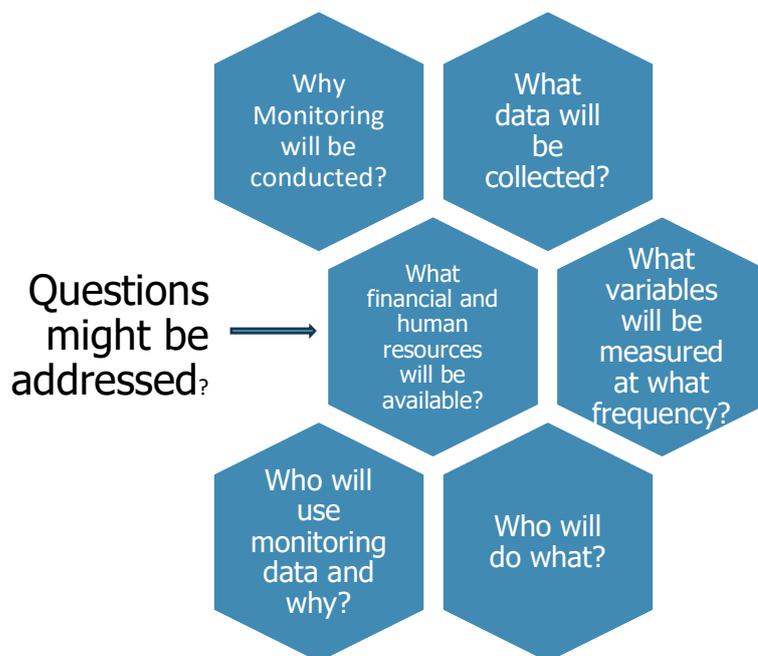


FIGURE 12: WHAT QUESTIONS MIGHT BE ADDRESSED FOR THE ESTABLISHMENT OF THE MONITORING PROGRAM

Water quality monitoring is essential for both urban and rural water supplies for various purposes, including obtaining a basic understanding, planning, and policy formulation, management and operational tasks, regulatory and compliance purposes, resource assessments, and so on.



FIGURE-9: OBJECTIVES OF THE MONITORING PROGRAM

Basic information:

- To establish a baseline understanding of water quality in different regions and sources
- To track changes in water quality over time
- To identify potential sources of pollution

Planning and policy information:

- To inform decision-making for water resource management and infrastructure development
- To support the formulation of water quality policies and regulations
- To evaluate the effectiveness of water quality interventions

Management and operational information:

- To ensure the provision of safe drinking water for public health
- To optimize treatment processes and minimize water losses
- To identify and address water quality issues in real-time

Regulation and compliance:

- To enforce water quality standards and regulations
- To hold polluters accountable for their actions

Resource assessment:

- To determine the availability and suitability of water resources for different uses
- To assess the potential impacts of development projects on water quality

Other purposes:

- To support research and development in water quality science
- To raise public awareness about water quality issues
- To promote sustainable water management practices

Urban and Rural Water Quality Monitoring

Water quality monitoring is essential for both urban and rural water supplies, but the specific approaches and challenges differ between these settings. Urban areas require more intensive monitoring to address the complexities of their water sources and infrastructure, while rural areas face challenges in accessing resources and expertise for effective monitoring. Collaboration between government agencies, water utilities, and community organizations is crucial to ensure comprehensive and sustainable water quality monitoring in both urban and rural areas. While they share common goals and approaches, there are distinct differences and similarities between water quality monitoring in urban and rural settings.

Similarities in Water Quality Monitoring:

There are a few similarities in water quality monitoring between urban and rural contexts. Both urban and rural water quality monitoring share several fundamental objectives. The following figure shows these objectives.



FIGURE 14: SIMILARITIES BETWEEN URBAN AND RURAL DWQ MONITORING

- **Protecting public health:** The primary goal of water quality monitoring is to safeguard public health by ensuring that drinking water is free from harmful contaminants.
- **Maintaining water resource quality:** Monitoring aims to preserve the overall quality of water resources, protecting them from pollution and ensuring their suitability for intended uses.

- **Compliance with standards:** Monitoring data is used to assess compliance with established water quality standards and regulations.
- **Identifying and addressing pollution sources:** Monitoring helps identify sources of pollution and track their impacts on water quality.

Differences in Water Quality Monitoring:

Despite these common objectives, water quality monitoring in urban and rural areas differs in several aspects:

- **Nature of water sources:** Urban water supplies typically rely on treated surface water or groundwater from centralized sources, while rural water supplies often use untreated groundwater from individual wells and springs (in hilly areas), rainwater, and treated pond water through community-based PSFs.
- **Types of contaminants:** Urban water sources are more susceptible to contamination from industrial discharges, urban runoff, and sewage disposal. Rural water sources are more prone to contamination from agricultural activities, animal waste, and naturally occurring substances like arsenic, salinity, etc.
- **Monitoring frequency and intensity:** Urban water supplies are typically monitored more frequently and intensively due to the higher population density and potential for large-scale contamination events. Rural water supplies may have less frequent monitoring, with a focus on specific contaminants such as arsenic, salinity, etc., or areas of concern such as arsenic-prone areas, coastal belts, etc.
- **Monitoring infrastructure and technology:** Urban areas often have more advanced monitoring infrastructure and technology, including real-time sensors and automated data analysis systems in developed countries and periodic manual sampling and laboratory analysis in developing countries. Rural areas may rely on simpler monitoring methods, such as field test kits.
- **Institutional arrangements and responsibilities:** There are institutions for managing urban water quality monitoring, such as centralized water utilities like DWASA, CWASA, etc., or municipalities and city corporations, while rural monitoring may involve community-based organizations or individual well owners.

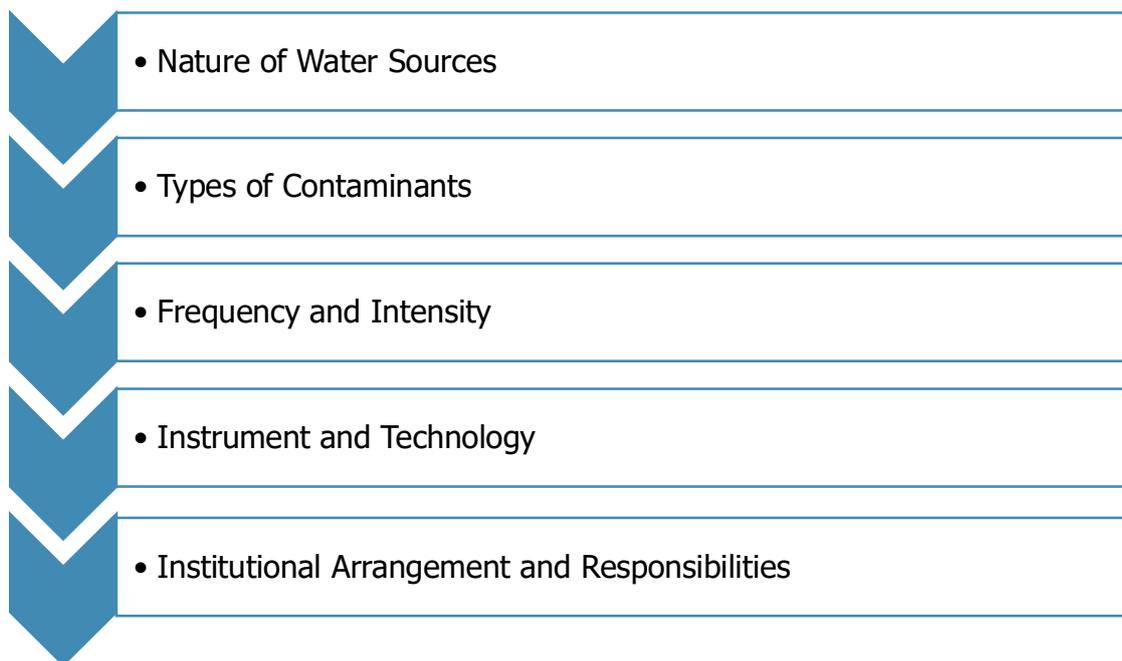


FIGURE 15: KEY POINTS OF DIFFERENCES BETWEEN URBAN AND RURAL DWQ MONITORING

Bangladesh Context

In response to the lack of a robust water quality monitoring system in Bangladesh, the Department of Public Health Engineering (DPHE) developed a comprehensive protocol for rural water supply systems. This protocol, published in August 2005, was designed to address the shortcomings of the existing system. Consequently, the DPHE protocol was designed to establish a regular monitoring framework for critical water quality parameters while also incorporating periodical testing for potential future contaminants.

The DPHE (Department of Public Health Engineering) has developed three manuals for water supply monitoring and surveillance, catering to both urban and rural areas. These manuals were created as part of the PICMaC (Partnership on Improving Critical Management of Water Supply in Bangladesh) project, supported by JICA (Japan International Cooperation Agency). The manuals are as follows:

1. Drinking Water Monitoring and Feedback Mechanism for Pourashava (Urban Areas)
2. Drinking Water Monitoring and Feedback Mechanism for Rural Areas

The primary objective of these manuals is to establish a fundamental monitoring mechanism for DPHE, Pourashavas (municipalities), and Union Parishads (local government units) as routine activities. This initiative aligns with the decentralization concept adopted by the Government of Bangladesh (GoB).

Drinking Water Quality Surveillance for Urban and Rural Areas

(1st day 4th Session)

Introduction of the Session	<ul style="list-style-type: none"> ○ Mutual acquaintance/Knowing each other of the participants ○ Description of training objectives ○ Expectations from that session ○ Pre-training Assessment
Purpose of the Session	<p>At the end of this session</p> <ul style="list-style-type: none"> ○ The Training personnel and participants get to know each other, ○ The Participant will be able to explain training objectives, ○ A learning environment will be created, ○ Coordination between expectations and topics can be achieved.
Duration	1 hour
Training Materials	White Board, White Board Marker, Flip Chart Board, Flip Chart Paper, Flip Chart Marker, Multimedia Projector, Screen, Duster, Manual.
The overall objectives of the Training	<p>At the end of the Training, the Participants can be able to</p> <ul style="list-style-type: none"> ○ Have a clear understanding of drinking water quality surveillance, ○ They can have an idea on drinking water quality surveillance, covering both urban and rural settings, what are the factors that need to be considered while developing and designing such a surveillance program in urban and rural areas, ○ The participants will be able to develop and design such surveillance programs.
Specific Objectives of the Training	<p>After completing the training, the Participants can have a clear idea on</p> <ul style="list-style-type: none"> ○ Importance of the Water being safe, Importance of Drinking Water Quality Surveillance, ○ What are the Types of Approaches for Water Quality Surveillance Program, ○ What are the Parameters Monitored in Drinking Water Quality Surveillance, Roles and Responsibilities in Drinking Water Quality Surveillance, ○ Adapting approaches to specific circumstances, Differences, and Similarities between Urban and Rural Drinking Water Quality Surveillance

Drinking Water Quality Surveillance for Urban and Rural Areas

(1st day 4th Session)

Introduction

Drinking water quality surveillance is a critical component of public health protection, ensuring that communities have access to safe and potable drinking water. It is a supplemental component to provide evidence regarding the safety of drinking water quality supplied by the water utilities, government, and individual users. Therefore, it is an external audit of the water supply services in the target areas, and it will be conducted every 3-5 years. Effective surveillance systems are essential for preventing waterborne diseases, safeguarding human health, and maintaining public confidence in the safety of drinking water supplies.

This surveillance contributes to the protection of public health by promoting the improvement of the quality, quantity, accessibility, coverage, affordability, and continuity of water supplies (known as service indicators) and is complementary to the quality control function of the drinking water supplier. Drinking-water supply surveillance does not remove or replace the responsibility of the drinking water supplier to ensure that a drinking water supply is of acceptable quality and meets predetermined health-based targets.

Importance of Drinking Water Quality Surveillance

Surveillance is an important element in the development of strategies for incremental improvement of the quality of drinking-water supply services. It is important that strategies be developed for implementing surveillance, collating, analyzing and summarizing data, and reporting and disseminating the findings and that the strategies are accompanied by recommendations for remedial action. Follow-up will be required to ensure that remedial action is taken.

Drinking water quality surveillance plays a crucial role in safeguarding public health as shown in the following figure.

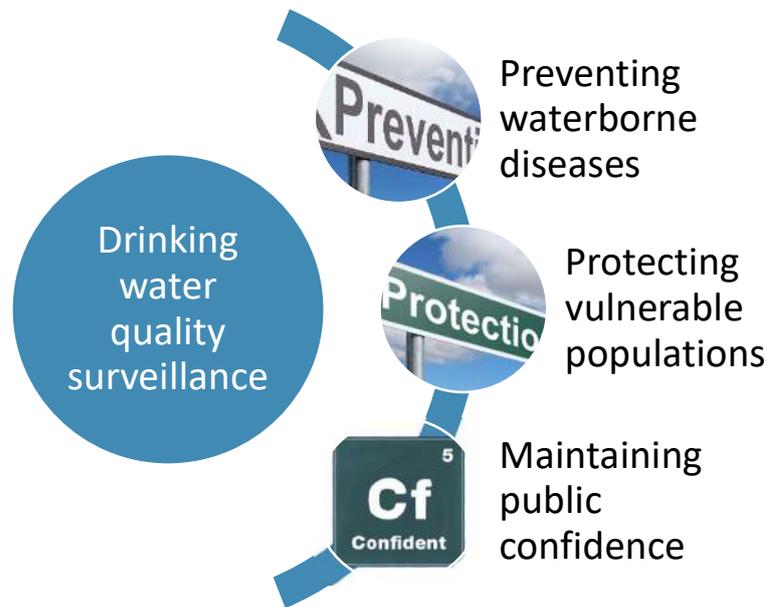


FIGURE-10: ROLE OF DWQ MONITORING IN SAFEGUARDING PUBLIC HEALTH

Preventing waterborne diseases: Surveillance systems detect and identify potential contamination events or changes in water quality that could pose a health risk.

Protecting vulnerable populations: Surveillance data helps target interventions and preventive measures to protect those most susceptible to waterborne diseases.

Maintaining public confidence: Effective surveillance systems reassure the public that their drinking water is safe and promote trust in water providers.

Types of Approaches

There are two types of approaches to surveillance of drinking water quality: audit-based approaches and approaches relying on direct assessment. Implementation of surveillance will generally include a mixture of these approaches according to supply type. Often it is not possible to undertake extensive surveillance of all community or household supplies. In these cases, well-designed surveys should be undertaken to understand the situation at the national or regional level.



FIGURE 11 TYPES OF SURVEILLANCE

Audit: The audit-type approach of drinking water quality surveillance is a method of assessing the overall performance of a drinking water supply system in terms of its ability to deliver safe and potable water to consumers. This approach focuses on evaluating the system's management practices, operational procedures, and compliance with regulations.

Key Characteristics of the Audit-Type Approach are shown below.

- **Emphasis on documentation and records:** The audit-type approach relies heavily on reviewing documentation and records to assess the system's performance. This includes reviewing water safety plans, water quality monitoring data, operational logs, maintenance records, and training records.
- **Third-party verification:** An important element of the audit-type approach is the involvement of an independent third party to conduct the audit. This helps to ensure objectivity and impartiality in the assessment process.

This approach has several advantages. A few of these advantages are given below.

- **Comprehensive assessment:** The audit-type approach provides a thorough evaluation of the drinking water supply system, identifying both strengths and weaknesses.
- **Identification of systemic issues:** This approach can help to identify systemic issues that may not be apparent from routine water quality monitoring alone.
- **Promotion of accountability:** The involvement of an independent third party helps to promote accountability and transparency in the system's operation.
- **Emphasis on supplier responsibility:** The focus on supplier self-assessment and accountability encourages proactive measures to maintain water quality.

Besides the above advantages, this approach has also a few limitations such as:

- **Resource-intensive:** Conducting a comprehensive audit can be time-consuming and resource-intensive, requiring specialized expertise.
- **Potential for overemphasis on compliance:** The focus on documentation and compliance may lead to an overemphasis on meeting regulatory requirements rather than achieving optimal water quality outcomes.

The audit-type approach is a valuable tool for evaluating the overall performance of drinking water supply systems and identifying areas for improvement. By comprehensively assessing management practices, operational procedures, and compliance with regulations, this approach can help to ensure that drinking water supplies consistently deliver safe and potable water to consumers.

Direct assessment: It may be appropriate for the drinking water supply surveillance agency to carry out independent testing of water supplies. Such an approach often implies that the agency has access to analytical facilities with staff trained to carry out sampling, analysis, and sanitary inspection. It also implies that surveillance agencies can assess findings and report to and advise suppliers and communities. A surveillance program based on direct assessment would normally include:

- specified approaches to large municipality/small municipality/community supplies and individual household supplies;
- sanitary inspections to be carried out by qualified personnel;

- sampling to be carried out by qualified personnel;
- tests to be conducted using suitable methods by accredited laboratories or using approved field-testing equipment and qualified personnel;
- procedures for reporting findings and follow-up to ensure that they have been acted on.

For community-managed drinking-water supplies and where the development of in-house verification or third-party arrangements is limited, direct assessment may be used as the principal system of surveillance. This may apply to drinking water supplies in small towns by small-scale private sector operators or local government. Direct assessment may lead to the identification of requirements to amend or update the WSP.

Parameters Monitored in Drinking Water Quality Surveillance

A wide range of parameters are monitored in drinking water quality surveillance to assess the overall quality and safety of drinking water. The specific parameters monitored and the frequency of monitoring will vary depending on the water source, treatment processes, and local risk factors. Details of parameters to be selected, sampling or assessment location and frequency, sampling or assessment methods and equipment, and schedule for sampling or assessment will be discussed in a separate session.

Roles and Responsibilities in Drinking Water Quality Surveillance

Ensuring timely action to prevent problems and ensure the correction of faults should be one aim of a surveillance program. So, the surveillance agency must be supported by strong and enforceable legislation. There may at times be a need for penalties to encourage and ensure compliance. However, the agency must develop a positive and supportive relationship with suppliers, with the application of penalties used as a last resort. The roles of the authorities responsible for drinking-water supply surveillance encompass four areas of activity as shown in the following diagram.

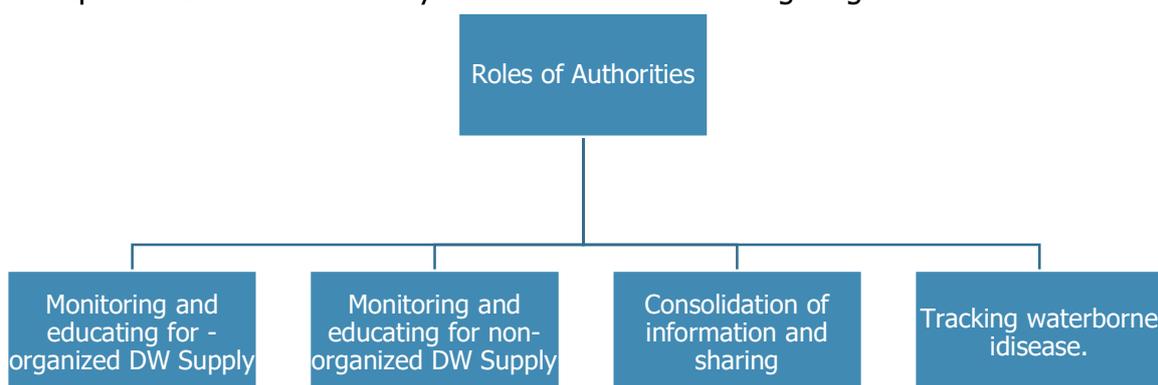


FIGURE-12: ROLES AND RESPONSIBILITIES OF A SURVEILLANCE PROGRAM

1) **Monitoring and educating for organized water supply:**

Monitoring water quality and providing education on safe water practices to populations having access to organized drinking water supplies,

2) **Monitoring and educating for non-organized water supply:**

Monitoring water quality and providing education on safe water practices to populations without access to organized drinking water supplies, including communities and households.;

3) **Consolidating and Sharing Information:**

Gathering and analyzing data from various sources allows for a thorough understanding of the state of drinking water across a country or region. This understanding serves as crucial input for developing logical public health policies and practices.;

4) **Tracking waterborne diseases:**

participation in the investigation, reporting, and compilation of outbreaks of waterborne diseases.

Effective drinking water quality surveillance requires collaboration and coordination among various stakeholders, including:

- **Government ministries/agencies:** Government agencies are responsible for setting water quality standards and regulations, overseeing surveillance programs, and ensuring compliance.
- **Water utilities:** Water utilities are responsible for monitoring the quality of water they distribute to their customers, implementing treatment processes, and responding to contamination events.
- **Public health agencies:** Public health agencies play a crucial role in assessing health risks associated with water quality, investigating outbreaks, and educating the public about water quality issues.
- **Local Government Institutions/Community Organizations:** Union parishad and community organizations can contribute to surveillance efforts by involving community members in monitoring activities, raising awareness, and advocating for safe drinking water.

Adapting approaches to specific circumstances

Urban areas:

In urban areas in Bangladesh, securing safe drinking water can be a complex journey. Mixed within the urban fabric are often multiple, often overlapping, sources of potable water such as large piped networks and public taps, point sources, and vended water. This intricate landscape demands a nuanced approach to ensuring the quality of the water used for drinking.

Effective surveillance programs must recognize and address these diverse sources. Monitoring water quality must go beyond the organized pipe networks and should cover all alternative options. This includes understanding the potential for deterioration during collection, storage, and household use, a crucial step in safeguarding public health.

In this context, zoning the urban area based on vulnerability and water supply arrangements may be used as a valuable tool. Such a system, encompassing formal and informal settlements, peri-urban areas, and all residents regardless of legal status, provides a framework for targeted resource allocation.

This zoning system serves another critical purpose: it ensures that non-piped water sources are not neglected by surveillance activities. By integrating them into the monitoring network, we can create a holistic picture of the urban water landscape, leaving no source untested and no community unprotected.

In essence, navigating the maze of urban water sources requires a multifaceted approach. By acknowledging the complexity of the system, prioritizing comprehensive surveillance, and adopting a zoning approach, we can ensure that all residents of urban areas have access to safe, reliable drinking water, regardless of their location or source.

Community-Managed Rural Water Supplies:

Rural water supply is mainly based on small community-managed drinking water supplies. Such Community-managed supplies may include simple piped water systems or a range of point sources, such as boreholes with hand pumps, pond sand filters, dug wells, and protected springs.

The control of water quality and implementation of surveillance programs for such supplies often face significant constraints and challenges. These typically include:

- limited capacity and skills within the community may increase the need for surveillance to assess the state of drinking water supplies and for surveillance staff to provide training and support to community members;
- the very large number of widely dispersed supplies, which significantly increases overall costs in undertaking surveillance activities.

Experience from both developing and developed countries has shown that surveillance of community-managed drinking water supplies can be effective when well designed and it works best when supportive, not punitive. Effective surveillance involves systematic surveys covering all aspects, from source water quality to household storage practices. This addresses the variability in systems and promotes healthy water management behaviors.

Experience has also shown that the role of surveillance may include health education and health promotion activities to improve healthy behavior toward management of drinking water supply and sanitation. Participatory activities can include sanitary inspection by communities and, where appropriate, community-based testing of drinking water quality using affordable field test kits and other accessible testing resources. Implementing all these actions in the field faces challenges that are difficult to overcome. As long as there is external support, these community approaches work well but experiences say that the sustainability of such approaches with the withdrawal of the external support faces a high level of risks.

Frequent visits to every supply may be impractical due to sheer numbers and resource limitations. Rolling programs with periodic visits are more feasible, aiming for at least one visit every 3-5 years. However, in densely populated countries like Bangladesh, the practicality and feasibility of such schedules require further consideration. In country like Bangladesh, one has to think about the practicality and feasibility of such a visit.

Differences between urban and rural drinking water quality surveillance

Urban and rural drinking water quality surveillance differ in several key aspects, including:

Frequency of Monitoring:

Urban drinking water systems are typically monitored more frequently than rural systems. This is because urban systems are more likely to be contaminated due to their higher population density and industrial activities.

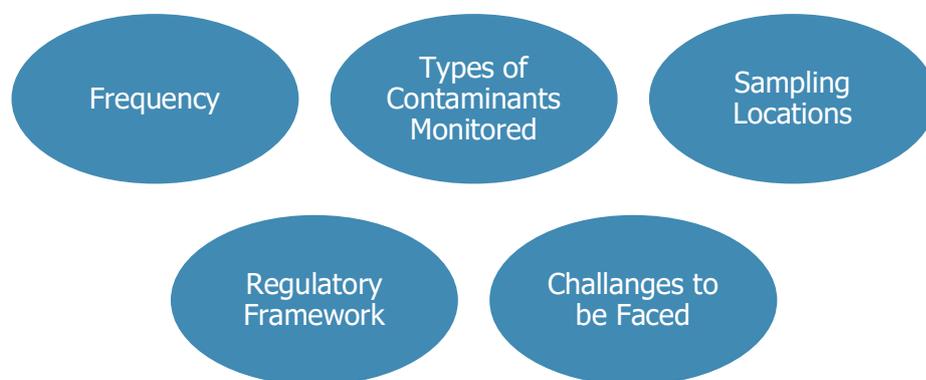


FIGURE -13: KEY ASPECTS OF DIFFERENCES BETWEEN URBAN AND RURAL DWQ SURVEILLANCE

Types of Contaminants Monitored:

The types of contaminants that are monitored in urban and rural drinking water systems can also differ. Urban systems are more likely to be contaminated with industrial pollutants, such as chemicals and metals, while rural systems are more likely to be contaminated with agricultural pollutants, such as pesticides and fertilizers.

Sampling Locations:

The sampling locations for urban and rural drinking water systems also differ. Urban systems typically have a more extensive network of sampling points than rural systems. This is because urban systems have a more complex distribution system and are more likely to have variability in water quality across different parts of the system.

Regulatory Framework:

The regulatory framework for drinking water quality surveillance also differs between urban and rural areas. In many countries, there are stricter regulations for drinking water

quality in urban areas than in rural areas. This is because urban areas are more likely to have the resources and infrastructure to comply with stricter regulations.

Challenges:

There are several challenges associated with drinking water quality surveillance in both urban and rural areas. In urban areas, the challenges include:

- The high cost of monitoring and treating drinking water
- The difficulty of managing a large and complex distribution system
- The increasing prevalence of new and emerging contaminants

On the other hand, in rural areas, the challenges include:

- The lack of financial resources and infrastructure
- The dispersed population
- The difficulty of accessing and monitoring water sources
- Despite these challenges, drinking water quality surveillance is essential for protecting public health in both urban and rural areas.

Similarities of Urban and rural drinking water quality surveillance

Despite the differences between urban and rural drinking water quality surveillance, there are also several key similarities. These similarities include:

The goal of protecting public health:

Both urban and rural drinking water quality surveillance programs are designed to protect public health by ensuring that drinking water is safe to consume.

The use of scientific methods:

Both urban and rural drinking water quality surveillance programs use scientific methods to collect and analyze data on water quality.

The importance of data management:

Both urban and rural drinking water quality surveillance programs rely on data management to track water quality trends and identify potential problems.

The need for public education:

Both urban and rural drinking water quality surveillance programs need to educate the public about the importance of safe drinking water and how to protect it.

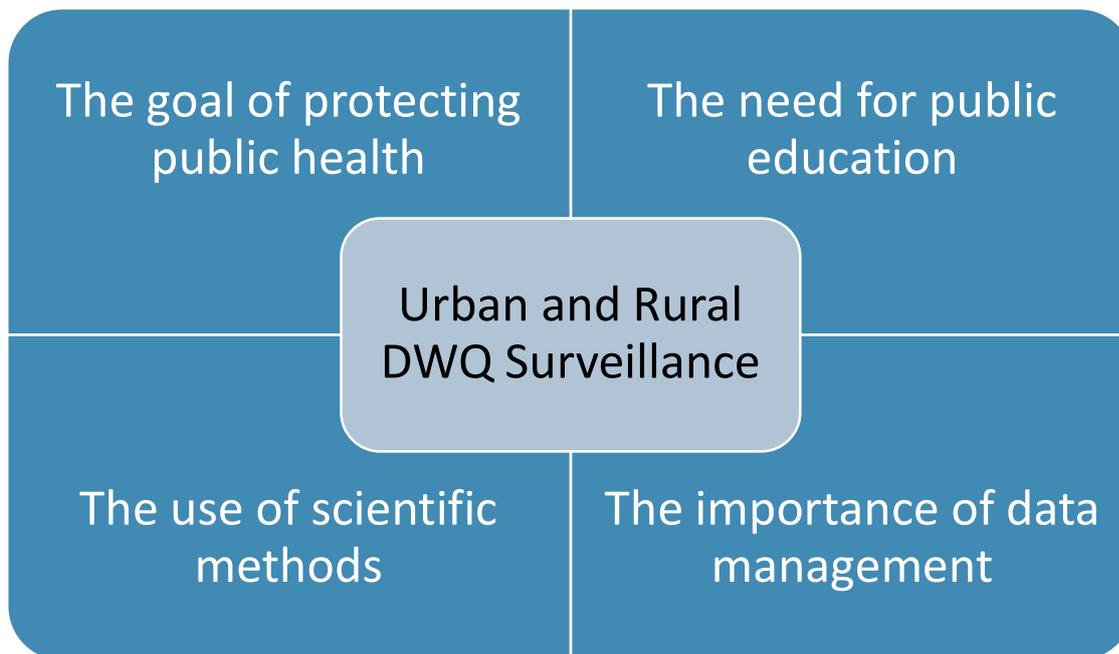


FIGURE 20: KEY SIMILAR ASPECTS OF DWQ SURVEILLANCE

In addition to these general similarities, there are also some specific similarities between urban and rural drinking water quality surveillance programs. For example, both urban and rural programs typically use the same types of water quality indicators, such as bacteria, chemicals, and metals. Additionally, both urban and rural programs typically use similar methods to collect and analyze water quality data

Conclusion

To effectively implement drinking water quality (DWQ) surveillance in Bangladesh, a comprehensive approach encompassing the development of a national surveillance plan, the establishment of a national DWQ database, training of personnel, increased funding, public awareness campaigns, strengthened regulatory frameworks, promotion of treatment technologies, encouragement of new monitoring technologies, international partnerships, and continuous monitoring and evaluation is essential. These steps will collectively ensure the safety of Bangladesh's drinking water for all citizens.

Water Quality Parameters

(1st Day, 5th Class)

Introduction	<ul style="list-style-type: none"> ○ Mutual acquaintance/Knowing each other of the participants ○ Description of training objectives ○ Expectations from that session ○ Pre-training Assessment
Purpose of the Session	<p>At the end of this session</p> <ul style="list-style-type: none"> ○ The Training personnel and participants get to know each other, ○ The Participant will be able to explain training objectives, ○ A learning environment will be created, ○ Coordination between expectations and topics can be achieved.
Duration	1 hour
Training Materials	White Board, White Board Marker, Flip Chart Board, Flip Chart Paper, Flip Chart Marker, Multimedia Projector, Screen, Duster, Manual.
Overall objective of the Training	<p>At the end of the Training, the Participants can be able to</p> <ul style="list-style-type: none"> ○ Identify the parameters that should be monitored in DWQ surveillance. ○ Select appropriate sampling or assessment locations and frequencies. ○ Develop and implement sampling or assessment schedules.
Specific Objectives of Training	<p>After completing the training, the Participants can have a clear idea on</p> <ul style="list-style-type: none"> ○ Water Quality Parameters, how they are selected, ○ Sampling Location and Frequency for both point sources and piped water supply system, ○ Sampling Methods and Equipment used during sampling, ○ Considerations of Management Decision Making, Preparation of Material and Equipment for Sampling.

Water Quality Parameters

(1st Day, 5th Class)

Introduction

A workable and effective drinking water quality monitoring and surveillance system needs a set of well-selected parameters. If these parameters are not selected in line with the objectives of the drinking water quality monitoring and surveillance system, the purpose of the whole monitoring and surveillance system will not be met. Besides the selection of appropriate parameters, the importance of selecting the optimum frequency of sampling, the appropriate methods and equipment, and developing and implementing sampling schedules cannot be ignored.

Parameters to be selected

The simplest combination of variables is temperature, electrical conductivity, pH, dissolved oxygen (DO), and total dissolved/suspended solids (TDS/TSS). These give the bare minimum of information on which a crude assessment of overall water quality can be based. More complex programs may analyze up to 100 variables, including a range of metals and organic micro-pollutants. Moreover, analysis of biota (plankton, benthic animals, fishes, and other organisms) and of suspended particulates and sediments can add valuable information.

The factors for the determination of water quality parameters to be monitored include:

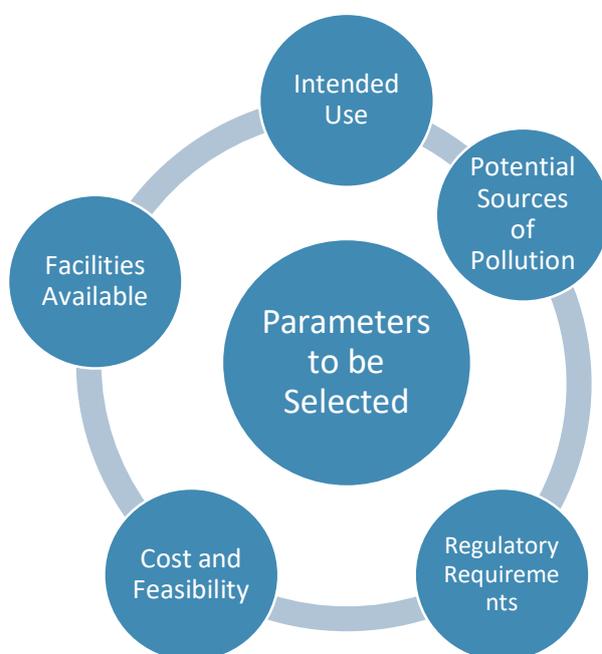


FIGURE-14: SELECTION CRITERIA OF PARAMETERS

Intended use of the water:

For whom and for what purpose, the water is intended to supply is important in the selection of specific water quality parameters that need to be monitored. For example, drinking water will need to be monitored for different parameters than wastewater or agricultural runoff.

Potential sources of pollution:

The potential sources of pollution at the source will also influence the parameters that need to be monitored. For example, if a source is a surface water body located near an agricultural area, it will be important to monitor for parameters such as nitrates and phosphates. If the source is groundwater, monitoring Arsenic is more important than Phosphates.

Regulatory requirements:

Sometimes, laws and regulations are in place that establish standards for water quality. If these regulations specify the water quality parameters that need to be monitored, then those should be included in the monitoring program.

Cost and feasibility:

The cost and feasibility of monitoring different water quality parameters is an important factor to consider. Some parameters, such as pH and dissolved oxygen, are relatively easy and inexpensive to monitor. Other parameters, such as trace organic compounds, can be more difficult and expensive to monitor.

Facilities Available for Testing:

The availability of testing facilities will limit the water quality parameters that can be monitored. For example, if a testing facility does not have the equipment to test for a particular parameter, then that parameter cannot be monitored.

According to WHO, priority parameters to be included in monitoring and surveillance are as follows:

- Microbiological quality (indicators of bacteria) and controlling parameters (disinfectant residuals like free chlorine residual, pH, and turbidity), also named critical parameters
- Physical and aesthetic parameters which cause rejection of water (taste, color, odour)
- Chemicals of known health risks like heavy metals (As), nutrients, etc.

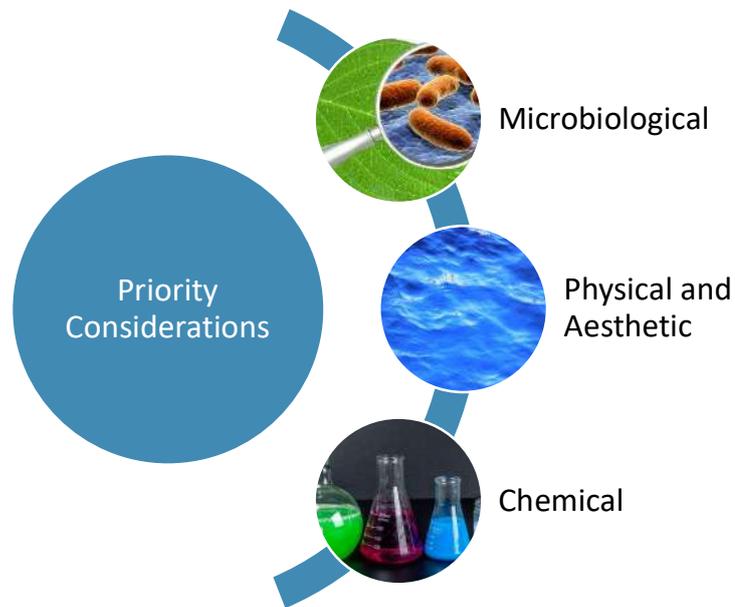


FIGURE-15: WHO SUGGESTED PRIORITY PARAMETERS FOR DWQ MONITORING AND SURVEILLANCE

The testing parameters are different depending on the water source (surface water, rainwater, and groundwater), the type of supply (point source, piped system), and the sampling location in that system (intake, water treatment plant, distribution, collection, storage level).

The following table shows an example of ideal monitoring and surveillance parameters, to be checked by urban areas of Bangladesh. Characteristics of water quality are different in each Pourashava. Therefore, it is necessary to set up water quality parameters according to their circumstances such as industrial type and density, agricultural situation, geological situation, etc. However, the frequency of testing will differ for monitoring and surveillance purposes.

Mode of supply	Parameters
For HTWs ¹ , RWH ² , PSF ³ , IFG ⁴ , GFS ⁵ and ART ⁶	Fecal coliform, As, Fe, Cl, turbidity, color, odor ※ RWH does not need to be tested As. ※ Cl is less necessary to be tested outside coastal and industrial areas.
For surface water, raw water (catchment, intake)	pH, BOD, DO, COD, TOC, NH ₃ , NO ₃ , fecal coliform, pesticides, etc. ※ Cl is less necessary to be tested outside coastal and industrial areas.

Piped water supply systems	Fecal coliform, pH, As, Fe, Cl, NO ₃ , residual chlorine, turbidity, color, odor, etc. ※ Cl is less necessary to be tested outside coastal and industrial areas.
Water stored at consumer's level	Fecal coliform, pH, As, Fe, Cl, NO ₃ , turbidity, color, odour etc. ※ Cl is less necessary to be tested outside coastal and industrial areas.

¹HTWs: Hand Tube Wells (including Shallow Tube Wells (STW), Tara Tube Wells (TTW), Very Shallow Tube Wells (VSST) and Deep Tube Wells (DPP)) / ²RWH: Rain Water Harvesting / ³PSF: Pond Sand Filter / ⁴IFG: Infiltration Gallery / ⁵GFS: Gravity Flow System / ⁶ART: Arsenic Removal Technology (PICMAC Guidelines 2012)

Water quality monitoring and surveillance protocol for RWS system in Bangladesh published by DPHE in August 2005, suggests a longer list of parameters for monitoring and surveillance purposes for rural water supply systems in Bangladesh. That list is shown below. The below table shows the suggested minimum numbers of parameters for testing. If additional parameters as outlined below can be covered, it will be highly desirable and will be treated as a fine-tuning exercise. However, that highly ambitious protocol could not be implemented because of inadequate or no funding, lack of willingness, lack of adequate workforce, etc.

Technology	Suggested Parameters	Additional Parameters
Pond sand Filter (PSF)	Fecal Coliform Sanitary Inspection Color Odor Turbidity pH (if Chlorinated) Residual Chlorine (If Chlorinated) Algae Nitrate Chloride	Pesticide Manages Iron Arsenic (If Pond is filled with tubewell water)
Dug Well/Ring Well	Fecal Coliform Sanitary Inspection Color Odor Turbidity pH (if Chlorinated) Residual Chlorine (If Chlorinated) Arsenic	Chloride Pesticide

	Nitrate Electric Conductivity Iron Manganese	
Rain Water Harvesting	Fecal Coliform Sanitary Inspection Color Odor Turbidity pH (if Chlorinated)	Iron Zinc Lead
Iron Removal Unit	Fecal Coliform Sanitary Inspection Color Odor Turbidity pH Arsenic Iron Manganese	
Arsenic Removal Technologies (ARTs)	Arsenic Fecal Coliform Color Odor Turbidity	
Shallow and Deep tube-wells	Fecal Coliform Sanitary Inspection Color Odor Turbidity Arsenic Nitrate Chloride Iron Manganese Total hardness	Barium Chromium Molybdenum Selenium Cadmium Cyanide Mercury
Rural Piped Water Supply	Source Water: Selection of parameters based on types of sources <i>Distribution</i> Fecal Coliform Color Odor Turbidity pH (if Chlorinated) Free and total residual Chlorine	Depends on the source of water.

Sampling Location and Frequency

While developing a monitoring plan sampling or location and frequency are two important factors to be considered to ensure that the data collected is accurate, reliable, and relevant to the purpose of the monitoring plan. Improper location may not represent the real scenario. On the other hand, how frequently water quality will be monitored affects the cost. Here are a few factors that influence the sampling location and frequency.

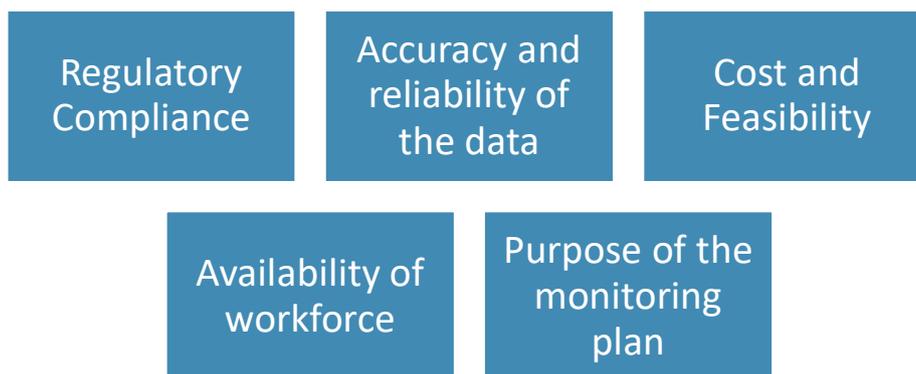


FIGURE 23: FACTORS THAT INFLUENCE THE SELECTION OF SAMPLING LOCATION

Accuracy and reliability of the data:

The location and frequency of sampling can affect the accuracy and reliability of the data collected. For example, if samples are collected from a single location at a single point in time, the data may not be representative of the overall water quality. It is important to collect samples from multiple locations and over time to get a more accurate picture of the water quality. For examples,

In a lake or reservoir, it may be necessary to sample at different points to determine whether water quality can be estimated at a single point or whether the lake or reservoir behaves as several separate water bodies with different water quality characteristics. It is also essential to investigate variations in water quality with depth especially during stratification. Lakes and reservoirs are generally well-mixed when stratification breaks down and sampling from a single depth or the preparation of a composite sample from two depths may adequately represent the overall water quality.

For groundwaters, it is important to confirm whether or not the well casing is perforated, allowing access to more than one aquifer. If this is the case then an alternative site should be sought or measures taken to sample from a single aquifer only. The latter is generally problematic.

Cost and feasibility:

The location and frequency of sampling or assessment can also affect the cost and feasibility of the monitoring plan. More frequent sampling and assessment will typically

be more expensive. It is important to prepare a plan with a minimum number of locations and a minimum number of frequencies balancing the need for accurate and reliable data with the cost and feasibility of the monitoring plan. For example, limited funds and a large number of point water sources make monitoring the water quality of rural water supplies very difficult, limiting the frequency of sampling

Availability of workforce:

The availability of a trained workforce can also limit the frequency of sampling.

Regulatory requirement:

The regulatory requirement is also a factor to consider when developing a sampling schedule.

Purpose of the monitoring plan:

The purpose of the monitoring plan will also influence the location and frequency of sampling or assessment. For example, if the purpose of the monitoring plan is to ensure that the water quality is meeting regulatory standards at all points in the system, then monitoring the water quality at different locations throughout its distribution system will be important. On the other hand, if a scientist studying the effects of climate change on water quality may need to collect samples from the same location over time to track changes in water quality.

Considering the above points, we may summarize the points to be considered for the selection of sampling location in the context of urban Bangladesh here. As per the recommendations of the PICMaC Guideline 2021, the following are consideration points for the selection of sampling locations for the monitoring and surveillance program.

Point sources:

For point sources, sample locations should be representative of point source outlets, buckets used to withdraw water, and storage in households in a target Pourashava.

Piped water supply system: For piped water supplies, samples shall be taken from locations that:

- Shall be representative of the main components of the water supply system, i.e. raw water from the water source, treated water from the treatment plant, distributed water at connections and taps, and stored water in households.
- Shall be representative of unfavorable conditions found in the water supply system, i.e. points of possible contamination such as unprotected sources, loops, reservoirs, low-pressure zones, ends of the system, etc.
- Shall be distributed throughout a distribution system, taking population distribution into account, with several sampling points proportional to the number of branches.

- Shall be representative of water storage in households since recontamination of water represents a major health risk.
- Shall be taken into account the number of inhabitants served by each source in systems with more than one water source.

Sample Frequency

More frequent testing is required for monitoring while less frequent testing is required for the surveillance. According to WHO recommendations for surveillance, sampling shall be taken at a frequency of 3 to 5 years for both point source and piped water supply systems.

High-frequency monitoring parameters are index parameters, which affect the condition of water quality such as pH, EC, etc., and existing and/or high potential risks parameters such as As, saline coliform, etc. On the other hand, low-frequency monitoring parameters are potential hazardous parameters that were detected in the past, possibly existing with the consideration of land use and geological conditions, and where the concentration of field research result differs from the standards.



Microbiological parameters:

Microbiological parameters, such as bacteria and viruses, should be monitored on a more frequent basis than chemical or physical parameters. This is because microbiological contaminants can multiply rapidly and cause illness if present in drinking water. Again, if the source is groundwater, then less frequent sampling can be adopted. On the other hand, if the source is surface water, it needs more frequent sampling

Chemical parameters:

Chemical parameters, such as arsenic, lead, and nitrate, should be monitored on a less frequent basis than microbiological parameters, but still regularly. This is because chemical contaminants typically do not multiply in drinking water, but they can still cause health problems over time if consumed at high levels.

Physical parameters:

Physical parameters, such as turbidity and pH, should be monitored regularly, but less frequently than microbiological or chemical parameters. This is because physical

parameters are typically not harmful to human health, but they can affect the taste and appearance of drinking water.

The following table shows an example of, monitoring points and frequency for a piped water supply system to be checked by Pourashava (PICMAC Guideline 2021).

Parameters	Headworks	Untreated water reservoir	Treated water reservoir	Distribution	Connection	Tap
Turbidity	Twice daily	✓	✓	Monthly	✓	✓
Conductivity		✓		Monthly	✓	✓
Alkalinity		✓				
pH		✓		Monthly	✓	✓
Coliform	Weekly	✓	(✓)	Monthly	✓	✓
Residual Chlorine	Twice daily		✓	Monthly	✓	✓
Color	Weekly	✓	(✓)	Quarterly	✓	✓
Iron and inorganics	Depends on the quality of raw water					
Pesticide	Twice / year	✓	✓	✓	(✓)	✓

✓ Systematic monitoring (✓) Monitoring as necessary

The following approaches can be used to calculate the number of samples to be collected:

- The population approach, used by WHO, is based on the number of people using the water supply - and not the number of people residing in an area
- An alternative approach, which identifies areas that consistently fail on microbiological quality. Other factors may include the density of population and level of service, i.e. zoning process, with a greater number of samples taken from higher-priority areas

WHO-recommended minimum sample numbers for critical parameters for piped water supplies are shown in the below table.

Population Served	No. of monthly samples
< 5000	1
5000 - 100 000	1 per 5000 population
> 100 000	1 per 10 000 population, plus 10 additional samples

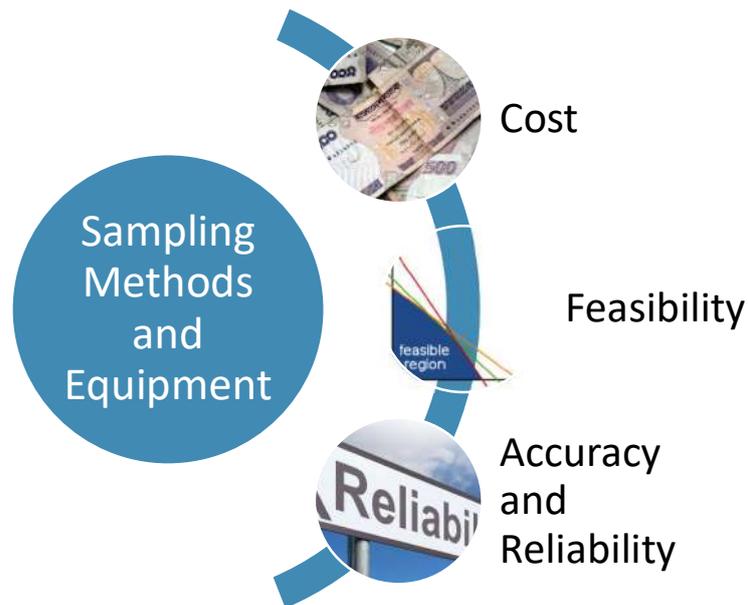
Water quality monitoring and surveillance protocol for RWS system in Bangladesh published by DPHE in August 2005, suggests frequency of monitoring for different types of technologies. The below table suggests the frequency of monitoring for different types of parameters for different types of technologies.

Technology	Suggested Parameters	Additional Parameters
Pond sand Filter (PSF)	Once every 30 days.	Iron and Manganese at the time of source selection Pesticide, Chloride, and Arsenic-once in a year.
Dug Well/Ring Well	Fecal Coliform, sanitation inspection, pH, residual chlorine, and aesthetical parameters- every 30 days All other suggested chemical parameters and E.C- every six months	Pesticide- once in a year Chloride- occasional
Rain Water Harvesting	Community level- every 3 months Household- randomly selected 50 households in a year.	Community level- every 3 months Household- randomly selected 50 households in a year. However, testing of zinc and lead depends on the material and conditions of roofs.
Iron Removal Unit	Every 3 months	
Arsenic Removal Technologies (ARTs)	Randomly selected 10 units in a month	

Shallow and Deep tube-wells	<p>Nitrate, and Chloride - once at the time of installation.</p> <p>Boron- once at the time of installation in coastal areas.</p> <p>Chloride- once at the time of installation. After this randomly selected 20 tube wells in a year in coastal or saline-prone areas.</p> <p>Other parameters- once at the time of installation. After this randomly selected 20 tube wells in a year.</p>	Once at the time of installation
Rural Piped Water Supply	<p>Chemical parameters- depends on the source follow recommendations for such parameters for other sources.</p> <p>Aesthetical and free chlorine- at the time of installation and preferably monthly but at least quarterly.</p>	Chemical parameters- depends on the source follow recommendations for such parameters for other sources.

Sampling Methods and Equipment

Careful consideration of the sampling methods and equipment is crucial when designing a monitoring plan to ensure that the data collected is accurate, reliable, and relevant to the purpose of the monitoring plan. Sampling methods and equipment can influence a monitoring plan in the following ways:



Accuracy and reliability of the data:

The sampling method and equipment used will affect the accuracy and reliability of the data collected. For example, if the sampling method is not representative of the overall water body, the data may not be accurate. Similarly, if the sampling equipment is not properly calibrated or maintained, the data may not be reliable.

Cost and feasibility:

The sampling method and equipment used will also affect the cost and feasibility of the monitoring plan. Balancing the need for accurate and reliable data with the cost and feasibility of the monitoring plan requires thoughtful planning because some sampling methods and equipment are more expensive than others.

Management Decision Making

When a water quality monitoring program is being planned, water authorities can reasonably expect that the program will yield data and information that will be of value for management decision-making. For examples,

- How the quality and quantity of water in a water body relate to the requirements of users.
- How the quality and quantity of water in a water body relate to established water quality standards.
- The capacity of the water body to assimilate an increase in waste discharges without causing unacceptable levels of pollution.
- The appropriateness and effectiveness of control strategies and management actions for pollution control.

- The trends of changes in water quality concerning time as a result of changing human activities in the catchment area.
- Control measures that should be implemented to improve or prevent further deterioration of water quality

The PICMAC Guideline 2021 says that the selection of the sampling method will be dependent on the objectives of the sampling plan. It recommends the following sampling methods and suggests that DPHE shall select suitable methods for each sampling point.

Sampling Methods	Outline
Judgemental sampling	sampling is performed at a specific location (e.g. a pipe outlet in a river) to determine the presence or absence of the analysis, e.g. when pollution occurs
Systematic sampling	sample sites are chosen systematically to give a detailed picture of the conditions in the area of interest (e.g. to assess water quality trends in a specific area)
Random sampling	sample sites are chosen randomly throughout the area of interest, e.g. to assess the quality of water stored in households

Sampling procedure:

It is different from a category of water quality parameters such as physical parameters, microbiological parameters, heavy metals, etc. Therefore, water samples should be taken separately by each category. The following are sampling procedures by each category.

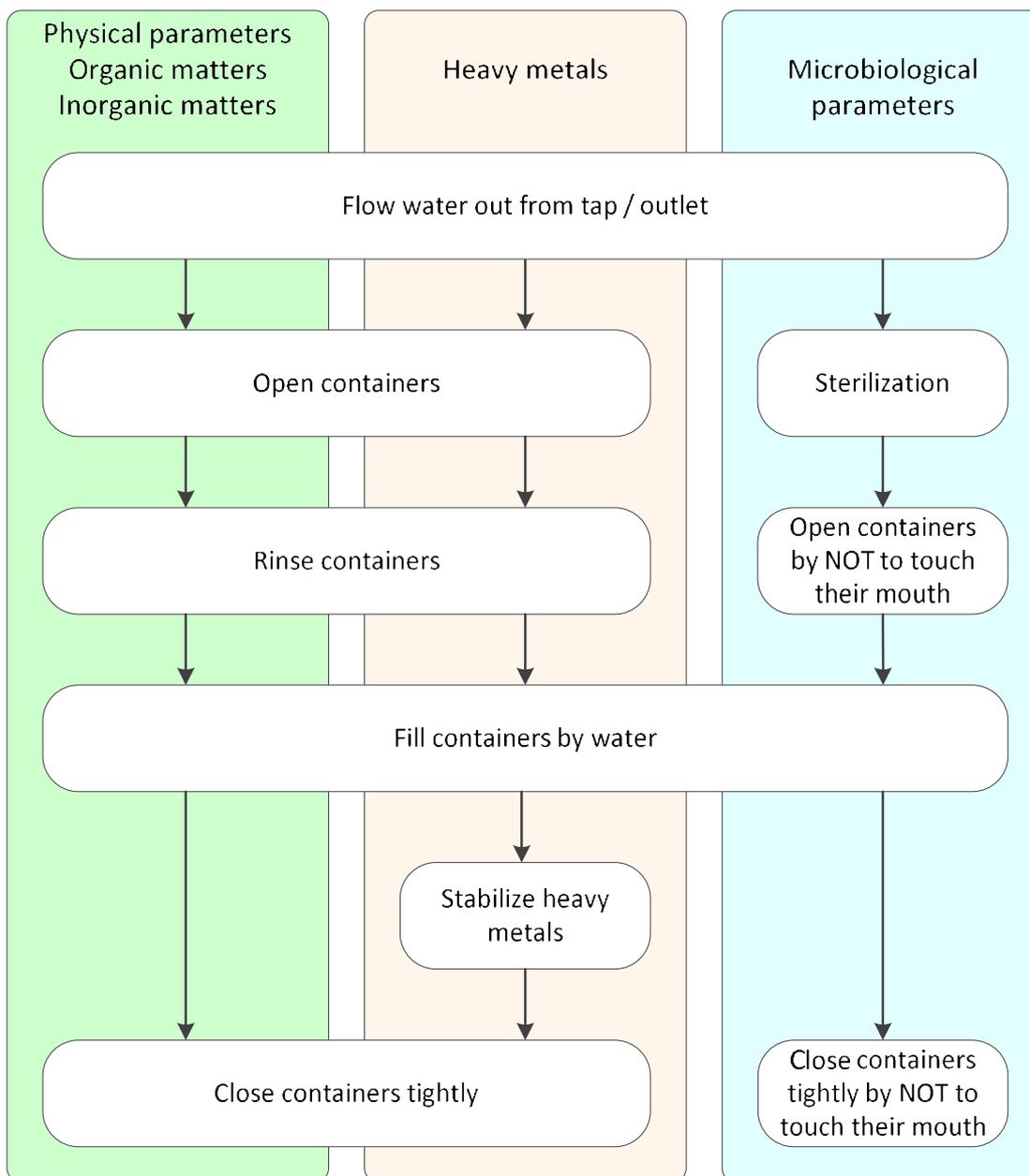


FIGURE-16: SAMPLE COLLECTION FLOW DIAGRAM

Preparation of Material and Equipment

Preparation is the key to fieldwork. Before leaving for the field, collectors shall determine the nature of the analysis to be assessed, the analytical method to be used, the sampling methodology (including sample quantity and size), the sampling location, the sampling safety, etc. Regarding the preparation of material and equipment for microbiological analysis, collectors shall ensure that the requirements, listed below table are fulfilled.

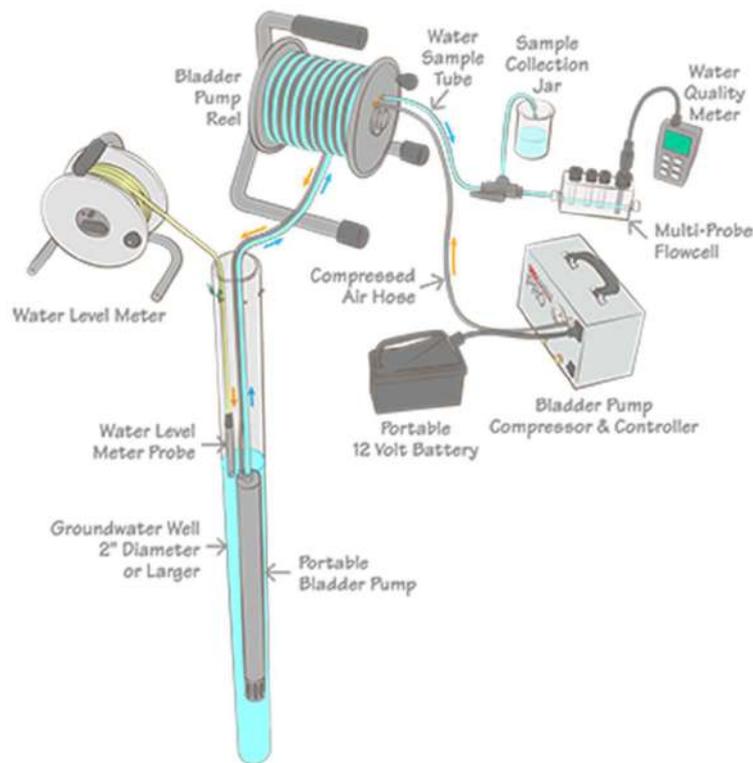


FIGURE 25: A FEW SAMPLINGS EQUIPMENT

Item	Requirement
Sample bottle	<ul style="list-style-type: none"> • Transparent glass or polyethylene materials (No rubber or cork) • Need to wash clearly • Need to sterilize for microbiological purposes
Equipment	<ul style="list-style-type: none"> • Calibration of field test kits • Prepare plates used to incubate samples • Prepare a sufficient amount of portable test kits • Properly calibrate measuring instruments of zonal and central laboratories
Material	<ul style="list-style-type: none"> • Prepare high-quality and standardized reagents • Prepare pre-treatment and preservation material if necessary • Prepare sufficient sample sheets
Supplies	<ul style="list-style-type: none"> • Prepare sufficient dishes, pads, filters, tablets and methanol to analyze samples and sterilize the equipment in the field
Label etc.	<ul style="list-style-type: none"> • Prepare labels and/or seals for sample bottles

Standardizing Quality Control: A Step-by-Step Guide to Validation, Verification, and Documentation

(2nd day, 1st Class)

Introduction of the Session	<ul style="list-style-type: none"> ○ Mutual acquaintance/Knowing each other of the participants ○ Description of training objectives ○ Expectations from that session ○ Pre-training Assessment
Purpose of the Session	<p>At the end of this session</p> <ul style="list-style-type: none"> ○ The Training personnel and participants get to know each other, ○ The Participant will be able to explain training objectives, ○ A learning environment will be created, ○ Coordination between expectations and topics can be achieved.
Duration	1 hour
Training Materials	White Board, White Board Marker, Flip Chart Board, Flip Chart Paper, Flip Chart Marker, Multimedia Projector, Screen, Duster, Manual.
Overall objective of the Training	<p>At the end of the Training, the Participants can be able to</p> <ul style="list-style-type: none"> ○ Develop a foundation in the principles of quality assurance systems for drinking water quality monitoring and surveillance. ○ Learn how to effectively validate drinking water quality test results to ensure their accuracy and reliability ○ Understand the different methods for checking and interpreting drinking water quality test results to identify potential health concerns. ○ Identify the qualifications and training required for staff involved and their responsibilities in quality assurance activities in drinking water quality monitoring and surveillance ○ Develop effective procedures for documenting and managing records to maintain data integrity and facilitate traceability.
Specific Objectives of Training	<p>After completing the training, the Participants can have a clear idea on</p> <ul style="list-style-type: none"> ● Quality assurance and validation (QA/V) ● Requirements for checking and interpreting results ● Responsibilities and necessary qualifications of staff, ● Documentation and management of records.

Standardizing Quality Control: A Step-by-Step Guide to Validation, Verification, and Documentation

(2nd day, 1st Class)

Introduction

Ensuring clean and safe drinking water is vital for public health. Monitoring and tracking drinking water quality is essential to protect public health by providing accurate and timely information about the quality of drinking water supplies. To safeguard public health effectively, a robust quality assurance system for drinking water quality monitoring and surveillance must be in place. This system should include validating results, checking and interpreting results, documenting and managing records, and training staff.

Validating results is crucial for ensuring the dependability of drinking water quality data. This involves verifying that water quality testing results are accurate and consistent with established standards and protocols. Validation procedures may involve comparing results to reference materials, participating in proficiency testing programs, and regularly calibrating testing equipment.

Checking and interpreting drinking water quality test results are equally important aspects of quality assurance. This involves reviewing the results to ensure they are consistent with the data and make sense in the context of the monitoring program. This may involve evaluating trends in water quality data, identifying potential outliers, and investigating anomalies.

The qualifications of staff involved in drinking water quality monitoring and surveillance are crucial for maintaining data quality. Staff should have a strong understanding of water quality parameters, testing methodologies, and quality assurance principles. Additionally, they should be proficient in data management and reporting procedures.

Documenting and managing records are essential for maintaining the integrity of drinking water quality data. This includes documenting the procedures used for sample collection, handling, analysis, and reporting of results. Proper documentation ensures traceability and facilitates data review and audits.

Quality Assurance and Validation (QA/V)

Quality assurance and validation (QA/V) methods are essential for ensuring the accuracy and reliability of water quality monitoring data. QA/V methods can include things like:

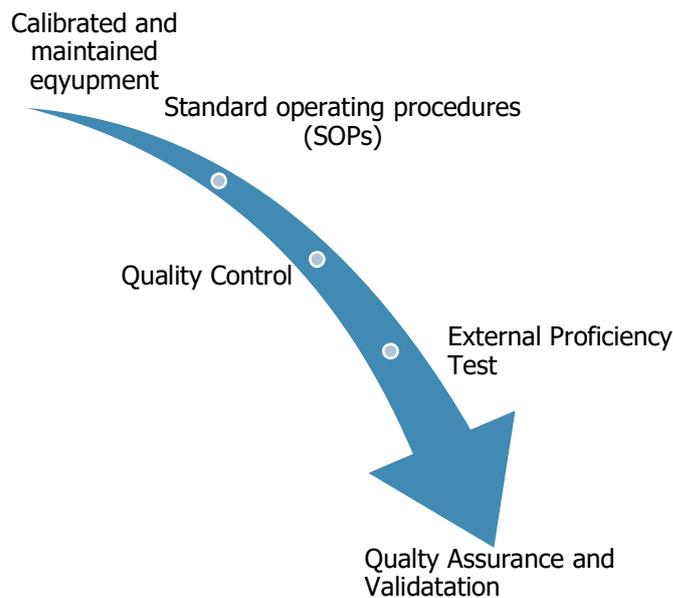


FIGURE 26: QUALITY ASSURANCE AND VALIDITY PROGRAM

- Using calibrated and maintained equipment
- Using standard operating procedures (SOPs) for sampling, analysis, and data reporting
- Conducting quality control checks, such as duplicate samples and blanks
- Participating in external proficiency testing programs

When designing a water quality monitoring and surveillance plan, it is important to select QA/V methods that are appropriate for the parameters being monitored and the resources available.

There are a few other factors such as the availability of funds and qualified staff, the complexity of the water supply system, and the size of the water supply system can influence the methods for quality assurance and validation of results (QA/V).

Availability of funds and qualified staff:

QA/V methods can be expensive and time-consuming, so the availability of funds and qualified staff can limit the number and type of QA/V methods that can be used. For example, a small municipality with limited resources may not be able to afford to participate in external proficiency testing programs or to hire a dedicated QA/V officer.

The complexity of the water supply system:

The complexity of the water supply system can also influence the QA/V methods that can be used. For example, Water utilities like DWASA, CWASA, and KWASA responsible for a complex water supply system with multiple treatment plants and distribution networks may require more complex QA/V methods than a simple water supply system.

Size of the water supply system:

The size of the water supply system can also influence the QA/V methods that can be used. For example, a large water supply system like WASAs with a large number of sampling points may require more frequent QA/V checks than a small water supply system with a small number of sampling points.

It is important to select QA Use internal quality control checks, such as duplicate samples and blanks./V methods that are appropriate for the specific water supply system and the resources available. Water utilities with limited resources may need to be creative in developing QA/V programs that are affordable and effective.

Here are some tips for developing a QA/V program on a limited budget:

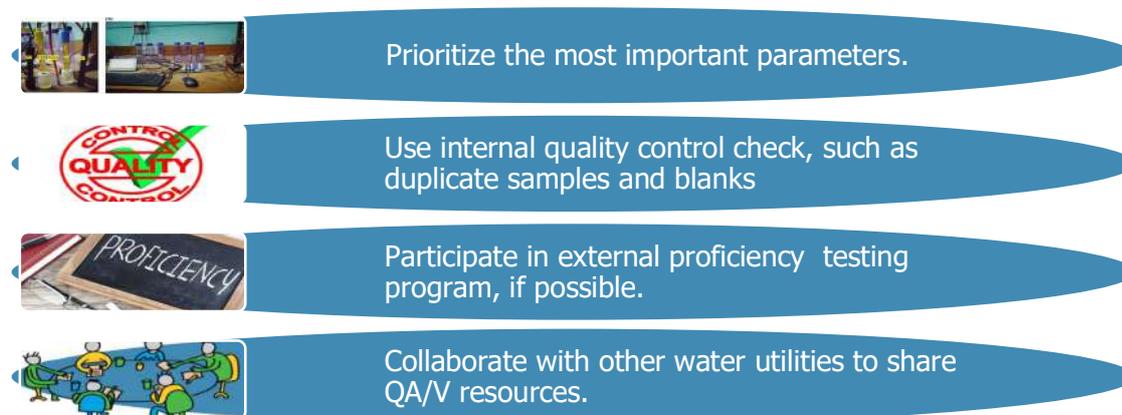


FIGURE 27: TIPS FOR A QA/V PROGRAM DEVELOPMENT WITH A LIMITED BUDGET

By following these tips, water supply authorities can develop QA/V programs that help to ensure the accuracy and reliability of their water quality data, even with limited resources.

Requirements for checking and interpreting results

Checking and interpreting results is a critical step in the design and development of a drinking water quality monitoring program. By regularly reviewing and analyzing monitoring data, responsible authority can identify trends, patterns, and potential problems, and make necessary adjustments to the program accordingly.

Identifying new areas of concern: By reviewing monitoring data over time, the water supply authority can identify new areas of concern that may not have been previously apparent. For example, if monitoring data shows that a particular part of a distribution network is experiencing a decline in residual chlorine levels, this could indicate the presence of pollutants through leakages. This information can then be used to focus on these new areas of concern.

Making informed decisions: By understanding the results of water quality monitoring, program water supply authority can make more informed decisions about water quality management. For example, if monitoring data shows that the source of a drinking water

supply is being contaminated by a specific pollutant, this information can be used to develop strategies to reduce or eliminate the source of the pollution.

Responsibilities and necessary qualifications of staff

Water quality monitoring should be conducted by qualified staff. The specific qualifications required will vary depending on the complexity of the monitoring plan and the parameters being monitored.

When designing a water quality monitoring plan, it is important to identify the necessary qualifications of staff and to develop a training plan to ensure that staff have the skills and knowledge to conduct the monitoring effectively. For example, if a water quality monitoring plan is designed to be conducted by staff with limited experience, then it is important to develop a comprehensive training plan.

It is also important to consider the following qualifications when hiring staff for a water quality monitoring program:

Education and training: Staff should have a formal education in water quality monitoring and assessment or a related field. They should also have received training in the specific sampling and analytical techniques that will be used in the program.

Experience: Staff should have experience working in a water quality monitoring program, or a related field. This experience will help them to develop the skills and knowledge needed to successfully implement and manage the program.

Communication and interpersonal skills: Staff should be able to communicate effectively with a variety of audiences, both technical and non-technical. They should also be able to work effectively as part of a team. By hiring staff with the appropriate responsibilities and qualifications, water quality monitoring programs can be more effective and efficient.

Documentation and management of records

Documentation and management of records are essential for a drinking water quality monitoring and surveillance program. Two important points should be considered when starting a new program. Firstly, it is better to have a complete record of reliable data concerning water quality at a few sampling stations than to have a lot of data of questionable quality from many sampling stations. Secondly, if reported data are not credible, the program and its staff will lose credibility.

Well-maintained documentation and management of records provide several important benefits, as shown in the figure-28.

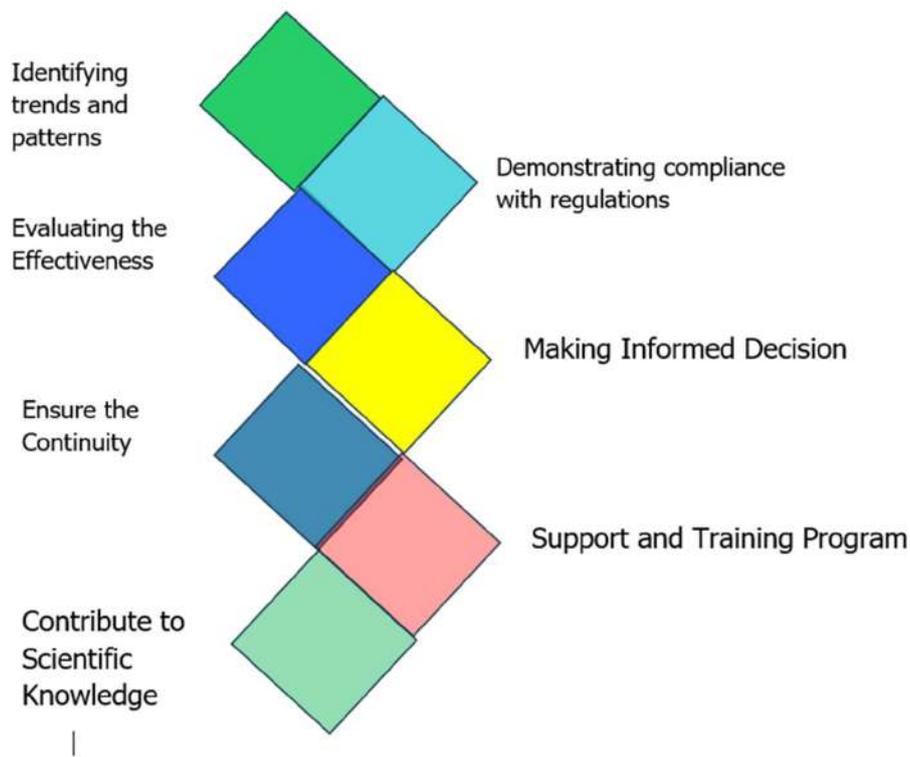


FIGURE-17: BENEFITS OF PROPER DOCUMENTATION AND MANAGEMENT OF RECORDING

Demonstrating compliance with regulations:

Many drinking water quality monitoring and surveillance programs are required to comply with government regulations. Documentation and management of records can help to demonstrate compliance with these regulations.

Identifying trends and patterns:

By reviewing monitoring and surveillance data over time, the water supply authority can identify trends and patterns in water quality. This information can be used to identify potential problems and to develop strategies to address them.

Evaluating the effectiveness of the monitoring and surveillance program:

Documentation and management of records can be used to evaluate the effectiveness of the monitoring and surveillance program.

Making informed decisions about water resource management:

By understanding the results of water quality monitoring, authorities can make more informed decisions about water quality management. For example, if monitoring data shows that a particular drinking water source is being contaminated by a specific pollutant, this information can be used to develop strategies to reduce or eliminate the source of the pollution.

Ensure the continuity of the monitoring program:

If staff members leave the monitoring program, or if the program is transferred to a new organization, well-maintained records can help to ensure that the program continues to operate smoothly.

Support training and development:

Documentation and management of records can be used to train new staff members and to develop new monitoring protocols and procedures.

Contribute to scientific knowledge:

Water quality monitoring data can be used to contribute to scientific knowledge about drinking water quality and its relationship to public health.

Conclusion

In many countries like Bangladesh, many water quality monitoring programs are understaffed with limited funds. Due to these limitations, these countries cannot effectively monitor their water resources. However, even with limited resources, these countries need to document and manage their water quality monitoring data. This data can be used to identify potential problems with water quality and to develop strategies to address them.

Sanitary inspections

(2nd Day, 2nd Class)

Introduction	<ul style="list-style-type: none"> ○ Mutual acquaintance/Knowing each other of the participants ○ Description of training objectives ○ Expectations from that session ○ Pre-Training Assessment
Purpose of the Session	<p>At the end of this session</p> <ul style="list-style-type: none"> ○ The Training personnel and participants get to know each other, ○ The Participant will be able to explain training objectives, ○ A learning environment will be created, ○ Coordination between expectations and topics can be achieved.
Duration	1 hour
Training Materials	White Board, White Board Marker, Flip Chart Board, Flip Chart Paper, Flip Chart Marker, Multimedia Projector, Screen, Duster, Manual.
Overall objective of the Training	<p>At the end of the Training, the Participants can be able to</p> <ul style="list-style-type: none"> ○ Understand the purpose and importance of sanitary inspections for drinking water quality monitoring and surveillance ○ Conduct a comprehensive sanitary inspection of a drinking water supply ○ Assess the potential risks to drinking water quality ○ Document and report sanitary inspection findings
Specific Objectives of Training	<p>After completing the training, the Participants can have a clear idea on</p> <ul style="list-style-type: none"> ○ Sanitary Inspection Report, and its importance, ○ Functions of sanitary inspection report forms ○ Design of sanitary inspection report forms ○ Risk assessment in Water Quality Monitoring.

Sanitary inspections

(2nd Day, 2nd Class)

Introduction

A sanitary inspection is an on-site inspection and evaluation by qualified individuals of all conditions, devices, and practices in the water supply system that pose an actual or potential danger to the health and well-being of the consumer. It is a fact-finding activity that should identify system deficiencies only sources of actual contamination but also inadequacies and lack of integrity in the system that could lead to contamination.



In small communities, where official visits by the surveillance officer are infrequent, responsible community members must assist the official in making the survey and learn how to conduct the survey independently.

The two principal activities are sanitary inspection and water-quality analysis. It has been suggested that sanitary inspection should take priority over analysis, but the two should be done together wherever possible. They are complementary activities; inspection identifies potential hazards, while analysis indicates whether contamination is occurring and, if so, its intensity. Sanitary inspections are essential for accurately interpreting laboratory results. Laboratory testing alone cannot provide a complete picture of water quality.

Sanitary inspection reports

The sanitary inspection report is the component of the survey that stems from in-person inspections of water sources (and piped supply systems when applicable), also known as a field survey. This direct approach allows for the identification of all potential and actual hazards that could contaminate the water supply. The inspection focuses on the physical structure of the supply, its operation, and external environmental factors. The hazards identified during the inspection are often visible and tangible, and they can be combined with analytical data to create a risk assessment.

Sanitary inspections provide crucial information about immediate and ongoing potential hazards associated with a community water supply, even in the absence of microbiological or chemical evidence of contamination. Additionally, inspecting supplies over an extended period provides a long-term perspective and helps identify and minimize risks caused by gradual deterioration in any aspect of the supply.

Functions of sanitary inspection report forms

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The specific functions of the sanitary inspection report are to:

- identify potential sources and points of contamination of the water supply;
- quantify the hazard (hazard score) attributable to the sources and supply;
- provide a clear, graphical means of explaining the hazards to the operator/user;
- provide clear guidance as to the remedial action required to protect and improve the supply;
- provide the raw data for use in systematic, strategic planning for improvement.

The sanitary inspection report may be considered as an integral part of a community survey. It should therefore not be restricted to factors that may cause problems with water quality, but should also take into account other service indicators, e.g. coverage, cost, continuity, and quantity. It should be possible to determine an overall measure of the sanitary state of the supply based on the checklist, and this hazard or risk score may be used in deciding priorities for remedial action by the community or by whichever agency is best able to intervene and make improvements.

Design of sanitary inspection report forms

The design, evaluation, and refinement of sanitary inspection report forms play a crucial role in developing effective surveillance or quality-control programs. Two primary approaches can be considered: utilizing pictures and concise checklists or employing more detailed checklists supplemented by explanatory notes. Both methods can be successful. However, in regions where the training level of environmental health inspectors or sanitary technicians may be limited, pictorial inspection forms may be the most effective approach. Therefore, this approach will be the focus of this discussion.

Ideally, inspection forms should be designed to enable community members or supply owners to conduct the survey or receive a summary of identified issues before the inspector's departure. This facilitates prompt agreement on necessary actions and immediate initiation of implementation at the local level. In cases where actions require

involvement from external parties, such as water supply or health agencies, the community should be informed of the recommendations that will be made. Copies of the complete sanitary inspection report should be distributed to all relevant authorities. Well-designed inspection forms can facilitate this process by incorporating duplicate or triplicate sheets along with "tear-off" slips outlining recommended actions.

The WHO Guidelines for Drinking Water Quality 2nd edition, vol 2 presents in Annexure 2 a series of model sanitary inspection report forms. With one exception, these forms follow a double-page format and include recognizable illustrations of various water supply scenarios. Potential hazards are identified and numbered. The forms also include details of the facility type, water supply, date of sanitary inspection visit, and other relevant information. A checklist of 10 or more points enables the assignment of a hazard score based on the total number of hazards identified.

In some countries, it may be necessary to consider hazards beyond those illustrated in the sample sanitary inspection forms provided in the WHO Drinking Water Guideline, 2nd edition, vol 3. Such additional hazards should be incorporated into the checklist. Sanitary inspection forms should be tailored to local circumstances, ensuring suitability for inspectors and comprehensibility for information recipients. Any included illustrations should accurately reflect the cultures and situations they are intended to represent. The range of report forms presented in this volume of guidelines covers most primary types of small-scale water supply installations. However, this list is not exhaustive, as local variations in design and cultural practices may significantly impact the design of such forms.

The underlying principle of the sanitary inspection report form design is the listing and verification of every fault that could compromise the quality of the supply during the sanitary inspection. Each fault represents a sanitary hazard. The likelihood of contamination increases with each additional fault; therefore, the total number of hazards can be summed to provide an additive sanitary risk score. However, this approach implies equal weighting of all risks, which is unlikely to be accurate, and the score may not directly correlate with the intensity of the resulting contamination. Therefore, incorporating differential weighting for local conditions is crucial to enhance the interpretation of the information and promote effective remedial actions.

Sanitary Inspection Form: Borehole with Hand Pump

Part 1. General information:

- a. Location:
- b. Village/Town:
- c. People served:
- d. Water sample taken? Sample ID
- e. Date of visit:

Part 2. Risk assessment: Circle the most appropriate answer. A 'Yes' answer means that there is a potential risk and a 'No' answer that there is no or very low risk. See explanation on reverse.

	Observation
1. Is there a latrine within 10 m of the borehole?	Y/N
2. Is there a latrine or other source of fecal contamination uphill of the borehole?	Y/N
3. Is there any source of other contamination within 10 m of the borehole (e.g., animals, agriculture, roads, industry, etc.)?	Y/N
4. Is the drainage absent or faulty allowing water to pool within 2 m of the borehole?	Y/N
5. Is the drainage channel absent, cracked, broken or in need of cleaning?	Y/N
6. Is the wall or fence around the pump inadequate?	Y/N
7. Is the well apron less than 2 m in diameter?	Y/N
8. Does spilt water collect in the apron area?	Y/N
9. Is the well apron or pump cover cracked or damaged?	Y/N
10. Is the hand pump loose at the point of attachment? For rope-washer pumps, is the pump cover missing?	Y/N

Risk of contamination (add the number of 'Yes' answers):/10

Part 3. Results and comments:

a. Risk of contamination (check the appropriate box):

9-10 = Very high	6-8 = High	3-5 = Medium	0-2 = Low

b. The following risks were observed:

Part 4. Name and signature of inspectors:



FIGURE-18: SAMPLE SANITATION INSPECTION FORM

Timing and frequency of sanitary inspections

Sanitary inspections should be undertaken regularly, ideally at the annual frequencies indicated in the below table. Depending on available facilities, resources, skilled workforce, etc., these annual frequencies can be modified. However, attempts should be made to fulfill the minimum requirement as shown in the below table.

Source and mode of supply	Community	Water-supply Agency	Surveillance Agency
Dug well with hand-pump	4	-	1
Shallow and deep tubewell with hand-pump	4	-	1
Rainwater catchment	4	-	1
Gravity spring	4	-	1
Piped supply groundwater sources (springs and wells), with and without chlorination			
<5000 Population	12	1	1
5000-20,000 Population		2	1
Treated surface source of piped supply, with chlorination			
<5000 Population	12	1	1
5000-20,000 Population	-	2	1
Distribution system of piped supply	-	12	1

New sources:

One of the most important surveys is that is undertaken when new sources of water are being developed. This survey should provide sufficient information to indicate the suitability of the source and the amount of treatment required before the water can be considered suitable for human consumption. When alternative water sources are under consideration, each should be surveyed. Physical, bacteriological, and chemical analyses should be carried out during catchment surveys

Routine surveys of Existing supplies:

While it is impractical for the surveillance agency to dedicate more than one or two days per system each year for a survey, this is insufficient. Consequently, sanitary surveys should also be conducted periodically by water-supply agency personnel or community members in addition to the surveillance agency.

Historically, the frequency of inspections and analyses has been determined by population size. The diversity of water-supply facilities and administrative structures makes it challenging to provide anything other than general guidelines for the frequency of these

surveys, as outlined in the table above. However, it is crucial to emphasize that these recommended frequencies serve as minimum values. Additionally, it is essential that any community report indicating the presence of significant risks be formally documented and acknowledged, and that the surveillance agency takes appropriate follow-up action.

Risk assessment

Risk analysis is a crucial component of drinking water quality monitoring and surveillance, as it helps to identify and assess potential hazards that could compromise the safety and quality of drinking water supplies. Sanitation inspection scores and bacteriological counts play a key role in this process by providing valuable information about the potential for contamination and the occurrence of harmful bacteria.

The risk assessment process helps to prioritize corrective actions and to inform decision-making about water treatment and disinfection strategies. It also provides a valuable tool for monitoring and tracking progress in improving drinking water quality.

		Sanitation Inspection Risk Score											
		0	1	2	3	4	5	6	7	8	9	10	
Bacteriological Count (counts/100)	>1000	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	100-<1000	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	10->100	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Red	Red	Red	Red	Red
	1-<10	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Red	Red	Red	Red	Red
	0	White	Green	Green	Green	Yellow	Yellow	Yellow	Red	Red	Red	Red	Red

	Green			Yellow				Red				
No Action	Low Risk Low action priority			Intermediate to High Risk Higher action priority				Very High-Risk Urgent action				

Group Work and Presentation (2nd Day, 3rd, 4th, and 5th Sessions)

Introduction	<ul style="list-style-type: none"> ○ Mutual acquaintance/Knowing each other of the participants ○ Description of training objectives ○ Expectations from that session ○ Pre-Training Assessment
Purpose of the Session	<p>At the end of this session</p> <ul style="list-style-type: none"> ○ The Training personnel and participants get to know each other, ○ The Participant will be able to explain training objectives, ○ A learning environment will be created, ○ Coordination between expectations and topics can be achieved.
Duration	1 hour
Training Materials	White Board, White Board Marker, Flip Chart Board, Flip Chart Paper, Flip Chart Marker, Multimedia Projector, Screen, Duster, Manual.
Overall objective of the Training	<p>At the end of the Training, the Participants can be able to</p> <ul style="list-style-type: none"> ○ Design and Develop Drinking Water Quality Monitoring Program ○ Design and Develop Drinking Water Quality Surveillance Program ○ Present before the Audience
Specific Objectives of Training	<p>After completing the training, the Participants can have a clear idea on</p> <ul style="list-style-type: none"> ○ How to Design and Develop Drinking Water Quality Monitoring Program ○ How to Design and Develop Drinking Water Quality Surveillance Program

Group Work and Presentation

(2nd Day, 3rd, 4th, and 5th Sessions)

Introduction

The resource person will tell the participants that today, they'll become water champions, tasked with designing a comprehensive monitoring or surveillance program for an imaginary village facing unique water quality challenges. As a team, they'll explore various aspects of water access, resource management, and community health to craft a robust plan that protects their target area's well-being.

Mission

Develop a detailed water quality monitoring or surveillance program for a rural/urban area struggling with specific water-related issues. The participants will select the target area for developing the monitoring or surveillance program. The resource person will assist the participants in identifying issues required for the development of the intended program and will guide their planning.

Forming the Team

The resource person will divide the participants into four balanced groups: They will elect a team leader and delegate roles within each group. The resource person will allocate the following tasks among the group.

- Developing a Monitoring Plan for an upazila
- Developing a Monitoring Plan for an urban area
- Developing a Surveillance Plan for an upazila
- Developing a Surveillance Plan for an urban area

Toolkit

Scenario specifics: The resource person will provide information about water supply challenges and the context of the target area. The participants will be allowed to assume any data and information required for their assignment.

Research resources: Training manual, relevant other guidelines, manuals, textbooks, articles, and online tools.

Creativity and teamwork: The participants will combine their expertise and brainstorm innovative solutions.

Planning the Program

The participants will define their program's objectives. They will think and discuss among themselves what are they aiming to achieve.

Then they will identify key monitoring parameters. They will think and brainstorm on what water quality parameters to be tested at what locations and how frequently.

They will choose appropriate monitoring methods from physical inspections to chemical testing, and select efficient and reliable methods, considering the context of the target area. They will also suggest, depending on the objectives, available resources, etc., a practical schedule for sampling to establish a timeline for completing different components of the surveillance program.

The participants will outline data collection and analysis procedures as well as quality assurance and validation of results. They will also suggest a clear system for gathering and interpreting data and communication and reporting strategies: They should realize the importance of how will they share their findings with relevant stakeholders.

Finally, the participants will find out the resource requirements. They will estimate personnel, equipment, and financial needs for program implementation.

While discussing and brainstorming on these issues, the participants may consult the relevant section of this training manual.

Important Points for the Participants

- Pay attention to the point that communication is the key to the successful outcome of the group work.
- Carefully listen to the imaginary scenario provided by the resource person to understand the imaginary scenario of the target area.
- Actively participate in the discussion, share ideas within the group, and clarify any doubts.
- Embrace interdisciplinary collaboration by learning from each other's expertise and sharing valuable insights.
- Divide responsibilities based on individual strengths and expertise.
- Think outside the box. Don't be afraid to propose innovative solutions and address potential challenges.
- Adapt the program to respect local customs and beliefs.
- Have fun and enjoy the learning process!
- Well-crafted monitoring or surveillance program will play a crucial role in safeguarding the health and well-being of citizens of the target areas and today will pave the way for a healthier future.
- Prepare a clear and engaging presentation to communicate the program effectively to the resource person and other participants.
- Anticipate potential questions that may arise during the presentation.

- Be ready to defend the rationale behind your choices and demonstrate a thorough understanding of the program.

Tips for Presentation

- Organize your presentation in a clear and logical structure.
- Start with an introduction to set the context, followed by objectives, methods, findings, and conclusions.
- Ensure a smooth flow between different sections to keep the audience engaged and make it easy for them to follow your presentation.
- Use visuals to illustrate key points and data.
- Be concise and to the point. Avoid unnecessary jargon or overly technical language.
- Communicate the key messages, focusing on the most important issues.
- Encourage audience interaction by incorporating opportunities for questions and discussions.
- Pay attention to your body language to convey confidence and engagement.
- Maintain eye contact with the audience, use gestures to emphasize key points, and vary your tone of voice to keep the presentation dynamic.

Tips for the Resource Person

- Encourage participants to be creative and imaginative while developing their program.
- Provide them with an imaginary scenario of the water supply status of the target area.
- Facilitate discussions and brainstorming sessions to encourage collaboration and knowledge sharing.
- Adjust and revise the training room based on the specific scenario provided.
- Provide necessary training materials.

Training Materials for Group Work

- Note Book
- Brown paper,
- Pens and Markers,
- Stands for hanging brown paper
- Tapes, clips, etc.
- if possible, laptops, and
- Screen

Time Management

Two sessions, each one hour long, are allocated for the formation of groups, allocation of tasks to each group, distribution of imaginary scenarios of the fictitious target areas, discussion by the resource person, and group work. Another session, one and a half an hour long will be allocated for the presentations by each group. Each group will get 10 minutes for the presentation and another 10 minutes for questions and answers.

References and bibliography

01. Tanvir Hossain, Dr. Md. Tajuddin Sikder and Md. Jakariya Jan 2015, "Assessment of public health affected by municipal piped water supply in Old Dhaka, Bangladesh"
02. Weragoda, S. K. (2005) THM Formation Modeling in Treated Water Using The Rapid Organic Characterization Technique. MSc thesis. Asian Institute of Technology School of Envir., Resources Develop. Thailand, 89 p.
03. Liu, Yansui, Md. Ariful Islam and Hay Gao, 2003, "Quantification of Shallow Water Quality Parameters
04. WHO 2011, Guidelines for Drinking Water Quality, 4th Edition
05. WHO, Guidelines for Drinking Water Quality, Vol-2, 2nd Edition

THE END



TRAINING ON WATER QUALITY MONITORING AND SURVEILLANCE (URBAN AND RURAL)



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