Standard Operating Procedure (SOP) for Routine Water Quality Surveillance in ULBs in Gujarat

Prepared by

Urban Management Centre

Under

PAS program

All photographs are by UMC unless otherwise mentioned.

Urban Management Centre (UMC)

The Urban Management Centre (UMC) is a not-for-profit organization based in Ahmedabad, Gujarat, working towards professionalizing urban management in India and South Asia. UMC provides technical assistance and support to Indian state local government associations and implements programs that work towards improvement in cities by partnering with city governments. UMC builds and enhances the capacity of city governments by providing much-needed expertise and ready access to innovations on good governance implemented in India and abroad. UMC is a legacy organization of International City/County Management Association (ICMA) and hence is also known as ICMA-South Asia. More details on www.umcasia.org

Performance Assessment System (PAS)

PAS, a five-year action research project, has been initiated by CEPT University with funding from the Bill and Melinda Gates Foundation. PAS aims to develop better information on water and sanitation performance at the local level to be used to improve the financial viability, quality and reliability of services. It will use performance indicators and benchmarks on water and sanitation services in all the 400-plus urban areas of Gujarat and Maharashtra. UMC and the All India Institute of Local Self Governance are CEPT's project partners in Gujarat and Maharashtra, respectively. More details are available on www.pas.org.in.

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List of Abbreviations

CPHEEO: Central Public Health and Environmental Engineering Organization

GUDM: Gujarat Urban Development Mission

GWSSB: Gujarat Water Supply and Sewerage Board

JMP: Joint Monitoring Program

MoUD: Ministry of Urban Development

NUSP: National Urban Sanitation Policy

PAS: Performance Assessment System

RC: Residual Chlorine

SOP: Standard Operating Procedure

TDS: Total dissolved solids

ULB: Urban Local Body

UNICEF: United Nations Children's Fund (United Nations International Children's Emergency Fund)

WASMO: Water and Sanitation Management Organization

WDS: Water Distribution System

WHO: World Health Organization

WTP: Water Treatment Plant

1. Introduction

Access to safe drinking water is an important determinant of public health. The Joint Monitoring program on Water Supply and Sanitation of the WHO and UNICEF reports that globally, diarrhea is the leading cause of illness and death. According to estimates around 3.7 crore Indians are affected by waterborne diseases annually and 15 lakh children die alone of diarrhea. Provision of safe drinking water hence is a crucial to ensure the health of a community and is a thrust area for Government of India's 12thFive Year Plan (2012-2017).

Though the access to clean drinking water in urban areas has vastly improved in the last few decades, there the quality of water supplied is still an area of concern. According to the National Urban Sanitation Policy (NUSP), inadequate discharge of untreated domestic/municipal wastewater has resulted in contamination of 75 per cent of all surface water across India leading to rampant spread of water and vector borne diseases in urban areas (Ministry of Urban Development, 2009).

Quality of drinking water is not a critical issue in urban Gujarat, but cities face problems of water contamination time to time arising from solid and liquid waste disposal from industries, depletion and degradation of ground water resources, lack of maintenance of water distribution pipelines(Hirway, 2005)

Given these challenges of water contamination and ill maintenance of the water supply system, the Ministry of Urban Development (MoUD) insists carrying out routine water quality management and surveillance practices to ensure safe water supply to consumers. Surveillance of drinking water quality is defined as the continuous and vigilant public health assessment and overview of the safety and acceptability of drinking water supplies (WHO, 1976). It involves laboratory and field testing of water samples collected from various points in the water supply system, including the source, water treatment plants, service reservoirs distribution systems and at the consumer end which are representative of the condition of water at the point and time of collection. The MoUD through its nodal agency Central Public Health and Environmental Engineering Organization (CPHEEO) has developed a manual in this regard, which guides Public Health and Engineering Departments, Urban Local Bodies (ULBs) and other water supply agencies on operations and maintenance of water supply system including management of water sources, water treatment, safe transmission of water and water quality surveillance. The manual is a useful resource on water supply management but does not provide a handy, comprehensive and easily accessible reference to ULBs on procedure for routine water quality surveillance.

1.1. Current status of water quality surveillance in urban Gujarat

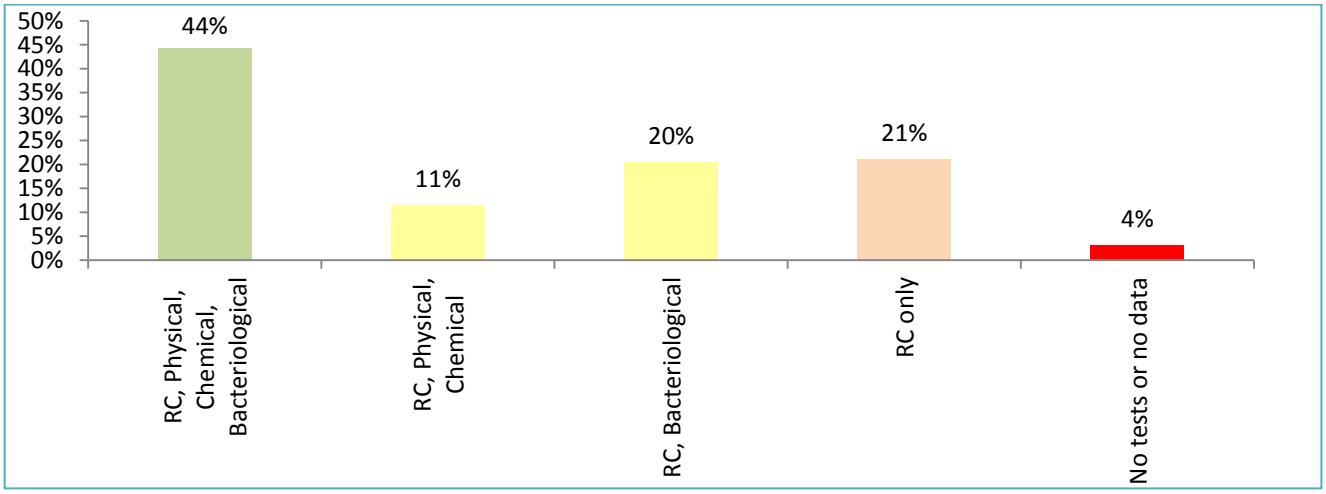
Urban local bodies in Gujarat are classified as Municipal Corporations and Class A, B , C and D municipalities based on population size as follows:

Classification of ULB	Population
Municipal Corporation	> 3 Lakh
Class A Municipality	1-3 Lakh
Class B Municipality	25,000-1 Lakh
Class C Municipality	10,000-25,000
Class D Municipality	< 10,000

Most ULBs in Gujarat perform some level of quality testing of their drinking water system. The ULB staff conducts Residual chlorine testing on site and sends water samples to government or accredited laboratories for chemical and bacteriological testing. Municipal corporations of Ahmedabad, Surat, Vadodara and Rajkot have their own laboratories. All other ULBs rely on district or other accredited laboratories for water quality testing. Evidences suggest municipal corporations have a somewhat established procedure for drinking water quality surveillance. Ahmedabad Municipal Corporation for instance publishes the results of water testing in local newspapers on a quarterly basis and Surat Municipal Corporation has received National Urban Water Award in 2008 and 2009 for ensuring quality water supply to its citizens. Municipalities although conduct water testing from time to time but do not have a set regime for routine surveillance and documentation and sharing procedures.

The data collected on water quality under the PAS program for 2011-2012 indicates that 95 % of water samples tested by ULBs conformed to the specified parameters of drinking water quality. The data reliability for water quality however falls under category-D implying a lack of established regimen for water quality monitoring and/or inadequate data recording and management practices. The following table presents the type of water quality tests being conducted by ULBs in Gujarat. Though the CPHEEO recommends conducting residual chlorine, physical, chemical and biological tests at a minimum, less than 50 percent ULBs carry out all of these required tests. Smaller cities such as Damnagar and Devgadhbariya do not conduct any water quality tests.

Water quality tests performed by ULBs in Gujarat, *Source PAS data 2011-12*



UMC conducted a review of water quality monitoring systems in three municipalities in Gujarat to understand existing surveillance practices and identify gaps in the water quality monitoring regime. The following tables present the water quality testing regime in the cities of Jetpur, Kathlal and Lathi.

Table 1 Water Quality Monitoring Regime in Jetpur, Source UMC primary survey, 2012

	Physical	Residual Chlorine	Bacteriological	Chemical
Source	No Testing	No Testing	No Testing	No Testing
WTP	No Testing	Daily	No Testing	No Testing
WDS	No Testing	No Testing	No Testing	No Testing
Consumer end	No Testing	Alternate days	Monthly (Sample sent to labs)	Monthly (Sample sent to labs)

Table 2Water Quality Monitoring Regime in Kathlal, Source UMC primary survey, 2012

	Physical	Residual Chlorine	Bacteriological	Chemical
Source	NA	NA	NA	NA
WTP	No Testing	No Testing	No Testing	No Testing
WDS	No Testing	No Testing	No Testing	No Testing
Consumer end	No Testing	Daily	Monthly (Sample sent to labs)	Monthly (Sample sent to labs)

Table 3Water Quality Monitoring Regime in Lathi, Source UMC primary survey, 2012

	Physical	Residual Chlorine	Bacteriological	Chemical
Source	NA	NA	NA	NA
WTP	No Testing	No Testing	No Testing	No Testing
WDS	No Testing	No Testing	No Testing	No Testing
Consumer end	No Testing	No Testing	No Testing	No Testing

The review reveals that smaller municipalities such as Lathi do not undertake routine testing of water samples for RC, chemical or bacteriological analysis. Even if ULBs conduct all the four required tests, they do not necessarily conduct them at a desired frequency or at all locations in the water supply distribution system as recommended by CPHEEO.

The purpose of Standard Operating Procedure (SOP) is to establish a uniform procedure for routine collection and testing of water samples by ULBs for the purposes of drinking water quality monitoring.

2. About the Standard Operating Procedure (SOP)

This Standard Operating Procedure (SOP) is a step-by-step guide for ULB's Water Supply Department staff to institute a framework for routine water quality surveillance. This SOP conforms to the CPHEEO manual and draws from UMC's experience of working with ULB's in Gujarat. It provides a set of written instructions on water sampling and analysis regime in a concise format. The SOP also contains a set of recording formats to help ULBs to document the water surveillance results for better decision making and improved governance.

2.1. Scope and applicability

The purpose of this Standard Operation Procedure (SOP) is to establish a uniform procedure for routine collection and testing of water samples for the purposes of drinking water quality monitoring. The procedures outlined in this SOP are applicable to all urban local bodies in Gujarat. This SOP includes the following procedures for assessment of quality of drinking water by ULBs:

- Methods to collect samples from various sources of water (ground and surface water) as well as treated water from WTP, head works, sub head works as well and individual house hold.
- Sampling regime including frequency, number of samples and sample quantity
- Methods and procedure to analyze (physical, chemical and biological properties of drinking water)
- Maintaining data records of collected samples
- Remedial measures in case of failure of sample

The scope of the SOP is limited to routine surveillance procedures. It does not cover testing procedures required for establishing new water sources to supply water for drinking or other consumptive uses. The SOP also excludes quality of water for industrial purpose.

2.2. Methodology of preparing SOP

The SOP is prepared based on the guidelines provided by CPHHEO, Manual on Operation and Maintenance of Water Supply systems, January 2005, Government of India, Ministry of Urban Development, New Delhi along with factual field data and information collected from various cities/towns regarding their current procedures for drinking water quality surveillance. The field visits were undertaken by UMC team members in order to obtain firsthand information through interaction with concerned officers in ULBS and water supply agencies regarding existing drinking water quality control monitoring systems, infrastructural facilities, and institutional arrangements for water quality testing and financial resources. The recommendations regarding sampling locations, actual number of samples to be collected, periodicity of sampling and the parameters for analysis conform to the CPHEEO manual.

The SOP was independently reviewed by qualified individuals with technical expertise in the urban water and sanitation sector to ensure that the procedures and protocols listed here are credible, technically accurate and appropriately written for the intended audience. The comments and feedback from the sector experts have been incorporated in the document.

2.3. Target audience

This SOP is targeted to the Chief Officers, Engineering, Health and Conservancy Department staff and/ or staff in-charge of routine surveillance of water distribution system in ULBs of Gujarat.

3. Water Sampling and Testing Procedure

This SOP lists clear step-by-step instructions for establishing regime, sample collection on site, storage and data recording. The water sampling and testing procedure is explained in these following seven sequential steps.

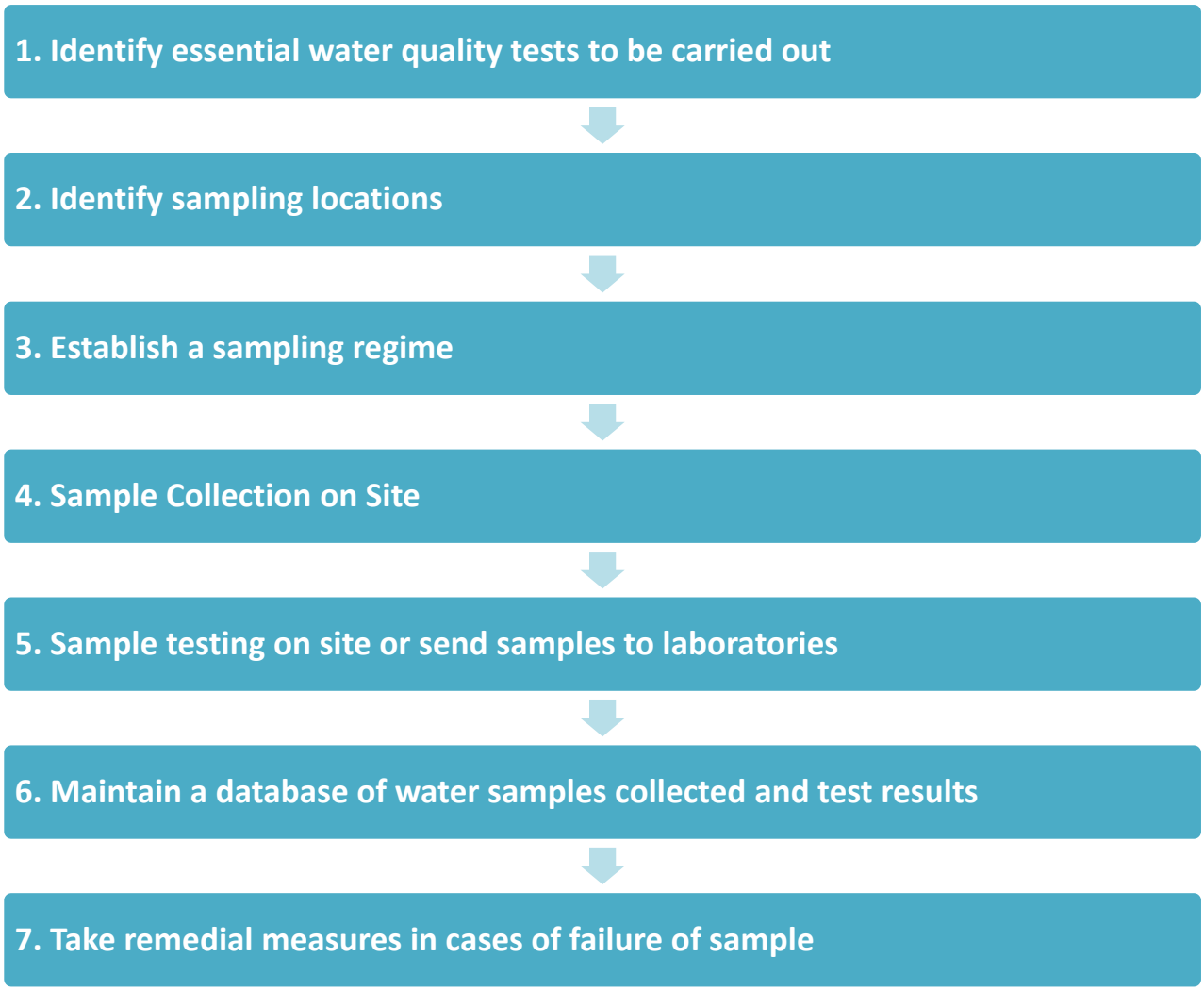


Figure 1Water sampling and testing procedure in seven steps

3.1. Identify essential water quality tests to be carried out in your city

To recognize the importance of routine water sampling and analyses, the Water Supply Department staff should be equipped with a basic understanding of various kinds of water quality tests and their importance. The following section provides a brief summary of water quality assessment parameters and the essential tests to be carried out by ULBs to ascertain drinking water quality.

Impure water has following characteristics

- a bad taste,
- color,
- odor, or
- cloudy appearance (turbidity)
- causes hardness,
- causes corrosiveness and staining
- damages growing plants and is a cause of disease

Water has a strong tendency to dissolve other substances including gases, dust particles, organic material, microbes as well as soluble minerals. In urban areas, the quality of surface water as well as groundwater is greatly influenced by land uses and by human activities. Rivers and lakes get contaminated by industrial effluents, chemicals and untreated sewage. Effluents from industries and malfunctioning septic tanks also pollute ground water. Hence it is important to monitor drinking water quality from time to time to ensure that the water supplied is for human consumption. Water impurities include industrial and commercial solvents, metal and acid salts, sediments, pesticides, herbicides, plant nutrients, radioactive materials, road salts, decaying animal and vegetable matter, and living microorganisms, such as algae, bacteria, and viruses.

Water Supply Department of ULBs must carry out the following four tests to assess the quality of drinking water, and check for the presence of above mentioned impurities and pollutants:

1. **Residual Chlorine (RC) Test**
   The most common test carried out on site to test the presence of residual chlorine in drinking water. Residual chlorine indicates that a sufficient amount of chlorine was added to the water to kill disease causing bacteria and viruses making the water safe for consumption.

2. **Physical Test**
   This set of tests generally conducted on site includes analysis of turbidity, pH, TDS, taste, colour, odour and temperature value to assess physical properties of water.
   The standards for physical characteristics of water are listed in Annexure 1


RC testing on site


Physical tests for colour

3. **Chemical Test**

Chemical tests provide assessment of total hardness (as CacO3, ppm), chlorides (as cl) , sulphates (as SO4), fluorides(as F), nitrate (as NO3), calcium(as Ca), magnesium (as mg), alkalinity and acidity(pH). Some basic chemical tests can be performed on site using water quality testing kit, however most ULBs in Gujarat send water samples to laboratories for chemical testing.

The standards for chemical characteristics of water are listed in Annexure 2

4. **Bacteriological Test**

Bacteriological tests analyze the number of bacteria present in drinking water. Bacteriological tests are carried out in laboratories and include tests for total coliform and faecal coliform. There are two stages of bacteriological testing, the first test indicates presence of e-coli (if any) and the second test conducted in laboratory provides the most probable number (MPN) to assess the level of contamination.

The standards for chemical characteristics of water are listed in Annexure 3

The description of various physical, chemical and bacteriological characteristics of drinking water is provided in Box1 as additional reference.

In addition the CPHEEO also recommends testing water for presence of heavy metal and pesticides and other problem parameters such as Arsenic, Iron, and Manganese. Heavy metal pollution is not a critical concern in most parts of urban Gujarat, but some cities can be susceptible to ground water contamination because of excessive use of pesticides or other local issues such as heavy industrial discharge in water bodies. It is recommended that ULB carry out these tests on the discretion of the Water Supply Department staff. The identification of essential water quality tests should be done by the engineer in charge.

3.1.1. Sanitary inspections

For the adequate interpretation of the laboratory tests mentioned in Section 7.1.2, periodic sanitary inspection of the water supply distribution system is also recommended. Sanitary inspection includes a qualitative inspection of water system, including the source, transmission mains, treatment plants, storage reservoirs and distribution system. It allows ULBs and water supply agencies to uncover deficiencies, inadequacies and hazards such as overflows, contamination, pipe breakage etc. which could lead to contamination of water.

The format for sanitary inspection and preparation of sanitary report is provided in the CPHEEO manual and is attached in Annexure 4

Box 1: Drinking Water Characteristics

Physical Characteristics:

Turbidity: Turbidity is the cloudiness or haziness caused by individual particles which makes the water appear non-transparent. If a large amount of suspended solids are present in water, it will appear turbid in appearance indicating presence of impurities.

Colour: Safe drinking water should be colorless. Dissolved organic matter from decaying vegetation or other inorganic materials can impart colour to the water.

Taste and Odour: Most organic and some inorganic chemicals, originating from municipal or industrial wastes, contribute taste and odour to the water which may make it unfit for human consumption. Taste and odour can be expressed in terms of odour intensity or threshold values.

Temperature: The ideal temperature of water for drinking purposes is 5 to 12 °C - above 25 °C, water is not recommended for drinking. The increase in temperature decreases palatability, because at elevated temperatures carbon dioxide and some other volatile gases are expelled.

pH: pH value denotes the acidic or alkaline condition of water which is expressed on a scale ranging from 0 to 14, which is the common logarithm The recommended pH range for treated drinking water, is 6.5 to 8.5.

TDS: TDS is a measure of the combined content of all inorganic and organic substances contained in water in molecular, ionized or micro-granular (colloidal sol) suspended form.

Chemical Characteristics:

Acidity: Acidity is a representation of carbon dioxide or carbonic acids which causes corrosion in public water supply systems. Acidity of water may be caused by the presence of uncombined carbon dioxide, mineral acids and salts of strong acids and weak bases. It is expressed as mg/L in terms of calcium carbonate.

Alkalinity: The alkalinity of water is a measure of its capacity to neutralize acids. It is expressed as mg/L in terms of calcium carbonate. Alkalinity is an important parameter in evaluating the optimum coagulant dosage.

Chlorides: Chloride ion may be present in combination with one or more of the cations of calcium, magnesium, iron and sodium. Excessive chloride in water indicates presence of septic tank effluents, animal feeds, industrial effluents, irrigation drainage, and seawater intrusion in coastal areas.[1]

Flourides: Fluoride is a naturally occurring compound derived from fluorine. It is found in many rocks and minerals in the soil and enters drinking water as water passes through these soils. Fluoride has been shown to prevent tooth decay, but too much fluoride can cause teeth discoloration.

[1] Chloride Removal from Wastewater by Biosorption with the Plant Biomass, Universal Journal of Environmental Research and Technology, 2011

Hardness: Hardness of water signifies them dissolved mineral content. If water consumes excessive soap to produce lather, it is said to be hard. Hardness is caused by divalent metallic actions. The principal hardness causing cations are calcium, magnesium, strontium, ferrous and manganese ions. The total hardness of water is defined as the sum of calcium and magnesium concentrations, both expressed as calcium carbonate, in mg/L. Temporary or carbonate hardness can be precipitated by prolonged boiling. Non-carbonate ions cannot be precipitated or removed by boiling, hence the term permanent hardness.

Sulphates: Sulphates occur in water due to leaching from sulphate mineral and oxidation of sulphides. Sulphates are associated generally with calcium, magnesium and sodium ions. Sulphate in drinking water causes a laxative effect and leads to scale formation in boilers. It also causes odour and corrosion problems under aerobic conditions.

Iron: Iron is found on earth mainly as insoluble ferric oxide. When it comes in contact with water, it dissolves to form ferrous bicarbonate under favourable conditions. This ferrous bicarbonate is oxidised into ferric hydroxide, which is a precipitate. Iron imparts bad taste to the water and incrustations in water mains.

Solids: The sum total of foreign matter present in water is termed as 'total solids'. Total solids remain as residue after evaporation of the sample and its subsequent drying at a defined temperature (103 to 105 °C).

Nitrates: Nitrates in surface waters occur by the leaching of fertilizers from soil during surface run-off and also nitrification of organic matter. Presence of high concentration of nitrates is an indication of pollution. Concentration of nitrates above 45 mg/L causes a disease called methemoglobinemia.

Bacteriological Characteristics

Bacterial examination of water is very important, since it indicates the degree of pollution. Water polluted by sewage contains one or more species of disease producing pathogenic bacteria. Pathogenic organisms cause water borne diseases, and many non-pathogenic bacteria such as E.Coli, a member of coliform group, also live in the intestinal tract of human beings. Coliform itself is not a harmful group but it has more resistance to adverse condition than any other group. So, if it is ensured to minimize the number of coliforms, the harmful species will be very less. So, coliform group serves as indicator of contamination of water with sewage and presence of pathogens.

3.2. Establish sampling regime for your city

3.2.1. Identify sampling locations

The number of locations from where samples for water quality testing should be collected is based on the source of water and the water supply system in a city.

Sampling at source: Water samples should be collected at the fresh water and ground water source (if directly supplied to customers). In Gujarat, cities like Surat, Vapi and Valsad draw water from their own surface source, while others like Ahmedabad, Mehsana and Bhuj buy treated Narmada water from Gujarat Water Supply and Sewerage Board. Smaller cities with no fresh water source of their own often buy raw or treated water from State agencies or Irrigation Department to supplement their ground water resources.

Sampling at locations in the water distribution system: Raw surface water is first treated at water treatment plants while ground water is chlorinated and directly transferred to the water distribution system before it is supplied to consumers. It is important that the Water Supply Department carry out water sampling at all these locations in the water supply system. The following diagram illustrates water flow from source to the consumer end. These are the locations where water samples must be collected for quality testing.

Potential sources of water supply (ground water, own surface source, purchase treated water) are represented on the left side and labeled as 1a, 1b and 1c. If a ULB purchases raw/ treated water (case 1C), sample collection and testing at source is not required. The various points in the water supply distribution system are represented on the right as 2, 3 and 4.

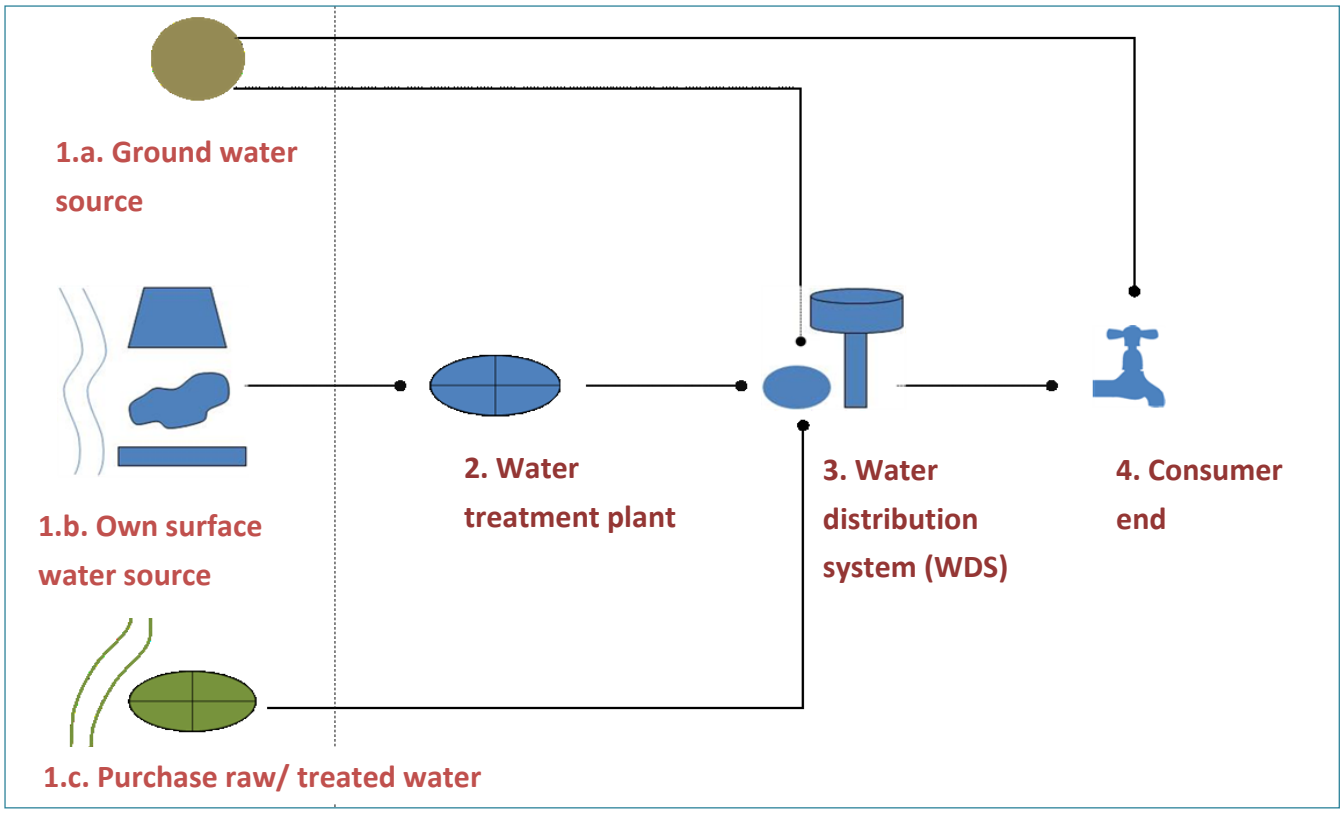


Figure 2: Points in water supply system where samples need to be collected and tested for drinking quality

It is recommended that the Water Supply Department make a sampling plan by taking into consideration the following criteria:

- Most cities in Gujarat have multiple sources of water. Sampling points should be selected such that all different sources from which water is obtained are covered.

C. Purchase raw/ treated water

- There should be at least one sampling point at the clean-water outlet of each water treatment plant (WTP). Similarly there should be at least one sampling point at the inlet of sump in a water distribution system(WDS)
- Sampling sites at the above mentioned locations should be fixed by the Water Supply Department. Fixed sites for sampling locations are useful for comparing water quality test results over time.
- In addition to the fixed locations, sampling should also be carried out at variable locations which prove helpful in detecting local problems in the water supply system.
- Sampling locations at consumer end should be identified based on the population served by each water distribution zones. Samples in all WDS zones in the city should be collected for testing.
- Within a WDS zone, sampling sites should be geographically distributed to include areas in close proximity as well as far from the WDS station.
- Samples should be collected in slum as well as non-slum areas proportionate to the slum population in a city. A portion of samples collected at consumer end should include community stand posts.
- Sampling sites within a WDS zone should be rotated to ensure that all areas zone are covered.
- Sampling at consumer end should include sites such as municipal schools and government hospitals.
- Identify staff responsible for sample collection on different locations. The following table suggests the staff that could be deployed for sampling at different locations:

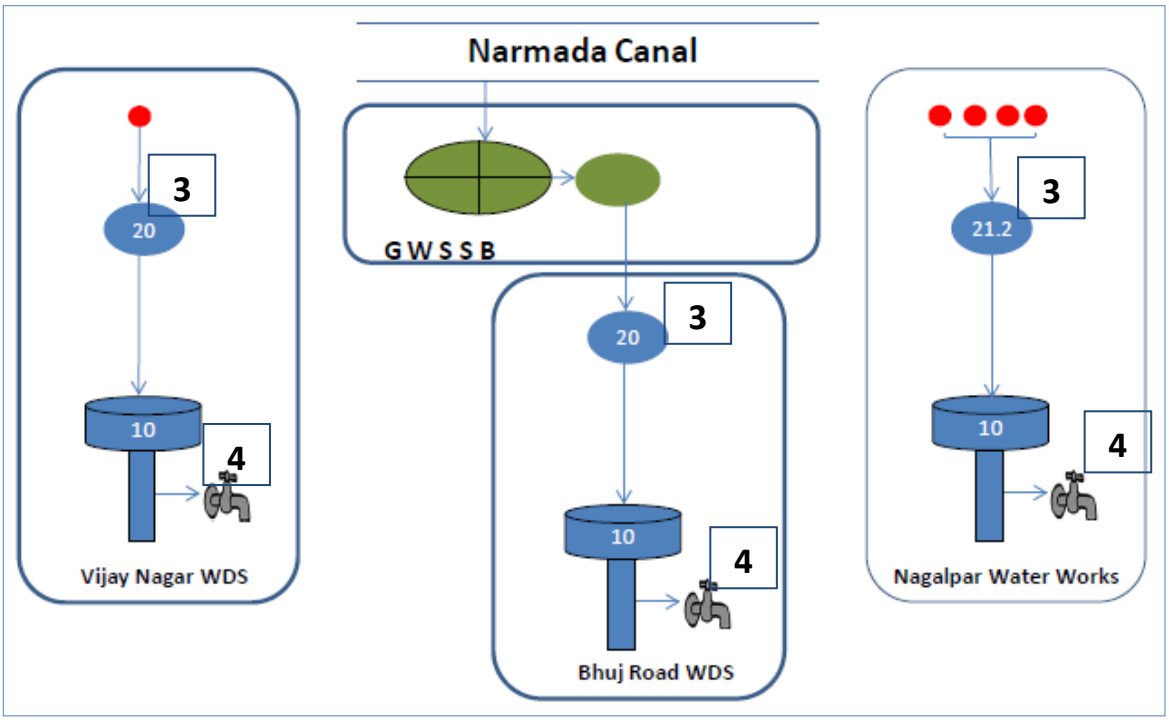
Table 4 Staff responsible for collecting water samples

	Staff responsible for sample collection
Source(Surface/ Ground)	Water Works Staff
Water Treatment Plant	Water Works Staff
Water Distribution System	Water Works Staff
Consumer end	Health/ Conservancy Department staff- outreach workers, sanitary inspectors

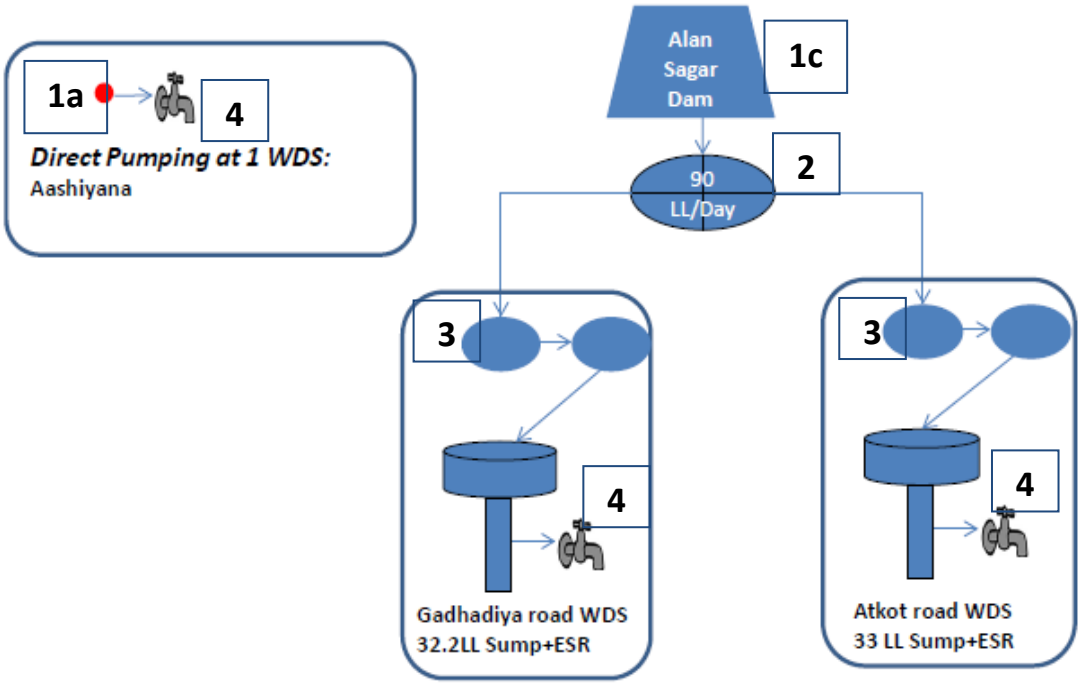
ULBs should use a detailed flow diagram of their drinking water distribution network from source to end to identify sampling locations, especially those which are most vulnerable in the supply system. Flow diagrams of drinking water distribution systems of all cities in Gujarat have been drawn under the PAS project and are available for download on the UMC website:
www.umcasia.org/uploads/Water_Supply_Flow_Diagram_of_Urban_Local_Bodies_2008_2009pdf.pdf

Cases of 2 cities in Gujarat have been illustrated in Box 2 as examples. The sampling locations for water quality tests for Anjar and Jasdan have been identified and marked on their respective flow diagrams.

Anjar Municipality (Class B)



Jasdan Municipality (Class D)



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3.2.2. Establish sampling frequency

Establish a sampling regime for various locations identified in the water distribution network. The sampling regime should list the number of samples to be collected and frequency of sampling at each sampling location

for the different water quality tests mentioned above. The following table provides the recommended frequency of sampling for different water quality tests for cities in Gujarat.

Table 5 Frequency of required water quality tests, source CPHEEO

	Frequency of Required Tests				Minimum number of Samples
	Physical	Residual Chlorine	Bacteriological	Chemical	
At source					
Ground water					
Tube well/ French well/ dug well (If drinking water is directly supplied to consumer end, chlorine dosage needs to be added)	Quarterly	Daily	Monthly	Quarterly	At each well
Hand pumps	Twice a year	-	Twice a year	Twice a year(in summers and rainy season)	At each hand pump
Surface water					
Raw Water: Rivers/ Infiltration wells/Lakes/Dams/Canal	Daily	-	Weekly	Daily	One per source
At Water Treatment Plant					
Outlet of WTP	Daily (Turbidity Only)	Hourly during supply time	Weekly	Daily	One per source
At Water Distribution System					
Inlet of main sump/ Ground level Storage Reservoir/Elevated Service Reservoir	Daily	Daily	Weekly	Monthly	Each WDS
At Consumer End					
Standpost	Daily (Turbidity only)	Daily	Monthly	Once an year	At 5-10 locations from each WDS zone for municipalities and 1 per 2500 households in municipal corporations. During monsoons or a disease outbreak, number of samples should be increased
Consumer End	Daily (Turbidity only)	Daily	Monthly	Once an year	

3.3. Sample collection on site

The objective of sampling is to collect a small portion of water which can be easily transported to laboratory, without contamination or deterioration and which should accurately represent the water being supplied.

3.3.1. Preparation and Planning

- Based on the established sampling regime identify the total number of samples to be collected, the sampling locations and the parameters for which samples need to be collected.
- Make a list of equipment for sample collection and on site testing.

Table 6 List of equipment for sample collection and field testing

List of equipment	
For sample collection	For onsite RC and physical testing
Sampling bottle	WASMO kit (if available)
Sticker label	Chlorometer
Sketch Pen	Test tube
Date collection formats	
Labels	

- For physical and RC tests, 500 ml virgin plastic bottles with air tight cap should be used for one sample collection. Purchase a mineral water bottle with its seal intact. Transfer/ consume the mineral water. Bottles are ready for sample collection.
- For chemical and bacteriological tests that are carried out at the state/ district laboratory, contact the laboratory to obtain trip blank bottles, the appropriate sterilized sample bottles and preservatives, and to confirm storage conditions and holding times.
- Prepare/ print data recording formats for various tests. Sample formats are provided in section7.
- Obtain any necessary permission for site access.
- Pre-clean sampling and sample processing equipment.
- In case of residual chlorine, the test is carried out at site itself. In such case standard test tube of capacity 10 to 25 ml is used
- In case of laboratory test take Print off all necessary sample labels, sample tracking forms

3.3.2. Follow procedure for sample collection at different locations

Sample collection from surface source

- Note sampling conditions such as location, time and surrounding conditions on the sample format.
- Always collect samples keeping the bottles facing upstream.
- Make sure any disturbed sediments are moved downstream by the current before collecting the sample.

- Samples should be collected in the river/lake/dam site if possible but if this area is to deep, choose a point in the channel cross-section where water is flowing and appears to be well-mixed (avoid backflows and eddies). In wetland areas with little or no flow, extreme caution should be taken to avoid contamination from sediment stirred up by boats or walking to sample locations.
- Use regular plastic bottles for collecting samples for physical and chemical tests and sterilized bottles for bacteriological testing. Reach forward facing the bottle opening into the current upstream and quickly plunge the container below the surface to avoid any introduction of surface scum or floating debris. Do not touch the inside of the bottle cap, lip of the container, or inside of the container. Avoid touching the bottle to the stream bottom.
- Be careful not to overfill sample bottles, unless directed by laboratory. For bottles pre-filled with preservative, overfilling could cause loss of the preservative.
- Bring the bottle up out of the water and immediately replace the cap.
- Repeat for the remaining sample bottles.

Sample collection from ground water source

- Wash your hands thoroughly.
- Note sampling conditions on field formats.
- Start the pump. Allow water to flow for 5 to 10 minutes
- Use regular plastic bottles for collecting samples for physical tests and sterilized bottles for bacteriological testing. Remove the sample bottle cap. Do not touch the inside of the bottle cap, lip of the container, or inside of the container.
- Be careful not to overfill sample bottles. Fill 80%-90% of the bottle with sample water. Leave some space for oxygen to avoid killing the bacteria in the sample. For bottles pre-filled with preservative, overfilling could cause loss of the preservative.
- Close the bottle tightly.
- Bring the bottle up out of the water and immediately replace the cap.
- Repeat for the remaining sample bottles

Sample collection from distribution system (WTP/ Head work/ Storage)

- Note sampling conditions on field sheet formats.
- Always collect samples facing from depth at least 30 cm from water level of WTP/Storage
- Use regular plastic bottles for collecting samples for physical tests and sterilized bottles for bacteriological testing. Remove the sample bottle cap.
- Submerged the bottle (if empty), collect the water sample from 30 cm depth

- In case of bottles filled with preservative, (For bottles pre-filled with preservative, overfilling would cause loss of the preservative and therefore some headspace must be remaining)
- Avoid touching the bottle to the stream bottom.
- Bring the bottle up out of the water and immediately replace the cap.
- Repeat for the remaining sample bottles


Photograph 1Water sampling at WTP in Surat

Sample collection from consumer end (House connection/ Stand post)

- Note sampling conditions on field sheets or infield notes, as specified in the SoP.
- Allow water to flow from tap or stand post for about one bucket
- Take 3 samples of 500 ml in test bottles (sterilized virgin plastic bottle with airtight cap for bacteriological testing and regular plastic bottles for RC, chemical and physical tests)
- Remove the sample bottle cap.
- Reach forward facing the bottle opening into the flow direction
- Do not touch the inside of the bottle cap, lip of the container, or inside of the container. Be careful not to overfill sample bottles, unless directed by laboratory. For bottles pre-filled with preservative, overfilling would cause loss of the preservative and therefore some headspace must be remaining.
- Immediately replace the cap.
- Repeat for the remaining sample bottles.

3.3.3. Storage, labeling and handling of samples

Samples for physical and RC testing:

Since these tests are carried out on site, there are no special handling, storage or transportation procedures. The samples collected should be immediately transferred to test tubes and tested. These samples need not be labeled. The samples collected for these tests should be discarded after the tests are done.

Samples for chemical and bacteriological testing:

Once the samples are collected from different locations, the bottles must be properly labeled. Sample label format is shown below.

Specimen Format for Water Sample Collection for Laboratory Analysis **Name and Address of Municipal corporation/ Municipality :** **Date of Sample Collection** **Time of Sample Collection** **Sample No:** **Purpose of Examination: (Physical / Chemical / Bacteriological)** **Source of Water Sample (Location of sample)** **Weather information** **Season (summer/ monsoon/ winter)** **Temperature** **Rainfall** **Need For Analysis : Routine / based on complaint or local epidemic** **Name of Sample Collector:** **Sign of Sample Collectors** **Sign of Supervisor** **Date & Time of Dispatch:**	**Label** **(Paste on Sample Collected)** **Sample No** **Date/Time** **Sample Location** **Date of Dispatch** **Sign/Name (Supervisor)**

Figure 3 Sample label to be pasted on sampling bottles

The samples collected for bacteriological testing must be stored in ice or refrigerated immediately after sample collection until delivery to the laboratory. The delivery at an accredited laboratory must happen within 3 hours of collection. Maximum allowable time is 24 hours[2]. It is recommended that the ULBs contact the laboratories for more specific instructions on sample storage and transportation requirements.

3.4. Sample testing

Once the samples are collected, the testing is carried out either on site or the samples are sent to accredited laboratories for testing. The practice in cities in Gujarat is to only conduct the physical and RC test on site. The State Government encouraged ULBs to even conduct chemical and bacteriological analysis on site using the water quality test kits provided by Water and Sanitation Management Organization (WASMO)- a special purpose vehicle of Government of Gujarat. However the field kits as not as widely used as most ULBs have not replenished the sample reagents provided as part of the kit.

[2] *Manual on Operation and Maintenance of Water Supply Systems, CPHEEO, Page 192*

The water quality testing field kits generally allow the following parameters to be tested:

Physical
Colour, Odour, Turbidity

Residual Chlorine

Chemical
Ph, hardness, indicative tests for chloride, fluoride and nitrates

Photograph 2 Kit for testing water quality in field

The following table presents a summary of the various water quality tests performed on site or in laboratories.

Table 7 Required on field and laboratory tests

Test	Test location
Residual Chlorine	On site using Water Quality Field Test Kits
Physical (turbidity, taste, colour, odour and temperature)	On site using Water Quality Field Test Kits
Chemical	Indicative tests using on site using Water Quality Field Test Kits. Samples to be sent to laboratories for testing.
Bacteriological	Preliminary test on site. Only positive cases sent to Municipal or other accredited laboratories

The steps involved in water quality tests to be carried out by municipal staff on site are described below:

3.4.1. Performing residual chlorine test

Aim

Chlorine is added to drinking water before distribution for disinfection. Chlorine also acts as an oxidizing agent. The residual chlorine test should be routinely carried out to check that a sufficient amount of chlorine was added to the water to kill disease causing bacteria. As per IS 10500, the acceptable limit of residual chlorine in water is 0.2 mg/l and permissible limit is 1 mg/l. In case of epidemics when protection against viral infections is required, the quantity should be minimum 0.5 mg/l.

Required instruments

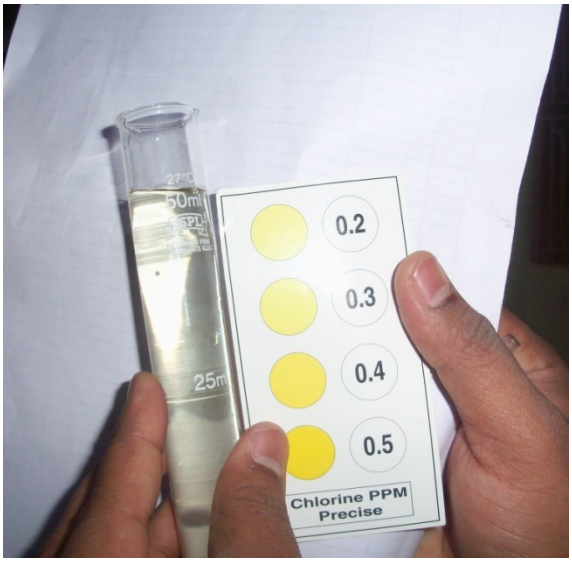
- Nessler tube/ test tube (50 milliliters)
- Standard color chart / chloroscope

- Appropriate Reagent Rod
- Nessler stand

Method

- Add 10 to 12 drops of the reagent in the test tube. Add water sample up to the50 milliliter marking and stir with a rod.
- Match color of water in the tube with standard color chart for chlorine or use a chloroscope.
- The reading of the matching color on the charts indicates the amount of residual chlorine in water.
- If the results shows nil or less than 0.2 ppm then perform the same \test again with a sample taken from the same spot within 5 minutes.
- If the amount of residual chlorine is still less than 0.2 ppm immediately send the sample for bacteriological testing.

**If using a field kit for water quality testing, the field staff should follow specific procedure given in the associated booklet.*



Photograph 3: RC testing on site

3.4.2. Performing physical tests

The following physical parameters should be checked by the field staff and noted on the recording formats.

- Color (By looking at the color of water)
- Odor (By smelling the sample water)
- Transparency / Turbidity (By looking for the clarity of water)
- Temperature (measured using thermometer)

Conducting turbidity test

Aim

Turbidity is the amount of cloudiness in the water and can be caused by silt, sand and mud as well as bacteria and other germs chemical precipitates. As per IS 10500, 1 NTU is the acceptable limit and 5 NTU is permissible limit.

Required instruments

- Glass beaker (100 milliliters)
- Ideal acknowledged picture with turbidity chart (provided in water quality test kits)

Method

- Take water sample up in a beaker to the100 milliliter marking.
- Place turbidity chart on a raised platform in an area with ample sunlight.
- Keep the beaker with the water sample on the ideal acknowledged picture.
- Look at the Ideal acknowledged picture through the beaker
- Match the ideal acknowledged picture seen from beaker with the turbidity chart.
- Record the turbidity NTU.

Result

- If the picture is seen clear, the water sample is clean with zero turbidity.
- If picture seen is not very clear, the water is turbid.
- If turbidity is less than 5 NTU, water is potable
- If turbidity is more than 5 NTU, water is not potable.
- If picture is not seen at all, the water is muddy. Muddy water is not potable

Conducting pH test:

Required instruments

- pH paper
- Given pH color chart
- Beaker

Method

- Take a small amount of water sample for testing in a beaker.
- Immerse the pH paper (about 1/2 inch) into the water.
- The pH paper will change its colour. Match the color of paper with the given pH chart and record the corresponding value.

Result

If the pH value of water sample is in the range of 6.5 to 8.5, the water is potable (good for drinking).

Conducting TDS (total dissolved solids) test

Required instruments

- TDS meter
- Beaker

Method

- Pour the sample water in a beaker.
- Dip the TDS testing machine in the sample water.
- Record the reading on the digital display on the machine.

Result

If the reading is up to 500 mg/l, the water is potable. A reading up to 2000mg/l is permissible to be considered as potable by IS 10500.

3.4.3. Performing bacteriological tests

Bacteriological tests are not conducted on site. Some kits allow indicative tests on site. If the results of these indicative tests are positive, the samples should be sent to laboratories for further testing. In cases where the ULBs are not conducting indicative tests on site, all samples collected for bacteriological testing should be sent to accredited laboratories.

3.4.4. Performing chemical tests

Chemical tests are not conducted on site. Some kits allow indicative tests on site. In any case samples for chemical testing should be sent to accredited laboratories. A list of laboratories in Gujarat carrying out different water quality tests is provided in the Annexure. Some indicative chemical tests such as **fluorides, chlorides and nitrates** can be conducted on field by following the instructions provided in the booklet of the water quality testing kits.

3.5. Remedial and preventive measures in case of compromised water quality

ULBs can discern the presence of pollutants and impurities in drinking water in one of the following three ways:

- Failure of water quality tests
- Unsatisfactory findings of sanitary inspection
- Complaints of dirty/ turbid water from citizens or a localized epidemic of enteric infection

The preventive and remedial procedures to be followed in each case are described below:

3.5.1. Failure of water quality tests

The following table provides a summary of remedial measures in case of failure of water quality tests:

Table 8 Remedial measures in case of failure of RC test

Sampling Location	Immediate Remedial Measure	Preventive Action
At WTP/WDS	Add more chlorine and repeat the test till the sample clear RC test. If the sample fails consecutively three times immediately send the sample for bacteriological testing.	Not applicable
At consumer end	Recommend boiling and using of chlorine tablets. Immediately send the sample for bacteriological testing.	Not applicable

Table 9 Remedial measures in case of failure of bacteriological tests

Sampling Location	Immediate Remedial Measure	Preventive Action
At source	Disinfect (chlorinate) water supply if feasible, recommend boiling or use of chlorine tablets at home. Conduct a detailed sanitary inspection and correct the shortcomings found	Protect the source and its catchment
At WTP/ WDS	Ensure 0.2 mg/l free residual chlorine at tail end. (super chlorination) Conduct a detailed sanitary inspection of whole water supply system and rectify the shortcomings found	Frequent and improved supervision of the whole system is necessary, careful operations and maintenance is essential, especially for intermittent systems.
At consumer end	Recommend boiling and use of chlorine tablets.	Ensure routine sanitary inspections and feedback information to the water supply agencies.

3.5.2. Unsatisfactory findings of sanitary inspection

In case of unsatisfactory findings of the sanitary inspection around untreated piped water supply, immediately protect the source and its catchment area, conduct a detailed sanitary inspection and immediately correct the shortcomings found. If the sanitary inspections around WTP or WDS report unsatisfactory findings, immediately collect samples and send for testing to confirm bacteriological quality. Recommend boiling of water or use of disinfectant (chlorine tablets) to area residents.

Frequent and improved supervision of the whole system is necessary, careful operations and maintenance is essential especially for intermittent systems. Ensure routine sanitary inspections and feedback information to the water supply agencies.

3.5.3. Localized epidemic of enteric infection

For immediate remediation, take samples for bacteriological analysis. Without waiting bacteriological results, immediately chlorinate water supply so that the tail end has minimum 0.5 mg/l of free residual chlorine. Recommend boiling and use of chlorine tablets at home Conduct a detailed sanitary inspection of source and distribution system and rectify the shortcomings found.

The preventive measures in this case would include elimination of the pollution source (for example, sewage getting mixed in drinking water supply because of a broken pipeline). Frequent and improved supervision of the whole system is necessary, careful operations and maintenance is essential, especially for intermittent systems. Ensure routine sanitary inspections, especially in areas prone to water logging and flooding.

3.6. Data recording and management

The analysis results for all samples tested in field or sent to the laboratory should be duly recorded and compiled by the ULB on a regular basis. The forms for recording these test results, should not be complicated, but must be comprehensive and provide all necessary information such as location where sample was taken, data and time and the results of the test. The forms should preferably be in the local language for the ease of field staff. This section presents comprehensive forms for recording sampling locations and test results for field tests. The laboratory carrying out the bacteriological and chemical tests should record the results obtained in a standardized form.

This following diagram shows the required forms to be filled on field as well as the formats for compiling the surveillance record on a monthly/ yearly basis.

Table 10 Required date formats for recording test results on site and compiling results on a regular basis

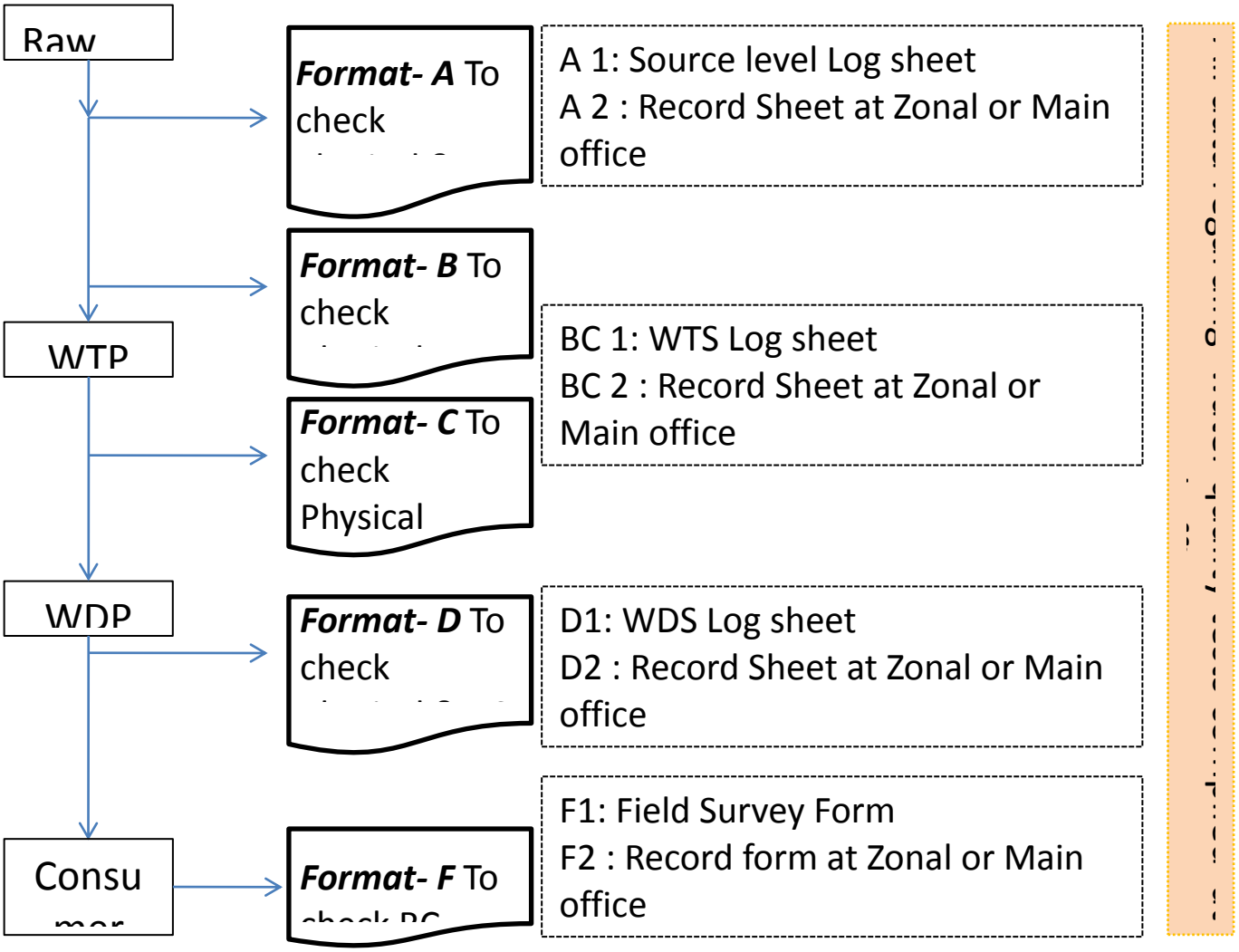


Table 11Sample Format for recording results of RC Test at Consumer Ends

Stage 1: Sample taken at End Point for RC (Residual Chlorine) **Consumer End Water Quality Test : Daily** *(Note: Form should be standardized for all surveyors.)* Name of Municipal Corporation / Municipality Agency / Department involved for Sample: Name of staff collecting samples:

Designation:

Date

Sample No.	Time	Admin Zone / Ward	Water Zone	Details (Address)	Source of Water	Residual Chlorine : Reading on Chlorometer (ppm) / Colour No	Test Results (Pass /Fail)	Sign	Remarks (if Failed)
1									
2									
3									
4									
5									
6									
7									

Table 12Sample Format for recording Physical & RC Test results at WTP/ WDS

WDS level Water Quality Test : Daily
log sheet

(Note: Form should be standardized for all WDS)

Name of Municipal Corporation / Municipality

Name of Department taking samples

Name and address of
WDS

Date	Time	Sump Level	Turbidity (N.T.U)	Chlorine (ppm)	TDS	Sign of pump operato	Sign of Chemis t /	Sign of in-charg

		meter	Raw Water	Set Water	Filter Water	Raw Water	Set Water	Filter Water	Raw Water	Set Water	Filter Water	r	Analyst	e officer

Total Sample s taken in the month:

Total No. of Samples	No. of Samples passed			No. of Samples failed		
	Turbidity	Chlorine	TDS	Turbidity	Chlorine	TDS

Table 13 Format for consolidating results of RC test

Stage 1: Report submitted by individual to supervisor

		Ward 1	Ward 2	Ward 3	Ward 4	Ward 5	Ward 6	Ward 7	Total
Total Samples Taken									
No of Samples passed									
No of Samples failed									

Sign of individual submitting the form **Sign of Supervisor**

Stage 2 : Daily Report to Chief Officer / Municipal Commissioner

To, Chief Officer/Municipal Commissioner

Name of Municipal Corporation / Municipality

Date

Ward Name	Total Samples	No. of Samples passed	No. of Samples failed	Remarks

Sign of Health Officer/ Water supply Engineer

Stage 3 : Monthly Report / Yearly to Chief Officer / Municipal Commissioner

To, Chief Officer/Municipal Commissioner

MC/Nagar Nigam Name:

Month: **Year:**

Ward Name	Total Samples (Previous Month)	Total Samples (Current Month)	No. of Samples passed (Previous Month)	No. of Samples passed (Current Month)	No. of Samples failed (Previous Month)	No. of Samples failed (Current Month)	Remarks		

Sign of Health officer / Water supply Engineer

Table 14Sample format for recording samples sent for analysis in labs

Location and address of Sample Collection											
Date	**Time**	**Season**	**Date of Sample Collection**	**Sample No.**	**Location**	**Analysis Type**	**Lab Name where sample sent for Analysis**	**Date**	**Date**	**Results (Pass/ Fail)**	**Supervisor's Sign**
					(Detail Address)	**(Bacteriological/ Chemical/ other)**		**(Sample Dispatched)**	**(Results Received)**	**Remarks**	
Sign of Record Manager									**Sign of Water Engineer / Health Officer**		

Table 15 Sample format for collating monthly records of water quality tests

Ward Name / WTP /WDS	RC Sample			Physical			Chemical :		
	Total	Pass	Fail	Total	Pass	Fail	Total	Pass	Fail
Total									

Table 16 Format for recording test results of all water quality tests

Ward Name / WTP /WDS	Calcium	Magnesium	Chloride	Sulphate	Nitrate	Fluoride	Dissolved Solids	Mineral Oil	Ammonia	Bacteriological		
	(if Fail , Due to which chemical)									Total	Pass	Fail
Total												

4. Benefits of adopting the SOP

The adoption and use of the SOP for routine water quality surveillance procedures for cities in Gujarat will help the ULBs better comply with the water quality protocols instituted by the Ministry of Urban Development, Government of India. The SOP will provide water works and engineering staff with all the information to establish a water quality monitoring regime. The consistent implementation of water quality surveillance processes and proper data recording and compilation of analyses results will improve the credibility and level of reliability of water quality data in ULBs. The ULBs should also share the water quality results regularly with citizens to increase transparency and accountability in municipal service provision.

The SOP could also prove as a useful resource for induction and training of new employees in the ULB. Adopting the SOP at the State level will enable the standardization and replication of monitoring procedures in all cities. It will also allow state level monitoring agencies such as the Gujarat Urban Development Mission (GUDM) to track and compare the performance of each city based on the standard protocols mentioned in the SOP.

The use of SOPs needs to be emphasized by GUDM as well as municipal commissioners and chief officers of ULBs. The SOP should be frequently reviewed and updated to comply with changes in the CPHEEO protocols. The SOP needs to be readily accessible as a reference for chief officers, engineers and water works staff either in hard copy or electronic format.

5. Definitions

Chlorine: Residual chlorine remaining in the water at the end of a specified period.

Chlorine Demand: the difference between the amounts of chlorine added to water and amount of residual chlorine remaining in the water at the end of a specified period.

Coli form Bacteria: group of bacteria predominantly inhabiting the intestine of human beings and animals, but also occasionally found elsewhere. Used to indicate presence of faecal pollution. Enteric having its normal habitat in the intestinal tract of human beings or animals.

Contamination: is the introduction into water of toxic materials, bacteria or other deleterious agents that make the water hazardous and therefore unfit for human use.

Organoleptic properties: Aspects of substances as experienced by the senses, including taste, sight, smell, and touch.

Palatable Water that is appealing to the sense of taste, sight and smell. Palatable water need not always be potable.

Parts per million (ppm) or milligrams per litre (mg/l) these terms are used to express the concentrations of dissolved or suspended matter in water. The parts per million (ppm) is a weight to weight or volume to volume relationship. Except in highly mineralized water, this quantity would be same as milligram per litre. This is preferable, since it indicates how it is determined in the laboratory.

Pathogens disease-producing organisms. Bacteria a group of universally distributed, essentially unicellular microorganisms lacking chlorophyll.

pH of water an expression of the Hydrogen ion concentration. Alkaline water is with pH of above 7 and acidic water has pH of below 7; whereas water with pH 7 is neutral.

Pollution is the introduction into water of substance in sufficient quantity to affect the original quality of water, make it objectionable to sight, taste, smell or make it less useful.

Potable Water that is satisfactory for drinking purposes from the standpoint of its chemical, physical and biological characteristics.

Toxic is harmful, destructive or deadly poisonous. Physiological effect having effect on the normal functions of the body.

Virus the smallest form capable of producing infection and diseases in human beings

Annexure

Annexure 1: Organoleptic and Physical parameters (Source: BIS: 10500, 2012)

Sr. No.	Characteristics	Prescribed values		Undesirable Effect
		Desirable limit	Permissible limit	
i)	Colour (Hazen units)	5	15	-
ii)	Odour	Agreeable	Agreeable	-
iii)	Taste	Agreeable	Agreeable	-
iv)	Turbidity (NTU)	1	5	Above 5 consumers acceptance decreases
v)	Dissolved solids (mg/l)	500	2000	Beyond this palatability decreases and may cause gastrointestinal irritation.
vi)	pH value	6.5-8.5	-	Beyond this range the water will affect the mucous membrane and/or water supply system.

Annexure 2: Chemical Parameters of Water

Source: BIS: 10500, 2012

Sr. No.	Characteristics	Prescribed values		Undesirable Effect
		Desirable limit	Permissible limit	
i)	Iron (as Fe) (mg/l)	0.3	No relaxation	Has adverse effect on domestic uses and water supply structures, and promotes iron bacteria
ii)	Aluminium (as Al) (mg/l)	0.03	0.2	Cumulative effect is reported to cause dementia (serious illness of the mind)
iii)	Copper (as Cu) (mg/l)	0.05	1.5	Astringent taste, discoloration and corrosion of pipes
iv)	Manganese (as Mn) (mg/l)	0.1	0.3	Beyond this limit taste/appearance are affected, has adverse effect on water supply structures.
v)	Zinc (as Zn) (mg/l)	5	15	Beyond this limit it can cause astringent taste and an opalescence in water.
vi)	Magnesium (as Mg) (mg/l)	30	100	Encrustation in water supply structure and adverse effects on domestic use.
vii)	Barium (as Ba) (mg/l)	0.7	No relaxation	May lead to cardiovascular problem.

viii)	Calcium (as Ca) (mg/l)	75	200	Encrustation in water supply structure and adverse effects on domestic use.
ix)	Silver (as Ag) (mg/l)	0.1	No relaxation	-
x)	Boron (as B) (mg/l)	0.5	1.0	-
xi)	Nitrate (as NO3) (mg/l)	45	No relaxation	Beyond this methaemoglobinamia takes place/may be indicative of pollution
xii)	Fluoride (as F) (mg/l)	1.0	1.5	High fluoride may cause fluorosis.
xiii)	Chlorides (mg/l)	250	1000	Beyond this limit taste, corrosion and palatability are affected.
xiv)	Total hardness (as CaCO3) (mg/l)	200	600	Encrustation in water supply structure and adverse effects on domestic use.
xv)	Ammonia (as total ammonia-N) (mg/l)	0.5	No relaxation	Toxicological effect about 200 mg per kg of body weight.

Annexure 3: Bacteriological Parameters of Water

Source: BIS: 10500, 2012

Organisms	Guidelines
All water intended for drinking E. coli or thermo tolerant coliform bacteria	Must not be detectable in any 100 ml sample.
Treated water entering the distribution system E. coli or thermotolerent coliform bacteria Total coliform bacteria	 Must not be detectable in any 100 ml sample. Must not be detectable in any 100 ml sample.
Treated water in the distribution system E. coli or thermotolerent coliform bacteria Total coliform bacteria	Must not be detectable in any 100 ml sample. Must not be detectable in any 100 ml sample. In the case of large supplies, where sufficient samples are examined, must not be present in 95% of samples taken throughout any 12 month period.

Annexure 4: Formats for Sanitary Inspection

Source: Guidelines for drinking-water quality, Volume 3 Surveillance and control of community supplies, World Health Organization, Geneva, 1997

Type of facility	**TUBEWELL WITH HAND-PUMP**		
1	Municipality/Municipal Corporation.....		
2	Address.....		
3	Water authority/ engineer signature.....		
4	Date of visit.....		
5	Water sample taken? Y/N Sample no.		
II	**Specific diagnostic information for assessment**	**Risk**	
		Yes	**No**
1.	Is there a latrine within 10 m of the hand-pump?		
2.	Is the nearest latrine on higher ground than the hand-pump?		
3.	Is there any other source of pollution (e.g. animal excreta, rubbish, and surface water) within 10 m of the hand-pump?		
4.	Is the drainage poor, causing stagnant water within 2 m of the hand-pump?		
5.	Is the hand-pump drainage channel faulty? Is it broken, permitting ponding? Does it need cleaning?		
6.	Is the fencing around the hand-pump inadequate, allowing animals in?		
7.	Is the concrete floor less than 1 m wide all around the hand-pump?		
8.	Is there any ponding on the concrete floor around the hand-pump?		
9.	Are there any cracks in the concrete floor around the hand-pump which could permit water to enter the well?		
10.	Is the hand-pump loose at the point of attachment to the base so that water could enter the casing?		
	Total score of risks..... /10		
	Contamination risk score: 9–10 = very high; 6–8 = high; 3–5 = intermediate; 0–2 = low		
III Results and recommendations			
The following important points of risk were noted: ..... (list nos 1–10) and the authority advised on remedial action.			
Signature of sanitarian.....			

Type of facility DEEP BOREHOLE WITH MECHANICAL PUMP			
1	Municipality/Municipal Corporation.....		
2	Address.....		
3	Water authority/ engineer signature.....		
4	Date of visit.....		
5	Water sample taken? Y/N Sample no.		
II	**Specific diagnostic information for assessment**	**Risk**	
		Yes	**No**
1	Is there a latrine or sewer within 15–20 m of the pumphouse?		
2.	Is the nearest latrine a pit latrine that percolates to soil, i.e. unsewered?		
3.	Is there any other source of pollution (e.g. animal excreta, rubbish, and surface water) within 10 m of the borehole?		
4.	Is there an uncapped well within 15–20 m of the borehole?		
5.	Is the drainage area around the pumphouse faulty? Is it broken, permitting ponding and/or leakage to ground?		
6.	Is the fencing around the installation damaged in any way which would permit any unauthorized entry or allow animals access?		
7.	Is the floor of the pumphouse permeable to water?		
8.	Is the well seal unsanitary?		
9.	Is the chlorination functioning properly?		
10.	Is chlorine present at the sampling tap?		
	Total score of risks..... /10		
	Contamination risk score: 9–10 = very high; 6–8 = high; 3–5 = intermediate; 0–2 = low		
III Results and recommendations			
The following important points of risk were noted: ..... (list nos 1–10) and the authority advised on remedial action.			
Signature of sanitarian.....			

Type of facility PROTECTED SPRING SOURCE			
1	Municipality/Municipal Corporation.....		
2	Address.....		
3	Water authority/ engineer signature.....		
4	Date of visit.....		
5	Water sample taken? Y/N Sample no.		
II	**Specific diagnostic information for assessment**	**Risk**	
		Yes	**No**
1	Is the spring source unprotected by masonry or concrete wall or spring box and therefore open to surface contamination?		
2.	Is the masonry protecting the spring source faulty?		
3.	If there is a spring box, is there an unsanitary inspection cover in the masonry?		
4.	Does the spring box contain contaminating silt or animals?		
5.	If there is an air vent in the masonry, is it unsanitary?		
6.	If there is an overflow pipe, is it unsanitary?		
7.	Is the area around the spring unfenced?		
8.	Can animals have access to within 10 m of the spring source?		
9.	Does the spring lack a surface water diversion ditch above it, or (if present) is it non-functional?		
10.	Are there any latrines uphill of the spring?		
Total score of risks..... /10			
Contamination risk score: 9–10 = very high; 6–8 = high; 3–5 = intermediate; 0–2 = low			
III Results and recommendations			
The following important points of risk were noted: ..... (list nos 1–10) and the authority advised on remedial action.			
Signature of sanitarian.....			

Type of facility SURFACE SOURCE AND ABSTRACTION			
1	Municipality/Municipal Corporation.....		
2	Address.....		
3	Water authority/ engineer signature.....		
4	Date of visit.....		
5	Water sample taken? Y/N Sample no.		
II	**Specific diagnostic information for assessment**	**Risk**	
		Yes	**No**
1	Is there any human habitation upstream, polluting the source?		
2.	Are there any farm animals upstream, polluting the source?		
3.	Is there any crop production or industrial pollution upstream?		
4.	Is there a risk of landslide or mudflow (causing deforestation) in the catchment area?		
5.	Is the intake installation unfenced?		
6.	Is the intake unscreened?		
7.	Does the abstraction point lack a minimum-head device (weir or dam to ensure minimum head of water)?		
8.	Does the system require a sand or gravel filter?		
9.	If there is a filter, is it functioning badly?		
10.	Is the flow uncontrolled?		
Total score of risks..... /10			
Contamination risk score: 9–10 = very high; 6–8 = high; 3–5 = intermediate; 0–2 = low			
III Results and recommendations			
The following important points of risk were noted: ..... (list nos 1–10) and the authority advised on remedial action.			
Signature of sanitarian.....			

Type of facility WATER-TREATMENT PLANT				
1.	Date of survey...../...../.....			
2.	Survey of	Source	Intake	Treatment plant Distribution
3.	Carried out by ..... Name of person ..... Agency			
4.	Name of supply ..... State ..... District ..... Treatment plant			
5.	Address:			
6.	Person in charge			
7.	Year started operation			
8.	Area served..... Population served.....			
9.	Treatment-plant capacity Designed..... Actual.....			
10.	Security of plant Fence: Y/N Security guard: Y/N			
Record keeping				
1.	Chemical consumption:			
2.	Process-control tests:			
3.	Bacteriological examination:			
4.	Residual chlorine:			
5.	Others:			
Maintenance				
			Cleaning	Calibrating/oiling/ greasing
1.	Screen			
2.	Pumping facility			
3.	Chlorine-dosing facility			
4.	Alum-dosing facility			
5.	Fluoride-dosing facility			
6.	Instrument (gauge, recording devices, etc			
7.	General housekeeping			
8.	Storage of chemicals			
			Adequate	Inadequate

Personnel					
1.	No. of present staff…….. …….. Permanent Casual				
2.	Academic level of the plant superintendent or the most senior operator of the treatment plant:				
3.	Length of service in present water-treatment plant:				
4.	Total experience in water treatment:				
Complaints received					
1.	From operators:				
2.	From management:				
Problems (if any) with:					
			Yes	No	Description of problems
1.		Fine screen:			
2.		Grit chamber:			
3.		Oil and grease trap:			
4.		Presedimentation:			
5.		Activated carbon:			
6.		Aeration:			
7.		Coagulation and flocculation:			
8.		Sedimentation:			
9.		Filtration:			
10.		Fluoridation:			
11.		Disinfection:			
12.		Other process:			
13.		Process control:			
14.		Record keeping:			
15.		Maintenance:			

Remedial measures recommended	
1.	Measures to be taken immediately:
2.	Measures to be taken later on:
Have problems identified in the previous sanitary survey been corrected?	
Signature of inspector:	

Type of facility PIPED DISTRIBUTION			
1	Municipality/Municipal Corporation.....		
2	Address.....		
3	Water authority/ engineer signature.....		
4	Date of visit.....		
5	Water sample taken? Y/N Sample no.		
II	**Specific diagnostic information for assessment**	**Risk**	
		Yes	**No**
1.	Is there any point of leakage between source and reservoir?		
2.	If there are any pressure break boxes, are their covers unsanitary? If there is a reservoir:		
3.	Is the inspection cover unsanitary?		
4.	Are any air vents unsanitary?		
5.	Is the reservoir cracked or leaking?		
6.	Are there any leaks in the distribution system?		
7.	Is the area around the tapstand unfenced (dry stone wall and/or fencing incomplete)?		
8.	Does water accumulate near the tapstand (requires improved drainage canal)?		
9.	Are there human excreta within 10 m of the tapstand?		
10.	Is the plinth cracked or eroded?		
11.	Does the tap leak?		
Total score of risks..... /10			
Contamination risk score: 9–10 = very high; 6–8 = high; 3–5 = intermediate; 0–2 = low			
III Results and recommendations			
The following important points of risk were noted: ..... (list nos 1–10) and the authority advised on remedial action.			
Signature of sanitarian.....			

Annexure 5: Accredited Laboratories in Gujarat

(Source: http://www.indiawaterportal.org/sites/indiawaterportal.org/files/uploads/2008/08/water_cf2-rev.pdf)

Names of laboratories with contact addresses	Lab. Code Number (s)	Physical & Chemical Parameters analyzed (Method)	Instruments Available for Physical & Chemical Parameters Analysis	Biological & Microbiological Parameters can be analyzed	Instruments available for Bio/Micro Analysis	List of Auxiliary Equipments available
Ahmedabad Municipal Corporation , Sardar Patel Bhawan Danapith, Ahmedabad - 380 001 Gujarat Ph.: 079-25391811, 27551595, 25350858	12.M/D-MC/1	Col (P1.1), pH(P3.1), pH (P3.2), TDS (P5.1), Tu (P6.2), Alk (C1.1), Alk (C1.2), As (C5.3), Cd (C8.3), \ Ca (C9.3), Cr (C10.4), Cl (C11.1), Cu (12.3), CN(C13.3), F (C14.1), F (C14.2), RCl (C15.9), Fe(C16.1), Mg (18.4), MO(C21), Ni (C22.4), NO3(C23), NO2 (C24.1), Phenol (C26.1), Na(C31.3), SO4(C32.4), S(C33.2), TH(C34.1), TH(C34.2)	Flame Photometer, Oven, Muffle Furnace, Filter Photometer, Electrodes, Celsius Thermometer, Spectrophotometer, Soxhlet Extration Apparatus, Conductivity Meter, Magnetic Stirrer	Cb(Mb2.1) ,Fstr/Fsty(Mb4.1)	Autoclave, Incubator, Microscope	Chem. Balances, Water Distillation Apparatus, Centrifuge Machines, Colony Counters, Jar Test Apparatus, Imhoff Cones, Vaccume Pumps, Membrane Filter Assembles, Filter Pumps, Fridge, Heating Mantles, Fuel Gas, Hot Plates, Burners
Bhavnagar Municipal Corporation, Opp. Galaxy Cinema, Mangal Singh Road, Bhavnagar – 364 001 Gujarat Ph.: 0278 –2510532, 2439900	**12.M/D-MC/2**	Col (P1.1), Od (P2.1), pH(P3.1), Ta(P4), TDS(P5), Tu (P6.2), Alk (C1.1), RCl (C15.9), TH(C34)	NA	B2, Mb2, EC(Mb3),	NA	NA
Surat Municipal Corporation Head water Works, Varachha Road, Muglisara, Surat – 395 006 Gujarat Ph.: 0261-2422244, 2423750 -56, 2422285-87 Telex: 0188-251 SMC IN Fax: 0261-2422110 2451935	**12.M/D-MC/3**	Col (P1.2), Od(P2), pH(P3.1), Ta(P4), TDS(P5), Tu (P6.2), Alk (C1.2), Al (C2.3), MBAS(C3), As (C5.3), Cd (C8.3), Ca(C9.3), Cr (C10.4), Cl (C11.1), Cu (12.4), F (C14.2), RCl (C15.6), Fe(C16.1), Pb (C17.1), Mg (C18.4), Mn (C19.3), Hg (C20.1), Ni (C22.4), NO3 (C23.4), NO2 (C24.1), Phenol (C26.2), Se(C29.3), SO4(C32.4), TH(C34.1), TH(C34.2), Zn(C35.3)	Oven, Muffle Furnace, Electrodes, Celsius Thermometer, Spectrophotometer, Conductivity Meter, Magnetic Stirrer, AGA	Cb(Mb2.1), EC(Mb3.2)	Autoclave, Incubator, Microscope	Chem. Balances, Water Distillation Apparatus, Jar Test Apparatus, Vaccume Pumps, Membrane Filter Assembles, Fridge, Heating Mantles, Hot Plates
Vadodara Municipal Corporation,	**12.M/D-MC/4**	Col (P1.1), pH(P3.1), TDS (P5.1), Tu (P6.2), Alk (C1.2), Ca (C9.3), Cl	Oven, Muffle Furnace, Celsius Thermometer,	Cb(Mb2.1), EC(Mb3.2 (iii))	Autoclave, Incubator,	Chem. Balances, Water Distillation

Names of laboratories with contact addresses	Lab. Code Number (s)	Physical & Chemical Parameters analyzed (Method)	Instruments Available for Physical & Chemical Parameters Analysis	Biological & Microbiological Parameters can be analyzed	Instruments available for Bio/Micro Analysis	List of Auxiliary Equipments available
Khanderao Market, Vadodara – 390 001 Gujarat Ph.: 0265-2433344		(C11.1), F (C14.2), RCl (C15.9), Mg (C18.4), MO (C21.3), Na(C31.3), SO4(C32.4), TH(C34.1)	Spectrophotometer, Soxhlet Extration Apparatus, Conductivity Meter, Magnetic Stirrer		Microscope	Apparatus, Centrifuge Machines, Vaccume Pumps, Filter Pumps, Fridge, Heating Mantles, Fuel Gas, Hot Plates, Burners
GWSSB District Laboratory, 1st Floor Sterling Apartment, Uparkot Kalanala, Bhavnagar – 364001, Gujarat Ph.: 0278-437381, 2437381	**12.M/D-GWSSB/ 1**	Col (P1.1), Od(P2), pH(P3.1), TDS (P5.1), Tu (P6.2), Alk (C1.2), Ca (C9.3), Cl (C11.1), F (C14.1), RCl (C15.9), Mg (C18.4), SO4(C32.4), TH(C34.1)	Oven, Electrodes, Spectrophotometer, Colour Comparator	Cb(Mb2.1)	Autoclave, Incubator	Water Distillation Apparatus, Jar Test Apparatus, Fridge, Fuel Gas, Hot Plates, Burners
GWSSB District Laboratory, Banni Inspection Bunglow Compound, St. Xaveir's High School Road, Bhuj (Kachchh) – 370 001 Gujarat Ph.: 02832 - 220914	**12.M/D-GWSSB/ 2**	Col (P1.1), Od (P2.1), pH(P3.1), TDS (P5.1), Tu (P6.2), Alk (C1.2), Ca (C9.3), Cl (C11.1), F (C14.1), RCl (C5.1), RCl (C15.2), RCl (C15.9), Fe(C16.1), Mg (C18.4), NO3 (C23.2), SO4(C32.4), TH(C34.1)	Oven, Electrodes, Jackson Candle Turbidimeter, Spectrophotometer	Cb(Mb2.1), Fstr/Fsty(Mb4.1)	Autoclave, Incubator	Chem. Balances, Water Distillation Apparatus, Jar Test Apparatus, Fridge, Fuel Gas, Hot Plates, Burners
GWSSB District Laboratory, "Jal Bhavan" Saru Section Road, Jamnagar-361002 Gujarat Ph.: 0288- 2550253	**12.M/D-GWSSB/ 3**	Col (P1.1), Od (P2.1), pH(P3.1), TDS (P5.1), Tu (P6.2), Alk (C1.2), Ca (C9.3), Cl (C11.1), F (C14.1), RCl (C15.9), Mg (C18.4), NO3 (C23.2), SO4(C32.4), TH(C34.1)	Oven, Electrodes, Spectrophotometer, Colour Comparator	Cb(Mb2.1), Fstr/Fsty(Mb4.1)	Autoclave, Incubator	Chem. Balances, Water Distillation Apparatus, Jar Test Apparatus, Fridge, Fuel Gas, Hot Plates, Burners
GWSSB District Laboratory,	**12.M/D-GWSSB/**	Col (P1.1), Od (P2.1), pH(P3.1), TDS (P5.1), Tu (P6.2), Alk (C1.2),	Oven, Electrodes, Spectrophotometer,	Cb(Mb2.1), Fstr/Fsty(Mb4.1)	Autoclave, Incubator	Chem. Balances, Jar Test Apparatus,

Names of laboratories with contact addresses	Lab. Code Number (s)	Physical & Chemical Parameters analyzed (Method)	Instruments Available for Physical & Chemical Parameters Analysis	Biological & Microbiological Parameters can be analyzed	Instruments available for Bio/Micro Analysis	List of Auxiliary Equipments available
1st Floor "Jal Bhavan" Opp. R.T.O. Palavasana, Mehsana – 384 003 Gujarat Ph.: 02762 – 253565, 251886 Extension: 301 302	**4**	Ca (C9.3), Cr (C10.1), Cl (C11.1), F (C14.2), RCl (C15.9), Mg (C18.4), NO3(C23), SO4(C32.4), TH(C34.1)	Colour Comparator			Fridge, Heating Mantles, Fuel Gas, Hot Plates, Burners
GWSSB District Laboratory, "Jal Bhavan" 2nd Floor, Adajan O/H. Water Tank Campus, Adajan Road, Surat – 395 009 Gujarat Ph.: 0261 - 2682145	**12.M/D-GWSSB/5**	Col (P1.1), pH(P3.1), pH (P3.2), TDS (P5.1), Tu (P6.2), Alk (C1.2), Ca (C9.3), Cl (C11.1), F (C14.1), RCl (C5.1), RCl (C15.9), Fe(C16.1), Mg (C18.4), MO (C21.3), NO3(C23), SO4(C32.4), TH(C34.1)	Oven, Autoanalzer, Electrodes, Jackson Candle Turbidimeter, Spectrophotometer, Colour Comparator, Conductivity Meter	Cb(Mb2.1), EC(Mb3).2 (ii)	Autoclave, Incubator	Chem. Balances, Jar Test Apparatus, Fridge, Heating Mantles, Fuel Gas, Hot Plates, Burners
Gujrat SPCB Central Laboratory, Paryavaran Bhavan, Sector 10 – A, Gandhinagar – 382 010 Gujarat Ph.:079 –23222756, 23222095, 096 Fax: 079-23232156	**12.S/R-PC/1**	Col (P1.1), pH(P3.1), pH (P3.2), TDS (P5.1), Tu (P6.2), Alk (C1.2), As (C5.1),Cd (C8.1), Ca (C9.3), Cr (C10.1), Cr (C10.4), Cl (C11.1), Cu (12.1), CN(C13.3), F (C14.1), RCl (C15.9), Fe (C16.2), Pb (C17.2), Mg (C18.4), Mn (C19.3), Hg (C20.1), Ni(C22.1), NO3(C23.4), NO2 (C24.1), Phenol (C26.2), Na(C31.3), SO4(C32.4), S(C33.1), TH(C34.1), Zn(C35.1)	Flame Photometer, GLC, Oven, Muffle Furnace, AAS, Electrodes, Celsius Thermometer, Spectrophotometer, Soxhlet Extration Apparatus, Colour Comparator, Conductivity Meter, Magnetic Stirrer	Cb(Mb2.1), EC(Mb3),	Autoclave, Incubator , Microscope	Chem. Balances, Water Distillation Apparatus, Centrifuge Machines, Colony Counters, Imhoff Cones, Vaccume Pumps, Fridge, Heating Mantles, Fuel Gas, Hot Plates, Burners
Gujarat SPCB Regional Laboratory, Rameshwarnagar Sardar Patel Bhavan , Bedi Bandar Road, Jamnagar – 368 008 Gujarat Ph.: 0288 - 2752366	**12.S/R-PC/2**	Col (P1.1), pH(P3.1), TDS (P5.1), Tu (P6.2), Alk (C1.2), BO3 (C7.1), Cd(C8.1), Ca (C9.3), Cr (C10.1), Cl (C11.1), Cu (12.1), CN(C13.1), F (C14.2), RCl (C5.1), Fe (C16.2), Pb (C17.2), Mg (C18.4), Ni (C22.1), NO3(C23), NO2 (C24.1), Phenol (C26.2), Na(C31.3), SO4(C32.4),	Flame Photometer, GLC, Oven, Muffle Furnace, AAS, Electrodes, Spectrophotometer, Conductivity Meter, Magnetic Stirrer	Cb(Mb2.1),	Autoclave, Incubator	Chem. Balances, Water Distillation Apparatus, Colony Counters, Vaccume Pumps, Filter Pumps, Fridge, Heating Mantles, Fuel Gas, Hot Plates, Burners
Gujarat SPCB Regional Laboratory	**12.S/R-PC/3**	Col (P1.1), pH(P3.1), pH (P3.2), TDS (P5.1), Tu (P6.2), Alk (C1.2),	Flame Photometer, GLC, Oven, Muffle	Ben(B1.1), Cb(Mb2.1),	Autoclave, Incubator ,	Chem. Balances, Water Distillation

Names of laboratories with contact addresses	Lab. Code Number (s)	Physical & Chemical Parameters analyzed (Method)	Instruments Available for Physical & Chemical Parameters Analysis	Biological & Microbiological Parameters can be analyzed	Instruments available for Bio/Micro Analysis	List of Auxiliary Equipments available
338 Belgium Square Typical 1st Floor, Silver Plaza Complex, Opp. Linear Bus Stand Ring Road, Surat – 395 003, Gujarat Ph.: 0261 – 2442696 Fax: 0261-2429733		BO3 (C7.1), Cd (C8.1), Ca (C9.3), Cr (C10.4), Cl (C11.1), Cu (12.1), CN(C13.1), CN(C13.2), F (C14.1), F (C14.2), Fe(C16.1), Pb (C17.2), Mg (C18.4), Mn (C19.1), Ni (C22.1), NO3 (C23.4), NO2 (C24.1), Phenol (C26.2), Na(C31.3), SO4(C32.4), S(C33.2), TH(C34.1), TH(C34.2), Zn(C35.1)	Furnace, AAS, Celsius Thermometer, Jackson Candle Turbidimeter, Spectrophotometer, Soxhlet Extration Apparatus, Colour Comparator, Conductivity Meter, Magnetic Stirrer	Fstr/Fsty(Mb4.1),	Microscope	Apparatus, Centrifuge Machines, Colony Counters, Vaccume Pumps, Membrane Filter Assembles, Filter Pumps, Fridge, Heating Mantles, Fuel Gas, Hot Plates, Burners
Gujarat SPCB Regional Laboratory, GERI Compound, Race Course Road, Vadodara – 390 007 Gujarat Ph.: 0265 – 2354850, 2331928	**12.S/R-PC/4**	Col (P1.1), pH(P3.1), TDS (P5.1), Tu (P6.2), Alk (C1.2), Sb (C4.1), As (C5.1), Ba (C6.1), BO3 (C7.1), Cd (C8.1), Ca (C9.3), Cr (C10.1), Cr (C10.4), Cl (C11.1), Cu (12.1), CN(C13.2), F (C14.2), Fe(C16.1), Fe (C16.2), Pb (C17.2), Mg (18.4), Mn (19.1), Ni (C22.1), NO3 (C23.2), NO2 (C24.1), Phenol (C26.2), Ag(C30.1), Na(C31.3), SO4(C32.4), S(C33.1), S(C33.2), TH(C34.1), Zn(C35.1)	Flame Photometer, GLC, Oven, Muffle Furnace, AAS, Spectrophotometer, Soxhlet Extration Apparatus, Colour Comparator, Conductivity Meter, Magnetic Stirrer, AGA	Ben(B1.1), Cb(Mb2.1),	Autoclave, Incubator , Microscope	Chem. Balances, Water Distillation Apparatus, Centrifuge Machines, Colony Counters, Vaccume Pumps, Membrane Filter Assembles, Fridge, Heating Mantles, Fuel Gas, Hot Plates, Burners
Gujarat SPCB Regional Laboratory , C – 5/124, N.H. No. 8, GIDC Estate, Nr. Hotel Pritam, District Valsad – 396 195, Gujarat Ph.: 0260-2432089, 2426207 Fax: 0260-2432826	**12.S/R-PC/5**	Col (P1.1), pH(P3.1), pH (P3.2), TDS (P5.1), Tu (P6.2), Alk (C1.2), BO3 (C7.1), Cd (C8.1), Ca (C9.3), Cr (C10.1), Cl (C11.1), Cu (12.1), CN(C13.3), F (C14.2), RCl(C15), Fe(C16.1), Pb (C17.2), Mg (C18.4), Mn (C19.1), Hg (C20.1), MO(C21.1),Ni(C22.1), NO3(C23.4) , NO2(C24.1) Phenol (C26.2), Na(C31.3), SO4(C32.4), S(C33.2), TH(C34.1), Zn(C35.1)	Flame Photometer, GLC, Oven, Muffle Furnace, AAS, Jackson Candle Turbidimeter, Spectrophotometer, Colour Comparator, Conductivity Meter	Cb(Mb2.1),	Autoclave, Incubator	Chem. Balances, Water Distillation Apparatus, Centrifuge Machines, Vaccume Pumps, Fridge, Heating Mantles, Fuel Gas, Hot Plates, Burners
GWSSB Central Laboratory / Scientific Branch, Gujrat Jalseva Training Institute, 'G' Road Sector – 15	**12.S/R-PH/1**	Col (P1.1), Col (P1.2), Od (P2.1), pH(P3.1), TDS (P5.1), Tu (P6.2), Alk (C1.2), Ca (C9.3), Cl (C11.1), F (C14.1), RCl (C5.1), RCl (C15.2), RCl (C15.9), Fe(C16.1), Mg(C18.4), NO3 (C23.2), SO4(C32.4), TH(C34.1)	Flame Photometer, Oven, Electrodes, Celsius Thermometer, Spectrophotometer, Colour Comparator, Conductivity Meter	Cb(Mb2.1), EC(Mb3.1(i)), EC(Mb3).2 (iii)	Autoclave, Incubator, Microscope	Chem. Balances, Water Distillation Apparatus, Colony Counters, Jar Test Apparatus, Membrane Filter Assembles, Fridge,

Names of laboratories with contact addresses	Lab. Code Number (s)	Physical & Chemical Parameters analyzed (Method)	Instruments Available for Physical & Chemical Parameters Analysis	Biological & Microbiological Parameters can be analyzed	Instruments available for Bio/Micro Analysis	List of Auxiliary Equipments available
Gandhinagar – 382015 Gujarat Ph.:079 –23222216, 23223941 - 47 Fax: 079-23223243 E-mail: gjti@rediffmail.com						Fuel Gas, Hot Plates, Burners
GWSSB PHED, Regional Laboratory, Near T.B. Hospital, Civil Hospital Compound, Palanpur – 385 001 Gujarat Ph.: 02742 - 253750	**12.S/R-PH/2**	Col (P1.1), Od (P2.1), pH(P3.1), Ta (P4.1), TDS (P5.1), Tu (P6.2), Alk (C1.2), Ca (C9.3), Cl (C11.1), F (C14.2), RCl (C15.9), Fe(C16.1), Mg (C18.4), NO3(C23), SO4(C32.4), TH(C34.1)	Flame Photometer, Oven, Spectrophotometer, Conductivity Meter	Cb(Mb2.1), Fstr/Fsty(Mb4.1)	Autoclave, Incubator	Chem. Balances, Water Distillation Apparatus, Colony Counters, Fridge, Fuel Gas, Hot Plates, Burners
GWSSB Public Health Engineering Laboratory, Water Testing Unit, “Jal Bhavan” ,1st Floor GERI Campus, Race Course Road, Vadodara – 390 007 Gujarat Ph.: 0265 - 234428	**12.S/R-PH/3**	Col (P1.1), pH(P3.1), pH (P3.2), TDS (P5.1), Tu (P6.2), Alk (C1.2), Ca (C9.3), Cl (C11.1), CN(C13.2, F (C14.1), RCl (C15.9), Fe(C16.1), Mg (18.4), MO(C21), NO3(C23), Na(C31.3), SO4(C32.4), TH(C34.1)	Flame Photometer, Oven, Muffle Furnace, Electrodes, Celsius Thermometer, Spectrophotometer, Soxhlet Extration Apparatus, Colour Comparator, Conductivity Meter	Cb(Mb2.1), EC(Mb3),	Autoclave, Incubator, Microscope	Chem. Balances, Centrifuge Machines, Jar Test Apparatus, Vaccume Pumps, Fridge, Heating Mantles,Hot Plates, Burners
GWSSB Public Health Engineering Laboratory, Soil Testing Unit , “Jal Bhavan” 1st Floor GERI Campus, Race Course Road, Vadodara – 390 007 Gujarat Ph.: 0265 - 2344428	**12.S/R-PH/4**	Col (P1.1), pH(P3.1), TDS (P5.1), Tu (P6.2), Alk (C1.2), Ca (C9.3), Cl (C11.1), CN(C13.2, F (C14.1), RCl (C15.9), Fe(C16.1), Mg (C18.4), MO (C21.3), NO3(C23), Na(C31.3), SO4(C32.4), TH(C34.1)	Flame Photometer, Oven, Muffle Furnace, Electrodes, Celsius Thermometer, Spectrophotometer, Soxhlet Extration Apparatus, Colour Comparator, Conductivity Meter	Cb(Mb2.1), EC(Mb3),	Autoclave, Incubator, Microscope	Chem. Balances, Centrifuge Machines, Jar Test Apparatus, Vaccume Pumps, Fridge, Heating Mantles, Hot Plates, Burners

Names of laboratories with contact addresses	Lab. Code Number (s)	Physical & Chemical Parameters analyzed (Method)	Instruments Available for Physical & Chemical Parameters Analysis	Biological & Microbiological Parameters can be analyzed	Instruments available for Bio/Micro Analysis	List of Auxiliary Equipments available
GWSSB, Public Health Engineering Laboratory Vadodara Gujarat	**12.S/R-PH/5**	Col (P1.1), pH(P3.1), pH (P3.2), TDS (P5.1), Tu (P6.2), Alk (C1.2), Ca (C9.3), Cl (C11.1), CN(C13.2), F (C14.1), RCl (C15.9), Fe(C16.1), Mg (C18.4), MO (C21.3), NO3(C23), Na(C31.3), SO4(C32.4), TH(C34.1)	Flame Photometer, Oven, Muffle Furnace, Electrodes, Celsius Thermometer, Spectrophotometer, Soxhlet Extration Apparatus, Colour Comparator, Conductivity Meter	Cb(Mb2.1), EC(Mb3),	Autoclave, Incubator, Microscope	Chem. Balances, Centrifuge Machines, Jar Test Apparatus, Vaccume Pumps, Fridge, Heating Mantles, Hot Plates, Burners
Gujarat State Fertilizers & Chemicals Limited, Agro Development & Agro Services Department, Soil & Water Testing Laboratory, Vadodara Gujarat Ph.:0265– 2242451, 2242651, 2242751, 242641 Fax: 0265-2240966, 2240119 E-mail: adas_stl@gsfcltd.com , ho@gsfcltd.com	**12.S/R-OT/1**	Col (P1.2), Od (P2.1), pH(P3.1), TDS (P5.1), Tu (P6.2), Alk (C1.2), Al (C2.3), MBAS(C3), As (C5.3), Cd (C8.3), Ca (C9.3), Cl (C11.1), F (C14.2), Mg (C18.4), NO3 (C23.2), SO4(C32.4), TH(C34.1)	Flame Photometer, Oven, AAS, Spectrophotometer, Conductivity Meter	Cb(Mb2.1)	Autoclave, Incubator, Microscope	Chem. Balances, Water Distillation Apparatus, Fridge, Heating Mantles, Fuel Gas, Hot Plates, Burners

Annexure 5: Comments and Feedback on the SOP by Sector Experts

Dr. D M Mohan
Consultant, World Bank

SOP: The SOP is well prepared. No comments can be given by me. I am of opinion that strictly following the SOP, monitoring water quality can be streamlined. SOP provides corrective actions where required. The big picture is that the WSS in India are normally functioning satisfactorily; quite often it is observed that, they are unable to provide the services effectively for which they have been constructed, as they remain defunct or non functional most of the time. Deficiency of adequate financing for asset management is quite often the reason cited for this. This may not be always so, since few other reasons for the present status are: (i) Inadequate workmanship during construction, (ii) Lack of real time information/data on system assets and O&M status, (iii) Inadequate training of O&M personnel, (iv) Inadequate emphasis on preventive maintenance.

My observations in WSS: In my visits to several WSS, quite often I find that: Both raw water and clear water bulk flow meter are also not working. jar test apparatus to determine dosage of alum is out of order, physical balance to measure small quantity of alum for jar test is not functional, turbidity meter is not functional to assess the raw water turbidity, weighing machine to add required quantity of alum is not functional, alum mixers are corroded, gravity alum dosers are not working, flash mixers, and calrifloculators are not working; all these affect the turbidity removal to the level the filters can treat. Filters are often found choked, air wash is inadequate due to inefficient or non working blowers and backwashing is not done promptly. All instrumentation on filters such as rate controllers, LOH and ROF gauges are non functional. The covers over filtered water chambers are broken exposing the filtered water to contamination. In distribution system, the service reservoirs are not cleaned promptly, covers over the reservoirs are broken or kept open, the finial ventilators over ESR s have become nesting place for pigeons. Leaks at point of consumer connections and in consumer pipes can also lead to contamination. With a view to provide sustainable service including supply of drinking water of required water quality, the CPHEEO O&M manual provides checklists for various treatment plants, service reservoirs, electro mechanical equipment of WTP s and Pumping plants. If these checks are carried out rigorously, it will be possible to ensure supply of drinking water conforming to standards.

Source Water Quality: Disinfection with chlorine is the only process followed for ground water based schemes. Chemical correction of ground water quality for fluoride, iron, arsenic, salinity etc is rarely done in conventional treatment plants. Surface water is treated with chemical coagulation and filtration followed by disinfection for removal of turbidity and bacterial impurities. Drinking water quality at consumer end will conform to the standards, if only the following status is ensured:

For ground water based schemes, (i) the chlorinators must be in good working condition and (ii) supply of chlorine is ensured, so that required chlorine dosage is given, (iii) flow meter is in working condition so that required chlorine dosage is achieved.

For surface water based schemes raw water turbidity is to be removed through chemical coagulation and filtration, for which the alum weighing machines, alum mixers, and alum dosers, flash mixer, clari-flocculators and filters and filter back wash arrangements with air and water are functional; additionally the chlorinators must be in good working condition and supply of chlorine, alum and lime (where required) is ensured, so that required chlorine dosage is given. Flow meter is to be in working condition so that required chemical dosage is achieved.

The laboratories at WTP shall be functional with minimum requirement of a functional jar Test and physical balance along with functional Turbidity meter and pH meter and residual chlorine testing.

For both Ground water and surface water the storage reservoirs and service reservoirs have to be cleaned frequently to remove the accumulated silt

Manhole covers over filter water chambers, the storage reservoirs and service reservoirs shall be in place and water tight.

Quality of chemicals: the strength of alum being used is to be checked frequently. The strength of chlorine in bleaching powder where used in place of chlorine gas is also to be checked frequently.

Suggestions about sampling: Statistical number of samples collected and analysed is OK as per SOP. In respect of distribution system a correlation is to be established with areas where frequent occurrence of GE diseases is reported. Samples for residual chlorine have to be collected from such areas (GE cases) and also from the farthest tap from the ESR and pit taps are prevalent due to negative pressures.

Mr. S K Tasgaonkar
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This SOP is presumably supposed to be a template by the local bodies to be used by the operating staff. There are local bodies, varying from small municipalities to big municipal corporations. It will be useful to categorise these local bodies as per their size - may be in 3 or 4 categories or as per the state government's definition. The category of the local body will determine the organizational structure - whether a separate water supply department exists and the number and quality of staff. It may be a good idea to define the SOP for each category separately.

Clarification by UMC: We have added the class-wise categorization of ULBs in Gujarat in the background section and the current engineering staff available in these cities to carry out water supply related functions.

I find Table 5 as the guideline, defining the tests, frequency and number of samples, for all categories of local bodies. It may be better to adopt a sample of each category of local bodies, with population as the guideline, and define the tests, sample size and frequency separately for this sample local body. A particular local body will refer to that specific guideline as per its actual size and prepare its specific guideline for the use of its operating staff in clearly understandable terms. Idea is to provide ready to use tables for the purpose.

Clarification by UMC: The CPHEEO provides a different monitoring regime (only for ground water sources) for three categories of cities (with population less than 50,000, population between 50,000 and 1 lakh and with population above 1 lakh). Even within these categories, the frequency of only one test (bacteriological testing at the ground water source) is relaxed for cities with population less than 50,000 (quarterly vs. monthly).The quality monitoring at surface sources or in the water distribution system is the same irrespective of the size of the city. UMC believes that all residents should have access to safe drinking water and all ULBs irrespective of their size, should follow the set water quality monitoring regime. Since there is not much difference in the frequency and regime according to CPHEEO standards, the most stringent standard should be followed by all cities. Since the bacteriological testing is manadated to be conducted only once in a month, smaller ULBs do not have to dedicate a whole lot of additional human resources or time to follow the given regime.

Whether there is a possibility of outsourcing some functions, particularly in smaller local bodies, can be indicated.

Clarification by UMC: Yes. Given the shortage of staff and resurces in smaller ULBs, routine water quality monitoring functions can be outsourced to a private agency. We have added that in the SOP.

UMC has done primary survey of Jetpur, Kathial and Lathi. It may be better to indicate the size of these towns, source of water, organization available for water quality monitoring and peculiar problems faced by these towns. Some indication of the quality of monitoring in relation to these problems will help in defining the emphasis to be laid in the surveillance.

Clarification by UMC: The study of water quality monitoring provedures in these cities has all these details and is available as a separate document. The document can be provided with this SOP as a reference.

Table 1 mentions that water quality monitoring does not apply to source of water. Is it because this job is being done by some other organization?

Clarification by UMC: Yes. Water testing at source does not apply for Kathlal and Lathi because they use ground water sources and the water is sent to WDS before supplying it to consumers. Water testing at ground water source is only carried out if there is direct pumping to consumer end. Samples should be collected and tested at the surface source in Jetpur. We have corrected the table for Jetpur accordingly.

It my be useful to provide explanation for abbreviations. (ex. RC on page 5, which perhaps is for Residual Chlorine.

Clarification by UMC: We have added a list of abbreviations.

I do not have the copy of O&M Manual of CPHEEO and so am not in a position to make comments related to schedule of testing more precisely. Whatever I felt after going through your draft has been mentioned above. Some suggestions may not also be full relevant, since I do not know the exact scope and the target user of this document.I congratulate you for bringing out these guidelines and regret that I am not of much help due to my handicaps.

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