Ministry of Housing and Urban Affairs
Government of India

Atal Mission for Rejuvenation and Urban Transformation
अमृत 2.0

Advisory on

PROTECTION OF WATER QUALITY

in DISTRIBUTION SYSTEM

Ministry of Housing and Urban Affairs | Government of India

Central Public Health & Environmental Engineering Organisation (CPHEEO)

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FOREWORD

Safe and reliable drinking water is essential for good public health, quality of life, and sustainable urban water supply systems. Under AMRUT 2.0, States and Urban Local Bodies are delegated to move towards water-secure cities by providing 24×7 piped water supply (Drink from Tap) to all households. To achieve this objectives, not only investment in infrastructure but strong institutional arrangement, operational & preventive measures, and continuous protection of water quality across the entire water supply chain is also required.

While significant progress has been made in augmenting infrastructures and experience across the cities indicates that deterioration of water quality often occurs within transmission, storage, and distribution systems due to ageing infrastructure, intermittent water supply, leakages, cross-connections, and gaps in operation and maintenance. It is essential to address these challenges for sustainable water supply and boost the public confidence in achieving the vision of 'Drink from Tap'.

An Advisory on '**Protection of Water Quality in Distribution Systems'** has been prepared to provide structured and practical guidance to Urban Local Bodies and other Stakeholders to prevent the contamination in piped water supply. The Advisory outlines the key causes of water quality deterioration, steps for preventive maintenance, water quality monitoring & testing facilities, field-level inspection tools, and time-bound response actions to prevent water contamination incidents in piped water supply systems.

The Advisory is intended to support cities in strengthening distribution system integrity, improving operational preparedness, and adopting a preventive, system-wide approach to water quality management. The advisory may guide the Implementing Agency to improve service reliability, enhance public health protection, and achieve 'Drink from Tap' objectives under AMRUT 2.0.

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Preface

AMRUT 2.0 envisages making cities water secure and mandates States and Urban Local Bodies to provide 24×7 water supply of 'Drink from Tap (DfT)' quality to households. The water at the outlet of the treatment plant meets the prescribed drinking water standards however, maintaining the same quality throughout the transmission, storage, and distribution systems up to the consumer end requires continuous vigilance and effective operational practices. Water distribution systems are particularly vulnerable to contamination due to ageing assets, leakages, intermittent water supply conditions, cross-connections, and inadequate maintenance.

The Advisory on '**Protection of Water Quality in Distribution Systems'** has been structured as an actionable guidance documentto assist the Urban Local Bodies and other Stakeholders in identifying the risks of contamination, preventive actions, and emergency response mechanisms to be adopted for providing safe drinking water through piped water distribution systems. The Advisory lays out the practical guidance on reason for water quality deterioration, avoid intermittent water supply, preventive measures to control contamination, water quality inspection checklist, immediate response on water contamination and water quality sampling, monitoring & laboratory coordination along with institutional arrangement.

It is my pleasure to acknowledge the efforts made by CPHEEO, particularly Dr. Ramakant & Ms. Sravanthi Jeevan, Deputy Adviser (PHE), and team member Mr. Naveen Daila in framing the Advisory. I believe this document may serve as an important supporting tool in adopting preventive and corrective measures, protecting public health, improving reliability, and building citizen's confidence in water supply systems. Let us work together to ensure for safe drinking water to every consumer, at all times.

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EXECUTIVE SUMMARY

Introduction

Provision of safe and reliable drinking water to every household is a key public service function of Urban Local Bodies. The water supplied to the households should consistently meet the prescribed drinking water quality standards. This requires regular attention not only at the treatment stage, but across the entire water supply systems including transmission, storage, and distribution. Recognising this, water quality can be influenced by infrastructure condition, operational practices, and system management and this Advisory presents a structured overview of key factors affecting water quality and outline the preventive measures to support Urban Local Bodies in maintaining safe drinking water at the consumer end.

Major Reasons for Water Quality Deterioration

Water quality catastrophes in urban piped water supply systems commonly arise due to:

- **Leakages, pipe bursts, and defective joints**, which create direct entry points for contaminated groundwater or sewage
- **Cross-connections and inadequate separation** between water supply and sewerage or drainage networks
- **Ageing and corroded pipelines**, increasing failure frequency and internal contamination
- **Stagnation and prolonged retention of water at** dead ends and low-demand zones, leading to disinfectant decay
- **Poor maintenance of reservoirs, valve chambers, and appurtenances**, allowing ingress of pollutants
- **Insanitary practices during repairs and new connections**, including lack of disinfection and open pipe exposure
- **Insufficient water quality testing and surveillance mechanism**, delaying detection of contamination.

Preventive Actions and Risk Mitigation Measures

To address the contamination of water in piped water supply systems, the preventive actions and risk mitigation measures are as under:

- Systematic identification of contaminant hotspots through pressure monitoring, complaint analysis, and network vulnerability assessment
- Active leak detection and timely repair programmes, supported by asset inventories and failure history analysis
- Strict maintenance of positive pressure across the distribution system with the support of zoning of network, DMA implementation, and pressure management
- Maintenance of adequate residual disinfectant throughout the network with routine monitoring at representative locations and booster disinfection wherever required
- Strict enforcement of pipeline separation norms between water supply and sewerage systems including protective measures at crossings and vulnerable locations
- Regular cleaning and disinfection of water storage facilities including service reservoirs and overhead tanks at household levels
- Planned flushing of distribution networks particularly at dead ends and low-demand zones to flush off stagnation and sediment build-up
- Safe sanitary practices during repairs and construction including disinfection, flushing, and documentation before restoration of water supply
- Prevention and regularisation of unauthorised connections controlled by proper inspections, enforcement, and public awareness
- Strengthening of sewerage and septage management practices near water supply infrastructure
- Periodic review of network health and infrastructure condition with phased replacement of ageing and high-risk assets and
- Capacity building and training to field staffs supported by standard operating procedures (SoP) and field-level checklists.

Water Quality Testing and Surveillance

Effective prevention of water quality deterioration requires a structured system of water quality monitoring, sampling, and laboratory surveillance across the entire water supply chain. The key elements include:

- Sampling at critical control points including water sources, inlets and outlets of water treatment plants, service reservoirs, DMAs, distribution networks, and consumer ends

- Defined sampling frequencies based on water source type, population served, seasonal variation, and system risk with differentiated protocols for surface water and ground water sources
- Monitoring of key parameters, covering microbiological, physical, chemical, and disinfectant indicators including source-specific and location specific contaminants as per BIS guidelines
- Routine water testing at water treatment plants with daily monitoring of general and microbiological parameters and periodic testing of metals and source-dependent parameters, including blended water sources
- Surveillance within water distribution systems including service reservoirs, DMA extremities, and representative network locations with sampling frequency linked to population and system size.
- Provision of NABL-accredited laboratory facilities based on population served, with State-level laboratories catering to multiple ULBs and ULB-level central, basic, or mobile laboratories established in accordance with system size and monitoring load.
- Strengthening of water testing laboratory networks including State laboratories, ULB laboratories, mobile laboratories, and empanelled NABL accredited private laboratories where required
- Defined turnaround times with chemical test results reported within 24 hours and microbiological results within 48 hours and
- Use of mobile and field-testing tools for rapid assessment in high-risk, remote, or emergency situations, supported by data-driven decision-making support systems.

Overall, the Advisory is intended to support Urban Local Bodies in adopting a preventive, system-wide approach to drinking water quality management, thereby reducing contamination incidents, protecting public health, and improving reliability and trust in municipal water supply systems.

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1 Water Quality and Its Importance

Safe drinking water refers to potable water that complies with prescribed physical, chemical, microbiological, and radiological standards at the point of consumption. Compliance at the outlet of the water treatment plant alone does not ensure safety unless water quality is maintained throughout the transmission line, service reservoirs, and distribution systems up to the consumer end.

Inadequate management, monitoring, and surveillance of water supply and sanitation systems significantly increase the risk of contamination exposing urban populations to preventable health risks. Surveillance to ensuring safe drinking water at the consumer end cannot only be limited to water treatment plant performance alone, it extends to include operation & maintenance of transmission systems, service reservoirs, distribution networks, and house service connections.

The severity of health impacts depends on multiple factors including the type and concentration of contaminants, duration of exposure, and individual susceptibility. Certain location-specific contaminants such as fluoride, arsenic, or iron may require specific treatment interventions and should be addressed at the planning stage to ensure long-term compliance.

The transmission of diseases such as dysentery, cholera, diarrhoea, polio, typhoid etc are associated with the contaminated water supply to the users some of Contaminant and associated disease given in **Annexure-I**. Failure to maintain drinking water quality may result in public health emergencies, service disruptions, loss of public confidence, and administrative or legal consequences. Urban Local Bodies (ULBs) are therefore required to establish effective institutional arrangements for water quality surveillance, timely corrective & preventive actions, and transparent communication to increase the acceptability of pipe water supply by the citizens.

Drinking water quality management in urban areas is governed by standards and guidelines issued by the Bureau of Indian Standards (BIS), IS 10500:2012 and its amendment from time to time.

Water quality testing for compliance and regulatory reporting should be conducted in NABL accredited laboratories conforming to ISO/IEC 17025 to ensure accuracy, reliability, and traceability of test results. Water sampling procedures should follow the protocols outlined in the Manual on Water Supply and Treatment Systems (Drink from Tap), March 2024, published by Central Public Health and Environmental Engineering Organization (CPHEEO), which covers the selection of representative sampling points, sample collection, preservation, transportation, and documentation. Adherence to standard sampling procedures is essential to ensure that laboratory test results truly reflect the quality of water supplied to the consumers.

The principal reference standards include:

- IS 10500:2012 Drinking water – specification, prescribing acceptable and permissible limits for drinking water quality parameters
- IS 3025: Methods of Sampling and Test (Physical and Chemical) for Water and Wastewater.

1.1 Maintaining water quality across the system

To ensure the quality throughout the water supply system, monitoring of water supply systems at strategic locations, which are as under, is most important.

Source Protection	• Control pollution at raw water source • Protect catchments and wellhead zones
Treatment Adequacy	• Design systems to meet quality (IS 10500:2012) • Review performance for seasonal variations
System Disinfection	• Ensure effective disinfection in the systems • Provide continuous protection in water distribution
Residual Chlorine	• Maintain minimum residual chlorine at consumer • Prevent microbiological contamination at tail end
Distribution Integrity	• Maintain positive pressure in pipelines • Prevent leaks, stagnation and contamination
Water line–Sewer Interface	• Maintain prescribed separation norms • Prevent cross-contamination risks

1.2 Operational considerations for sustained water quality

Detailed engineering design for water supply systems based on DMA approach should account for present and anticipated variations in physical, chemical, biological, and radiological quality parameters. This incorporates appropriate treatment provisions, separation of water supply pipelines with sewer lines, and appropriate monitoring mechanism. The picture depicts DMA based planning approach for better operation & maintenance of water supply systems.

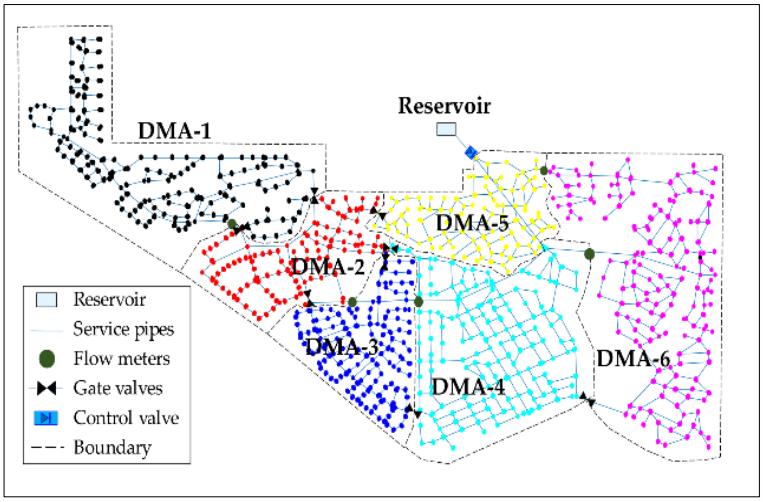


Figure 1: Representation of planning, design of water supply system

The flow chart given below depicts preliminary planning, design and operation and maintenance of water supply systems for better water quality.

Planning and Design Measures

- Encourage continuous pressurised water supply to prevent ingress of contaminated water through defective joints.
- Intermittent water supply increases the risk of negative pressure and contamination of water.
- Mandatory maintaining horizontal and vertical separation between water and sewer lines.

Pipe Material Selection

- Pipe should be strong enough to withstand external and internal pressure without any damage.
- Pipe material or inner lining material should be suitable for human health application.
- Pipes, joints, fittings, and appurtenances should conform to applicable BIS standards.

Operation and Maintenance Measures

- Active leakage or pipe burst detection should be repaired promptly.
- A residual chlorine (0.2 mg/l) should be maintained at the consumer end.
- Periodic cleaning and disinfection of water storage infrastructure should be carried out.
- Pipelines should be thoroughly disinfected after repair works and prior to resumption of water supply.

1.3 Separation norms between water supply and sewerage systems

- Sewer lines should be laid below water supply pipelines in accordance with prescribed separation norms.
- Sewer pipes and joints should be watertight to prevent leakage of sewage into surrounding soil and water mains.
- Leakages, overflows, and surcharging of sewer lines in proximity to water mains should be identified and rectified promptly.
- Manholes located near water pipelines should be properly sealed, covered, and maintained to prevent infiltration and exfiltration.

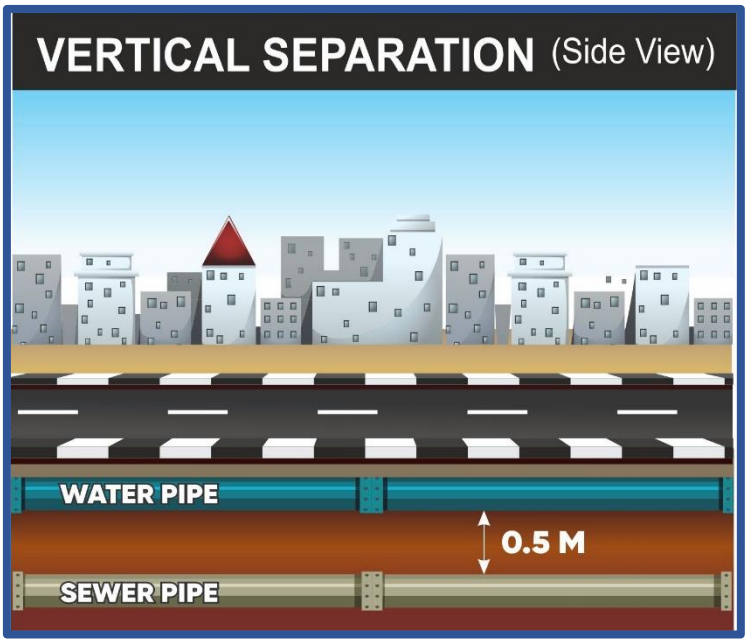
Horizontal separation:

A water main should be laid with at least 3.0m of horizontal separation from an existing or prospective drain or sewage line.

If 3.0m horizontal separation is not achievable, then the water pipeline should be internally lined and properly encased.

Vertical separation:

When water mains cross a lateral sewer line, storm drain, or sanitary sewer, the bottom of the water main is 0.5m above the top of the drain or sewer.

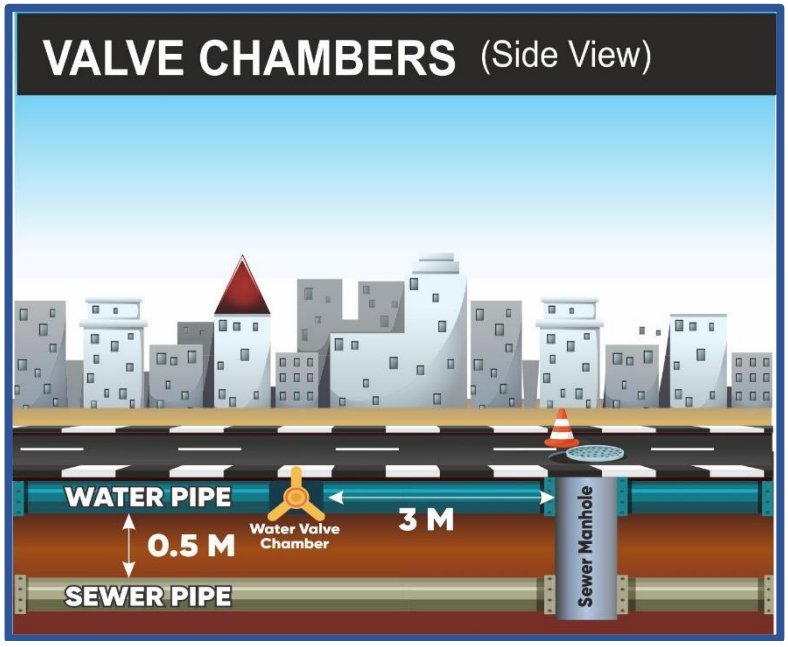


Crossings:

This vertical separation should be maintained for a distance of 3.0m on both sides, measured normal (perpendicular) to the sewer or drain it crosses.

Valve and Appurtenances:

Water valve should be placed at horizontal distance of 3.0m from the sewer manhole. These should be constructed to be watertight to prevent ingress of polluted water in water pipeline.

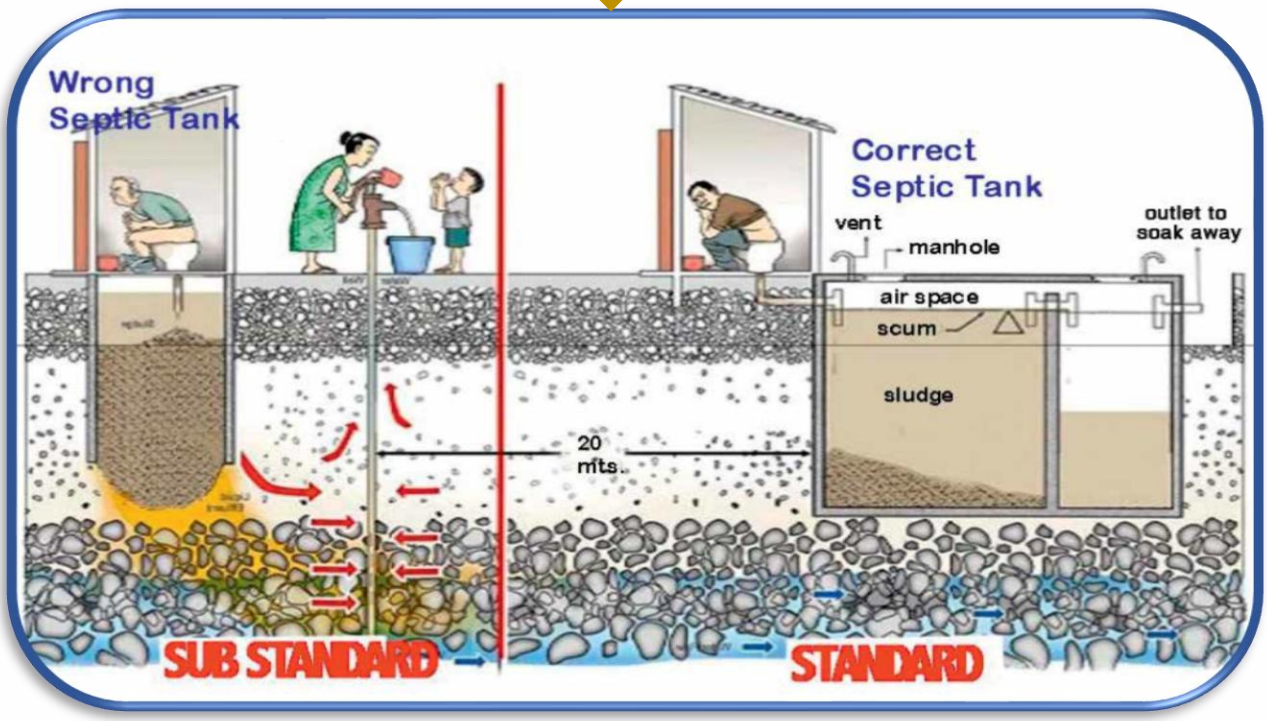


For further detailed guidance, Chapter 7 of Part-A **and** Chapter 8 of Part-B of the *Manual on Water Supply and Treatment Systems (Drink from Tap), March 2024*, published *by CPHEEO* may be referred to

1.4 Location of handpump versus septic tank

Septic Tanks and Hand pumps

Septic tanks and soak pits should be located at safe distances (min. 20 m) from handpump to avoid contamination of water, as depicted below.



For detailed guidance on septage management, “Advisory Note on Septic Management in Urban Areas” 2013, and “Advisory on Faecal Sludge and Septage Management in Small and Medium towns”, 2024 may be referred to.

2 Reasons for Water Quality Deterioration

Despite the compliance of drinking water standards at water treatment plant, deterioration of water quality frequently occurs within the distribution system.

In most of the urban areas, contamination of water incidents are not only caused due to treatment failure, but also a combination of ageing infrastructure, operational lapses, and interface issues with sewerage systems.
With the understanding of these causes, it is essential for early detection, timely prevention, and effective response to the failure incidents.

2.1 Leakages, pipe bursts, and defective joints

Leakages and pipe bursts create direct pathways for contaminated water, sewage, or storm water to enter into the water distribution system, particularly when pipelines are located in polluted or waterlogged environments.

Common reason of leakages and contamination:

Figure 2: Representation of pipe leakage, pipe burst and defective joint

- Pipe burst due to corrosive or aged pipeline.
- Leakages caused due to improper or weak joints in the pipeline.
- Leakages and contamination through defective joints.
- Sudden pressure surge(water hammer) also results in pipe leakages.

2.2 Cross-connections with sewerage and drainage systems

Cross-connections between water pipelines and sewerage network or drainage systems, whether permanent or temporary, is one of the most serious threat to the quality of potable water and its safety.

Figure 3: Cross connection of water supply with storm water drain and sewerage line

These may occur due to:

- Proximity of water pipelines to sewer or stormwater lines without adequate separation measures.
- Inadequate protection or no casing of water pipeline at drain crossings.

2.3 Ageing infrastructure, corrosion, and structural failure

A significant portion of urban water supply infrastructure including distribution network has exceeded its design life.

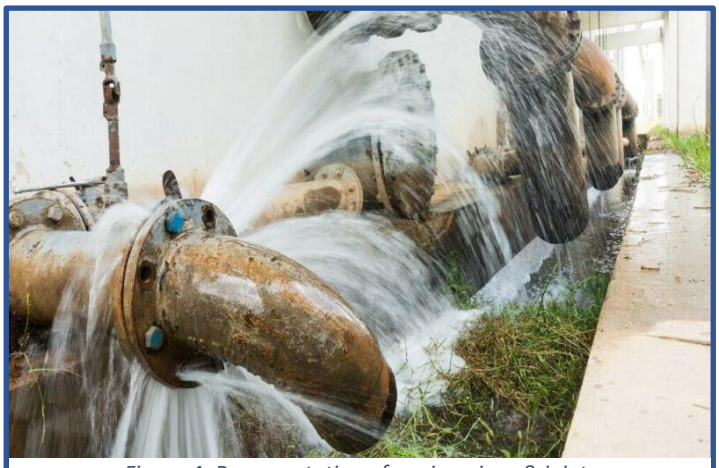


Figure 4: Representation of ageing pipes & joints

Common issues include:

- ageing storage reservoirs exhibits structural degradation leading to seepage and potential ingress of contamination
- Internal corrosion of metallic pipelines leading to tuberculation and leakage.
- Structural failure of brittle pipes or ageing pipelines.
- Reduced hydraulic capacity resulting in stagnation and pressure loss in pipeline.

2.4 Stagnation and prolonged retention of water in distribution lines

Dead-end sections and low-demand zones lead to stagnation and prolonged retention of water within the distribution pipelines.

This results in:

- Decay of residual disinfectant.
- Increased risk of microbial re-growth.
- Accumulation of sediments and biofilms.

2.5 Poor maintenance of reservoirs and valve chambers

Service reservoirs, overhead tanks, and valve chambers are critical control points from water quality point of view in the water supply system.

Figure 5: Poorly maintained valve chamber

Water quality deterioration may occur due to:

- Infrequent cleaning and disinfection of reservoirs.
- Damaged or missing covers allowing ingress of dust, animals.
- Waterlogging and sewage accumulation around valve chambers.
- Non-watertight construction or broken masonry.

2.6 Insanitary practices during repairs and new connections

Repair and construction activities pose a high contamination risk when sanitary protocols are not followed.

- Leaky or improperly joined pipes, poorly sealed manholes, and incorrect pipe alignment
- Low-quality pipes, fittings, or seals can corrode, crack, or fail, allowing contaminants to infiltrate the water system over time
- Connecting pipes without proper flushing after installation

Figure 6: Water pipeline laying openly in nallah

2.7 Inadequate sewerage maintenance near water mains

Poorly maintained sewerage systems significantly increase the risk of water supply contamination.

Critical issues include:

- Sewer leakages and exfiltration near water pipelines
- Backflow causing sewer overflows, sewage finding its way into valve chambers

Figure 7: overflowing sewerage manhole

2.8 Septage management failures and risk of cross-contamination

Figure 8: Representation of wrong septic tank practices

Improper management of septic tanks, soak pits, and other on-site sanitation systems pose a significant risk to drinking water, especially when located near boreholes, tube wells, hand pumps or water distribution pipelines.

Leaks, overflows, or delayed desludging of onsite sanitation systems can allow faecal contamination to the nearest water source. Pipelines with leaks or operating under low/ negative pressure are particularly vulnerable to ingress the pollutants.

2.9 Risks of intermittent supply

Intermittent water supply is a major contributor to water quality deterioration in urban water distribution systems.

Intermittent water supply causes:

- Negative pressure created within the pipelines.
- Contaminants present in surrounding soil, drains, or sewer lines sucked into the pipelines through leaks or joints.
- Water with high turbidity (muddy water) and contaminants flow in pipe lines.

2.10 Illegal or unauthorized connections

Illegal house service connections often create poorly sealed joints and cross connections allowing sewage or contaminants to enter into the water supply system.

A ferrule, if poorly installed or maintained, can act as a weak point in the pipeline, creating a direct entry path for contaminants into the water supply pipelines.

Such illegal connections bypass regular supervision, increase the risk of contamination of drinking water.

2.11 Lack of adequate disinfection

Inadequate or irregular disinfection allows to survive disease-causing microorganisms or regrow in the water supply system.

Key contributing factors:

- Under-dosing or irregular application of disinfectants.
- Failure of chlorination equipment or poor chemical handling.
- Absence of booster disinfection in long networks or low-pressure networks.
- Inadequate monitoring of residual chlorine/ disinfectant at consumer end

2.12 Lack of adequate water quality testing

Lack of systematic water quality monitoring at prominent location prevents early detection of contamination and delay in adopting corrective actions. When sampling is poorly distributed or not as per the procedures, contamination of water quality may go unnoticed until public health impacts occur.

Common gaps include:

- Insufficient sampling frequency and coverage across supply zones.
- Limited testing at distribution and consumer-end points.
- Inadequate laboratory facilities or delay in test results.
- Poor analysis of record/ data for operational decision-making systems.

3 Preventive Measures to Control Contamination

Ensuring safe drinking water is not just about treatment, it requires systemic preventive measures that address planning, design, operation, and routine maintenance of the entire water supply chain. The following measures are rooted in global water safety planning principles and field evidence from distribution system research and practice.

3.1 Identification of hotspots for contamination of water supply

Water quality deterioration often originates at specific vulnerable location within the distribution network. These hotspots require focused attention to prevent contamination from spreading system-wide. Regular hotspot identification enables targeted monitoring and preventive maintenance.

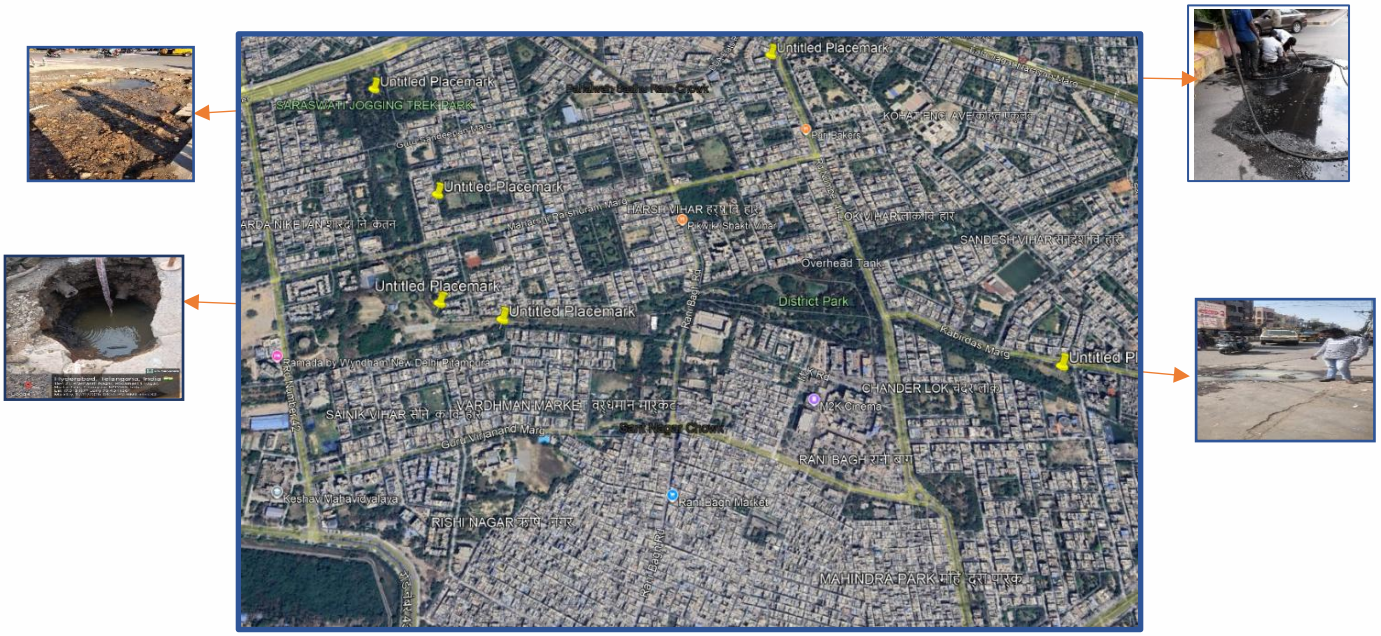


Figure 9: Representation of contaminated water supply hotspots

Preventive actions:

- Identify low-pressure zones, tail-end areas, and locations with recurring complaints.
- Focus on areas with frequent sewer overflow complaints.
- Map sections with frequent pipe bursts, valve failures, or illegal connections.
- Prioritise water zones close to sewer lines, drains, or flood-prone areas.
- Rank vulnerability using historical water quality, pressure, and failure data.

3.2 Arresting leakages from pipes & valves

Leakages are a primary pathway for contamination, especially under fluctuating pressure conditions in intermittent water supply systems. Undetected leaks compromise both water quality, water loss and system integrity.

Preventive actions:

Effective leakage control reduces intrusion of contaminant and preserves disinfectant residuals.

- Conduct periodic leak detection surveys using acoustic, pressure, and flow analysis methods.
- Maintain valves, joints, and fittings to ensure leak-tight operation.
- Establish response timelines for repair based on leak severity and location.
- Maintain records of failures to guide for future breakdown rehabilitation.
- Maintain optimum pressure in distribution system

Figure 10: Arresting of joints leakage

3.3 Regular maintenance of sewer and manhole

Defective sewerage infrastructure located near water pipelines poses a high contamination risk, particularly during overflows or surcharge conditions.

Preventive actions:

Well-maintained sewerage systems are essential for protecting potable water quality and water networks.

- Inspect sewer pipelines and manholes near water mains for leakage or structural damage.
- Promptly address blockages, overflows, and exfiltration of sewer.
- Ensure intact & sealed manhole cover, and not submerged during rainfall.
- Coordinate sewer repairs team with water supply team to protect adjacent pipelines.
- Take up periodic cleaning of sewers

Figure 11: Maintenance work of sewer manholes

3.4 Monitoring and maintenance of residual chlorination

Residual disinfectant/ chlorine provides continuous protection against microbial growth and minor ingress of contaminants within the distribution system.

Figure 12: Representation of staff checking residual chlorine kits and household level chlorine test

Preventive actions:

Consistent monitoring of residual disinfectant/ chlorine strengthens the microbiological safety barrier in distribution network.

- Monitor residual chlorine at water treatment plant, service reservoirs, and consumer end.
- Ensure compliance with minimum residual levels prescribed under IS 10500:2012 and its amendment time to time.
- Implement booster chlorination in zones in case of rapid residual decay.
- Recording and review trends to identify system weaknesses.

3.5 Check for minimum residual pressure

Positive pressure throughout the distribution network is critical to prevent ingress of contaminated water through leaks or defective joints.

Preventive actions:

Maintaining adequate pressure in water pipeline is a key hydraulic safeguard for water quality.

- Monitor pressure levels across the zones.

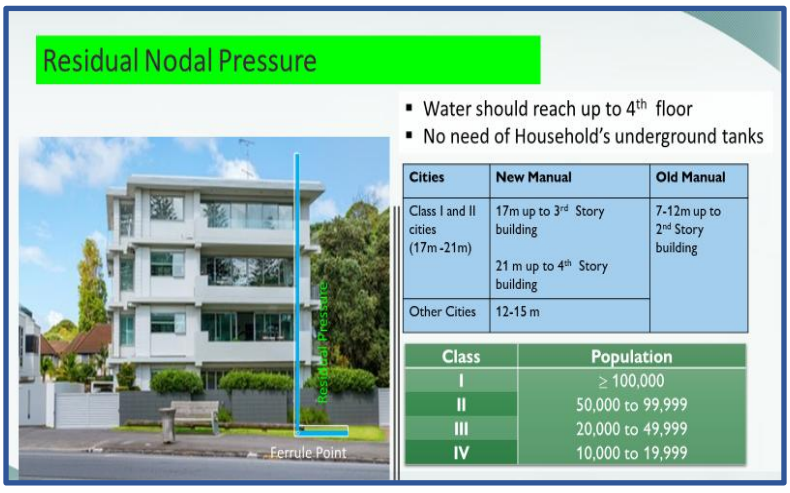


Figure 13: Representation of tail end pressure

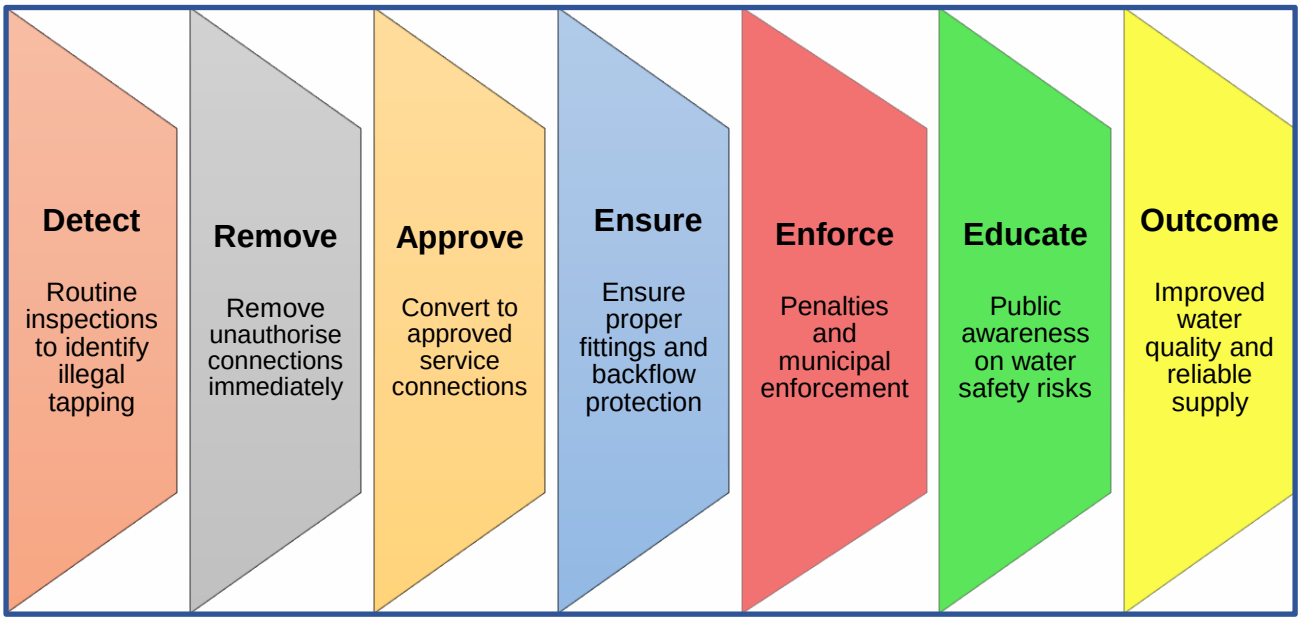
- Investigate abnormal pressure drops or fluctuations.
- Optimise pumping schedules and reservoir operations.
- Install pressure & flow control devices, wherever required.

3.6 Prevention of unauthorised connections

Illegal connections often introduce cross-contamination risks due to poor workmanship and absence of backflow protection.

Preventive actions:

Control of illegal connections not only monitor water theft but also protect water quality, water loss and increase in system reliability



3.7 Training of staff on safe water supply

Human factors play a critical role in maintaining safe water supply systems. Trained staffs are essentially required for effective operation and preventive maintenance. Well-trained personnel reduce operational errors and response delays.

Preventive action:

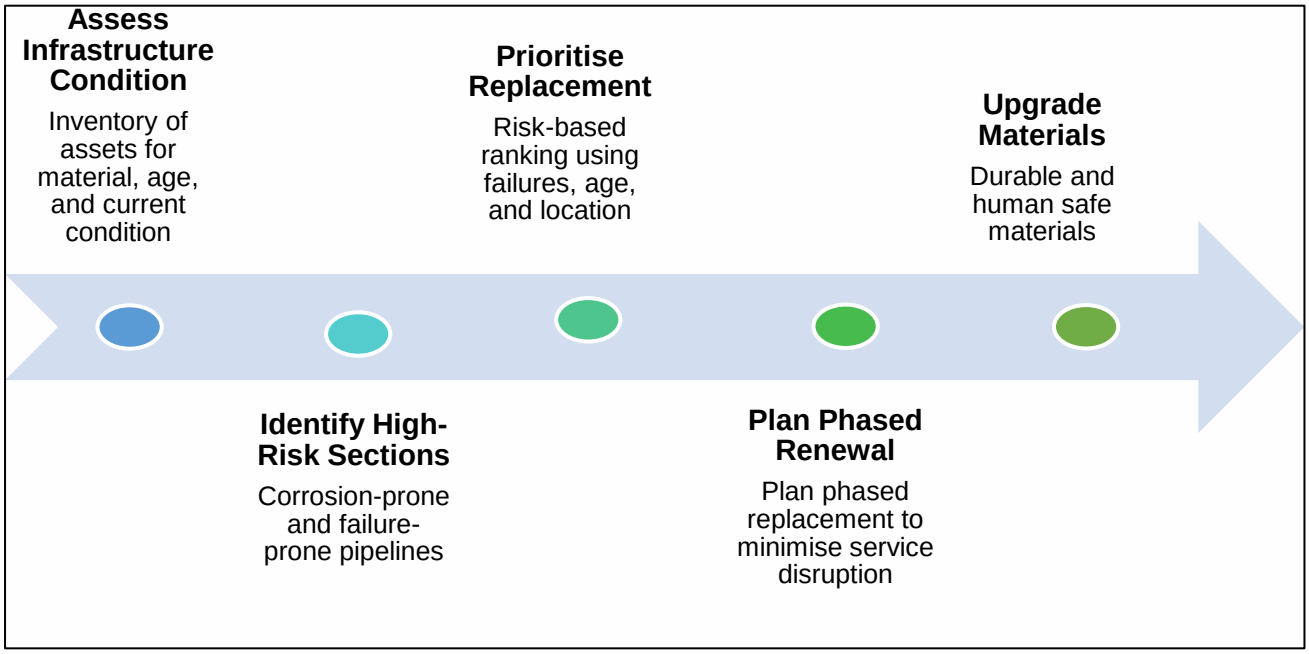
- Training to field staff on water quality risks and contamination pathways.
- Skill development related to chlorination, pressure management, and repairs.
- Conduct refresher training on emergency response procedures.
- Promote documentation on breakdown, failure, corrective & preventive actions and reporting discipline.

Figure 14: Staff training programme

3.8 Assessment of water supply infrastructure and planned replacement

Ageing and deteriorated pipelines increase leakage frequency and contamination vulnerability in the water distribution systems.

Preventive actions:



3.9 Conversion of intermittent to continuous water supply

Intermittent supply increases contamination risk due to vacuum creation during non-supply pressurised water in the pipelines.

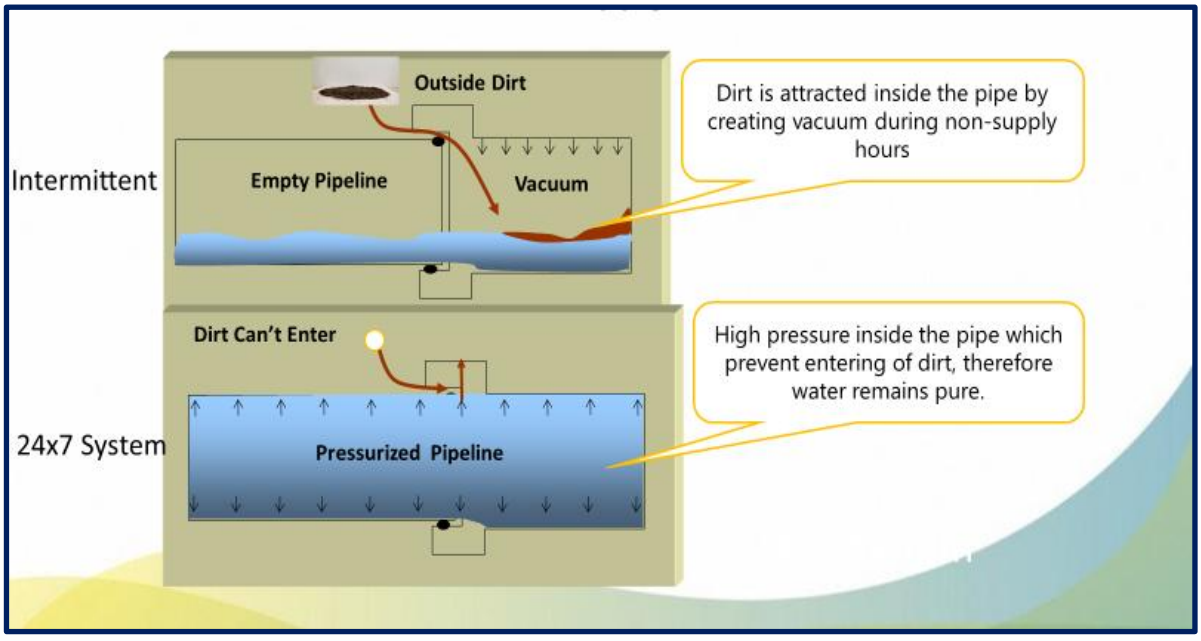


Figure 15: Representation of intermittent vs 24x7 water supply system

Preventive actions:

Continuous water supply is a long-term preventive solution for water safety.

- Gradually convert intermittent systems to continuous pressurised water supply systems.
- Strengthen network integrity before transition / conversion.
- Manage demand and NRW to support continuous water supply operation.
- Monitor water quality during and after conversion.

3.10 Pre-Monsoon preventive maintenance planning

Monsoon conditions significantly increase contamination risk due to flooding, sewer overflows, and pressure disturbances.

Preventive actions:

Pre-monsoon preparedness reduces emergency incidents during the rainy season.

- Inspect vulnerable pipelines, joints, valves, and storage structures.
- Repair defects before the onset of heavy rainfall.
- Desilt and clean drains to avoid flooding and back flow.
- Prepare emergency response and standby arrangements.

3.11 Infrastructure asset mapping

Accurate system information is fundamental for preventive maintenance and coordinated planning. Asset mapping enables informed and timely interventions.

Preventive actions:

- Develop GIS-based maps of water supply along with sewer, and septage infrastructure.
- Record of asset condition, failure history, and maintenance actions.
- Update the records after repairs and modifications in infrastructure.
- Use of maps to identify overlaps and risk zones.

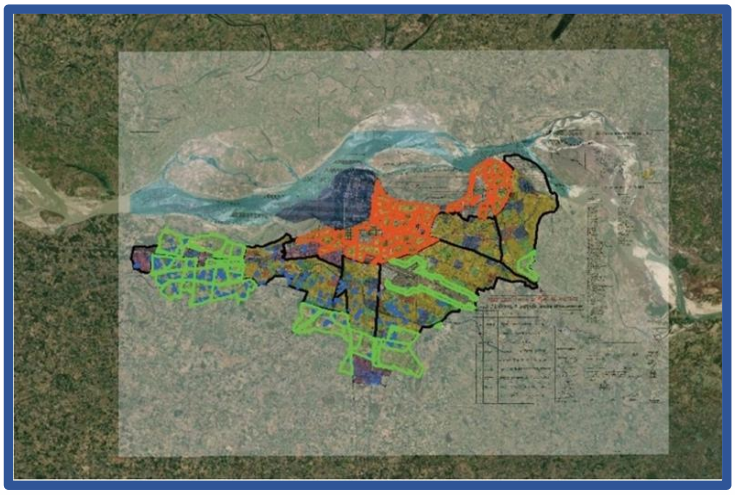


Figure 16: Representation of GIS mapping

3.12 Protection of water supply infrastructure

Protection of critical water supply assets such as service reservoirs, pumping station, treatment plants, and valve chambers is essential to prevent accidental contamination and physical damage. Proper physical security reduces public health risks and improves operational reliability.

Figure 17: Fencing of UGR

Preventive actions:

- Provide compound walls or security fencing of adequate height around reservoirs, pump houses, and treatment facilities.
- Restrict access to avoid unauthorised entry.
- Install adequate lighting within reservoir/ pumping station premises.
- Display clear and visible warning signage such as “No Entry” and “Authorised Personnel Only”.
- Conduct regular inspection and maintenance of walls, fencing and gates.
- Deploy guards/ CCTV for basic surveillance.

3.13 Scheduled cleaning and disinfection of storage facilities

Service reservoirs and storage tanks can become sources of contamination if not periodically cleaned and disinfected. Stagnation, sedimentation, or animal intrusion can degrade the water quality.

Figure 18: Reservoir cleaning in progress

Preventive actions:

Operational guidelines emphasise the importance of preventing stagnation and microbial growth through these practices.

- Clean reservoirs and overhead tanks at least twice a year.
- Inspect covers, vents, ladders, and inlets for sanitary integrity.

- Disinfect storage structures after cleaning and before returning to service.
- Monitor residual chlorine levels at inlet and outlet points.

3.14 Planned flushing of distribution networks

Flushing removes sediments and biofilms that can harbour microbes and reduce disinfectant effectiveness, especially in dead ends and low-flow zones. Flushing accelerates the removal of aged water, reducing disinfectant decay and minimizing stagnation risks.

Preventive actions:

- Schedule routine flushing for dead ends with high complaints.
- Coordinate flushing with monitoring data to target problem areas.
- Record flushing outcomes and update network health maps.

3.15 Safe practices during repairs and construction

Construction and repairing activities themselves can introduce contaminants if not properly controlled.

Preventive actions:

Good documentation supports accountability and trend analysis.

Figure 19: Repair and construction work with proper PPE kits

- Ensure proper repairing as per guidelines.
- Adopt safety precautions to avoid accident.
- Adopt PPE kits near construction works.
- Disinfect and flush repaired sections before reconnecting to the network.
- Use clean tools and ensure workers follow sanitary practices.
- Document all repair work and water quality outcomes.

3.16 Interdepartmental coordination

Integrated planning and coordination among various department minimizes risks arising from activities in adjacent infrastructure systems. Effective coordination aligns preventive maintenance with broader sanitation and stormwater strategies.

Preventive actions:

- Share work plans across departments before excavation or repairs.
- Examine impact of septage disposal activities near pipeline or water source corridors.
- Conduct joint inspections of utility corridors to eliminated anticipated risk zones.

3.17 Leak Detection

Undetected leakages in water distribution systems not only lead to water losses but also create direct pathways for the ingress of sewage, especially under low-pressure or intermittent water supply conditions. Proactive leak detection is therefore a preventive measure for protecting water quality.

Preventive actions:

- Implement regular leak detection surveys using acoustic tools, pressure monitoring, and flow analysis devices.
- District Metered Areas (DMAs) based planning to identify abnormal water loss.
- Using pressure and night-flow data to detect hidden or emerging leaks
- Prioritise repair of detected leaks where water pipeline is in proximity to sewer line.
- Maintaining records of leak locations and recurrence to frame rehabilitation plan.

3.18 Water quality Testing

Regular and systematic water quality testing is essential to ensure the effectiveness of treatment and disinfection in water supply systems. Continuous surveillance enables early detection of deterioration and supports timely corrective action before public health risks arise.

Preventive actions:

- Conduct routine water quality sampling at source, treatment plant outlet, service reservoirs, and consumer end.
- Monitor key physical, chemical, and microbiological parameters as per IS 10500:2012 and its amendment from time to time.
- Increase sampling frequency in vulnerable zones, tail-end areas, and after repair works complete.
- Ensure timely analysis through NABL accredited laboratories.

3.19 Periodic network health and vulnerability review

A proactive maintenance programme requires periodic assessment of system integrity. Preventive maintenance informed by data leads to better resource allocation and fewer emergency responses.

Preventive actions:

- Analyse pressure, quality, and complaint data to identify trends.
- Map vulnerability zones based on age, material, and past incidents.
- Upgrade targeted assets before failure occurs.
- Use data analytics and digital tools to support predictive maintenance.

Figure 20: Network health assessment process

3.20 Alternative and supplementary disinfection methods

Chlorine is widely used as chlorination agent. However, supplementary approaches can improve protection under specific conditions. Secondary disinfectants may help in challenging distribution environments.

Preventive actions:

- Evaluate suitability of chlorination for stable residuals.
- Explore UV treatment wherever applicable.
- Consider multi-barrier disinfection strategies tailored to local risks.

3.21 Field-Level initiatives

Public Display of Water Quality Parameters

- Public display of water quality parameters aims to ensure transparency and accountability of the supplied water.
- Real-Time water quality parameters displayed helps in building public confidence.

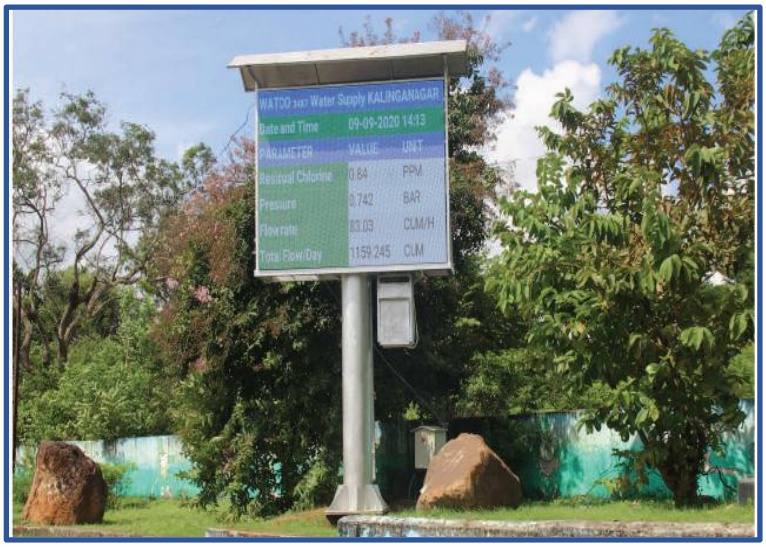


Figure 21: Display of water quality parameters

3.22 Water quality & preventive maintenance inspection checklist

Urban Local Body : _____
Zone / Ward : _____
Supply Zone / DMA : _____
Date : _____
Inspected by (Name & Designation) : _____

Daily Water Quality Checklist:

S. No.	Indicator	Status (OK / Not OK)	Remarks
1	Water is clear and free from visible turbidity		
2	No abnormal colour observed (yellow / brown / black / milky)		
3	No foul, sewage-like, or chemical odour		
4	No unusual taste reported by consumers		
5	No floating matter, oil film, or sediments		
6	Residual chlorine present at consumer end		
7	Residual chlorine ≥ 0.2 mg/l under normal conditions		
8	No complaints of low pressure or intermittent supply		
9	No active pipe leakage or burst in the locality		
10	No sewer overflow or manhole surcharging near water mains		
11	Valves and hydrants intact and not leaking		
12	Consumer complaints register reviewed		

Periodic Water Quality Checklist:

S. No.	Indicator	Status (OK / Not OK)	Remarks
1	Residual chlorine ≥ 0.5 mg/l during high-risk periods		
2	Bacteriological samples collected from consumer end		
3	E. coli / thermotolerant coliform absent in latest report		
4	Chemical parameters as per IS 10500: 2012		

5	Service reservoir cleaned and disinfected		
6	Valve chambers inspected and found watertight		
7	Dead-end flushing carried out		
8	Recent repair works disinfected before recommissioning		
9	Sewer lines near water mains checked for leakage		
10	Pressure conditions reviewed and found satisfactory		

Prescribed Frequency for Periodic Checks:

Activity	Recommended Frequency
Residual chlorine monitoring	Daily at consumer end
Bacteriological sampling	Weekly (small systems) / Fortnightly (large systems)
Chemical water quality testing	Quarterly
Service reservoir cleaning and disinfection	Once in 6 months (minimum)
Valve chamber inspection	Monthly
Dead-end flushing	Monthly or as required
Network integrity review	Quarterly
Sewer inspection near water mains	Monthly and after heavy rainfall

Trigger Conditions Requiring Immediate Action:

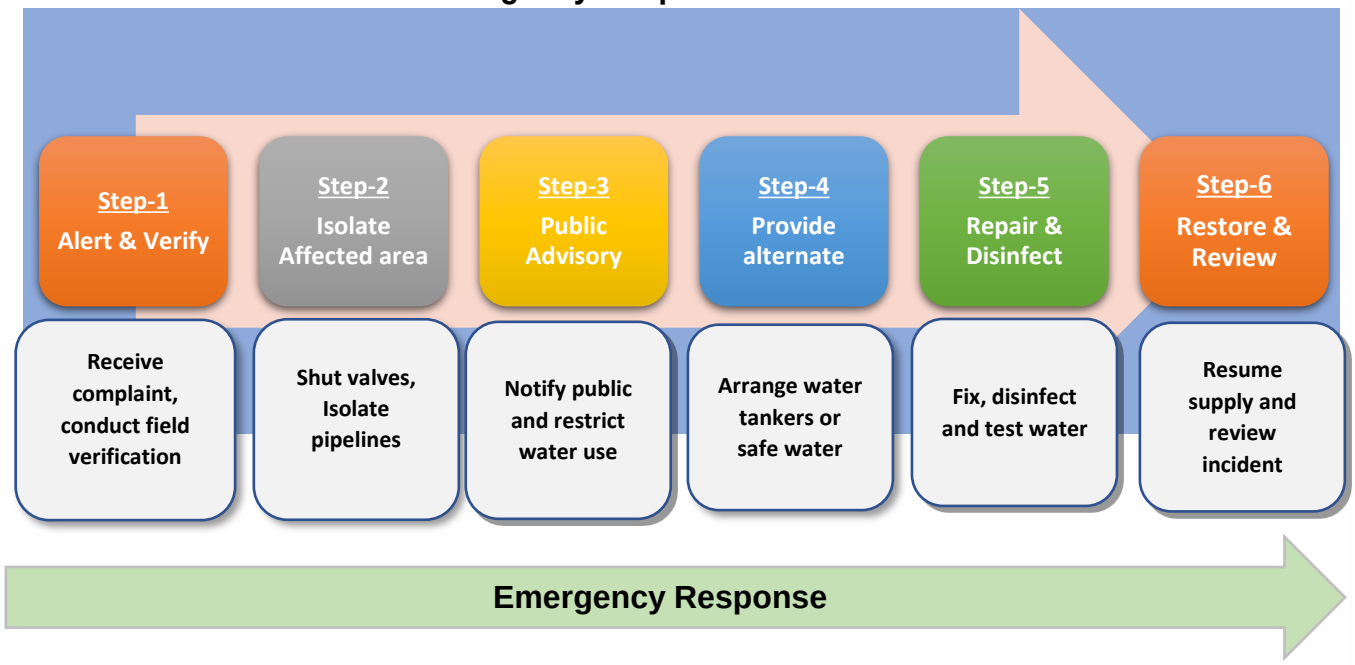
S. No.	Trigger Condition	Status	Remarks
1	Zero or very low residual chlorine at consumer end		
2	Presence of E. coli / coliforms in any sample		
3	Sewage smell or visible contamination in water		
4	Sudden increase in complaints from a locality		
5	Pipe burst or repair work near sewer line		
6	Prolonged low-pressure or negative-pressure condition		

4 Immediate Response on Water Contamination

Timely and structured response to water contamination incidents is critical to protect public health and restore consumer confidence. Any delay or uncoordinated action can result in rapid spread of contamination through the distribution system, escalation of health risks, and administrative liability for the Urban Local Body.

A step-by-step response framework to be followed immediately upon detection or suspicion of contamination.

Emergency Response Flowchart



4.1 Field verification and confirmation of contamination

Upon receipt of complaints, laboratory alerts, abnormal chlorine readings, or reports from health authorities, immediate field verification should be undertaken.

Actions include:

- Reported site inspection and adjoining areas.
- Ascertain the kind of contamination (chemical, biological or others).
- Collection of confirmatory water samples as per IS 3025 protocols.
- On-site testing for residual chlorine, turbidity, colour, and odour.
- Review of recent field conditions like repair works, pipe bursts, sewer overflows, or pressure drops.

4.2 Isolation of affected area or supply zone

Once contamination is confirmed or strongly suspected, the affected area should be isolated without delay.

Actions include:

- Identification of the smallest possible isolation zone using valves and DMA boundaries.
- Immediate closure of isolation valves to prevent further spread of contamination.
- Suspension of supply to the affected areas, if required.
- Ensuring isolation does not cause backflow or negative pressure in adjoining zones.

4.3 Public advisory and risk communication

Clear, timely and accurate communication is essential to prevent consumption of contaminated water by the consumer.

Actions include:

- Issue immediate public advisory through local media, SMS, ward offices, and public announcements.
- Clearly specify affected areas, nature of risk, and precautionary measures.
- Advise boiling of water or avoidance of consumption as far as possible.
- Coordinate messaging with the Health Department to ensure consistency.

4.4 Arrangement of alternate safe water supply

Safe alternate water supply should be arranged for the affected population without further delay.

Actions include:

- Deployment of water tankers from verified safe water sources.
- Provision of packaged drinking water for vulnerable institutions like hospitals and affected population.
- Ensuring disinfected tanker's water fitted with sealed delivery systems
- Maintain minimum quantity norms and equitable distribution in the affected areas.

4.5 Repair, rectification and disinfection measures

The root cause of contamination of water should be addressed on priority.

Actions include:

- Repair of pipe leaks, bursts, defective joints, or cross-connections.
- Rectification of sewer overflows or manhole defects near water mains.
- Replacement of damaged pipe sections wherever identified.
- Replacement of damaged pipe sections wherever identified.
- Thorough disinfection of repaired pipelines using approved chlorination procedures.
- Removal of illegal connections if found.

4.6 Flushing and restoration of supply

Before restoring water supply, the affected pipelines should be systematically flushed.

Actions includes:

- High-velocity flushing from upstream to downstream ends.
- Removal of stagnant water, sediments, and disinfectant residues.
- Monitoring of residual chlorine at multiple points during and after flushing.
- Restoration of water supply should be gradual to avoid pressure shocks and re-suspension of deposits.

4.7 Enhanced monitoring and clearance protocol

Enhanced water quality monitoring should be undertaken post-restoration.

Requirements include:

- Repeated water sampling for bacteriological and chemical parameters.
- Verification of residual chlorine at strategical locations and particularly at consumer end.
- Minimum two consecutive satisfactory test results before clearance.
- Increase sampling frequency for a defined surveillance period.

4.8 Conditions for resumption of normal supply

Normal water supply should be resumed only when all the following conditions are satisfied:

- Source of contamination has been fully eliminated.
- Distribution system integrity has been restored.
- Residual chlorine levels are stable and compliant.
- Bacteriological samples show no contamination.

5 Water Quality Sampling, Monitoring, and Laboratory Coordination

Water quality sampling and monitoring are essential for ensuring that treated water supplied through the distribution system consistently meets prescribed drinking water quality standards. A structured monitoring framework enables early detection of contamination, assessment of system performance, and timely corrective action. Effective coordination with laboratory facilities is critical for reliable testing, data interpretation, and regulatory compliance.

Water Quality and Sampling

The methodology of sampling and other details essential for water quality monitoring during the operational phase of a water supply project are provided hereunder

It is recommended to provide the following critical points to assess the water quality:

i) At the water source intake/tube well;
ii) At the inlet and outlet of water treatment plant;
iii) At the inlet and outlet of service reservoirs such as ESRs/ MBRs/ GSRs;
iv) Inlet and at the farthest point in each District Metered Area (DMA);
v) At discrete locations in the network/ DMA.

Frequency of Sampling at Water Source

Following is the list of the suggested minimum frequencies of monitoring specific parameters for surface water and ground water sources.

Frequency	Parameters
(i) Perennial rivers and lakes/ reservoirs: **4 times a year** (ii) Seasonal rivers: **3 times** during the flow period (at equal time intervals). (iii) Lake/ pond/springs or any other surface water source: **4 times a year**	**A. Pre-monsoon:** Once a year for all types of water source. (i) General: Colour, Odour, Temperature, pH, Electrical Conductivity (EC), Dissolved Oxygen (DO), Turbidity, Total Dissolved Solid (TDS). (ii) Nutrients: NO_3, PO_4 (iii) Demand parameters: Bio-chemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) (iv) Major ions: Sodium (Na^+), Potassium (K^+), Calcium (Ca^{++}), Magnesium (Mg^{++}), Carbonate (CO_3), Bicarbonate (HCO_3), Chloride (Cl), Sulphate (SO_4^-). (v) Other inorganic: Location specific parameters, if any (vi) Microbiological: Faecal Coliforms/ E.coli or Thermotolerant Coliforms (vii) Pesticides residues: As per Table 7.8 (Chapter 7 of Part A Water Manual) (viii) Metals: Arsenic (As), Cadmium (Cd), Mercury (Hg), Zinc (Zn), Chromium (Cr), Lead (Pb), Nickel (Ni), Iron (Fe), Manganese (Mn), Silver (Ag), Cu, Selenium (Se) **B. Rest of the year:** (i) General: Colour, Odour, Temperature, pH, Electrical Conductivity (EC), Dissolved Oxygen (DO), Turbidity, Total Dissolved Solid (TDS).

Frequency	Parameters
	(ii) Nutrients: NO_3 (iii) Demand parameters: Bio-chemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) (iv) Major ions: Sodium (Na^+), Potassium (K^+), Calcium (Ca^{++}), Magnesium (Mg^{++}), Carbonate (CO_3), Bicarbonate (HCO_3), Chloride (Cl), Sulphate (SO_4^-). (v) Other inorganic: Location specific parameters, if any (vi) Microbiological: Faecal Coliforms/ E-coli or Thermotolerant Coliforms.
(i) Groundwater: Twice a year in pre and post-monsoon season. The frequency may be reviewed after 3 years of monitoring	**A. <u>Pre-monsoon:</u>** (i) General: Colour, odour, pH, Electrical Conductivity (EC), Turbidity, Total Dissolved Solid (TDS) (ii) Major ions: Sodium (Na^+), Potassium (K^+), Calcium (Ca^{++}), Magnesium (Mg^{++}), Carbonate (CO_3), Bicarbonate (HCO_3), Chloride (Cl), Sulphate (SO_4^-), Nitrate (NO_3^-). (iii) Other inorganic: Location specific parameters such as fluoride, if any (iv) Microbiological: Faecal Coliforms/ E-coli or Thermotolerant Coliforms. (v) Pesticides residues: (vi) Metals: As, Cd, Hg, Zn, Cr, Pb, Ni, Fe, Mn, Ag, Cu, Se **B. <u>Post-monsoon:</u>** (i) General: Colour, Odour, pH, Electrical Conductivity (EC), Turbidity, Total Dissolved Solid (TDS), Nitrate (ii) Major ions: Sodium (Na+), Potassium (K+), Calcium (Ca++), Magnesium (Mg++), Carbonate (CO_3), Bicarbonate (HCO_3), Chloride (Cl), Sulphate (SO_4^-). (iii) Other inorganic: Location specific parameters such as fluoride, if any (iv) Microbiological: Faecal Coliforms/ E.coli or Thermotolerant Coliforms.
Ref.: CPCB Guideline 2007-08; Note: Emerging contaminants have to be handled separately	

Frequency at Water Treatment Plants

In case blended water (surface and groundwater are used in a treatment plant), water quality parameters for both surface and ground water sources should be monitored. The minimum frequency of key water quality parameters for surface and ground water sources at the inlet and outlet of water treatment plants is given below.

Frequency	Parameters
Rivers and lakes/ reservoirs	**A. <u>Every day:</u>** (i) General: Colour, Odour, Turbidity, EC/ Total Dissolved Solid (TDS), Free residual chlorine (at the outlet of treatment plant only) (ii) Microbiological: Faecal Coliforms/ Thermotolerant Coliforms.

Frequency	Parameters
	B. <u>Once a Month:</u> Metals: Aluminium Other: As per the quality of source water such as metals, etc. (to be decided by the concerned ULB)
Groundwater	**A. <u>Every day:</u>** (i) General: Colour, Odour, Turbidity, EC, Total Dissolved Solid (TDS), Free residual chlorine (at the outlet of treatment plant only) (ii) Microbiological: Faecal Coliforms/ E.coli or Thermotolerant Coliforms. **B. <u>Once a Month:</u>** (i) Toxic Metals: Aluminium (ii) Other: As per the quality of ground water such as fluoride, arsenic, etc. (to be decided by the concerned ULB)

Sampling at Balancing Reservoirs and DMA/ Distribution Network:

The distribution network (system) is the most important element of the water supply system. The following parameters to be checked in water distribution system.

i) Turbidity (Nephelometry);
ii) Conductivity/ Total Dissolved Solids (TDS) (Gravitometer);
iii) pH (Electrometric and colorimetric methods);
iv) E. (Escherichia)coli/ Thermotolerant Coliforms (MPN or MFT method);
v) Free /residual chlorine (DPD method)

The minimum sampling frequency and number of samplings in the distribution system following are provided.

Population Served	Maximum interval between successive sampling	*Minimum no. of samples to be taken from entire Distribution system	Parameter	Test to be Carried out
Up to 20,000	Seven days (minimum four samples per month)	One sample per 5,000 of population per month	All 5 parameters mentioned above	As per section 8.4.3.3, Part-B of Water Manual, CPHEEO
20,000 – 50,000	Four days (minimum eight samples per month)			
50,000 – 1,00,000	Two days (minimum 15 samples per month)			
More than 1,00,000	One day	One sample per 10,000 of population per month plus 10 samples		

*Wherever online water quality parameters are monitored, the laboratory water quality test may not be required for such parameters.

Sampling at Consumer Underground Sumps

ULBs should monitor water quality parameters quarterly for about 5% of the household's underground water tanks in a DMA, especially the consumer sumps that are found to be heavily leaking/ complaints regarding contamination and advise the consumers to replace or repair the underground tanks to make them watertight.

Establishing Monitoring and Surveillance Mechanism

Water quality laboratories are the main backbone of water quality monitoring and surveillance programme. The functions and responsibilities of various water quality monitoring and surveillance agencies are given below.

Agency	Function	Responsibilities
Surveillance Agency 1. State PHED 2. Urban Local Body 3. Local Health Authority, CMO/ Health Officer 4. State Pollution Control Board	Surveillance of drinking water quality	• To ensure that the drinking water is free from contaminants. • To find out what is wrong and assist in setting things right in both rural and urban systems.
Water Supply Agency 1. State PHED/ Water Boards/ Urban Development Deptt. 2. Urban Local Bodies/ Authority 3. Autonomous Agencies	Supply of potable water	• To provide sufficient potable water to the population at an adequate pressure
1. Central Pollution Control Board 2. State Pollution Control Board/ Authority	Controlling pollution of the water source	• To protect the raw water sources from being unduly polluted

Note:

- The concerned authorities seek accreditation for ULB-level laboratories through the NABL.
- Each ULB should ensure that an appropriate laboratory infrastructure as recommended by NABL should be first created before procuring the equipment.

ULBs may tie up with water testing laboratories (NABL accredited), which are in the private sector for water quality tests. Further, water quality testing facilities may be setup in science colleges/ universities/ technical institutions, and all such laboratories may be brought under the water quality testing network.

Turnaround Time

It is recommended that the turnaround time for testing the chemical parameters should not exceed more than 24 hours. In contrast, the turnaround time should not exceed 48 hours for testing the microbiological parameters.

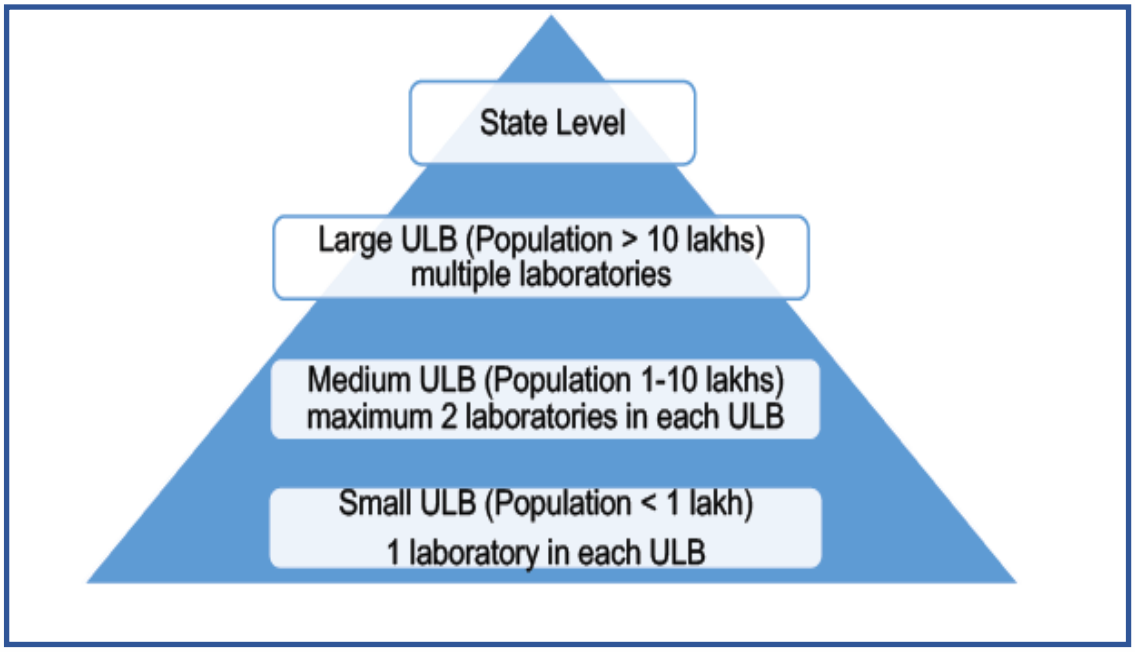
Proposed Institutional Mechanism of Laboratories

Strengthening of the network of water quality assessment laboratories is based on a state laboratory and a series of laboratories at the ULB including mobile and basic laboratories at the water treatment plant level. The laboratory at the water treatment plant can also serve the entire water supply system, including the function of the basic laboratory. ULB can have any of the following laboratory systems:

(i) Two laboratories separately catering to (a) the source and distribution system and (b) the basic laboratory at water treatment plant;

(ii) Single laboratory catering to the entire water supply system including water treatment plant.

The State laboratory should be accredited by National Accreditation Board for Testing and Calibration Laboratories (NABL). Laboratory network for water quality assessment is placed as under.



Mobile Drinking Water Quality Testing Laboratory

ULBs can procure mobile water quality testing laboratories to test specified endemic parameters, local communities' congregation areas, and inaccessible parts of the city. The mobile laboratories should be fully equipped to conduct on-the-spot water analysis concerning drinking water sources' safety.

6 Institution Arrangement

Effective protection of drinking water quality requires clear institutional roles, defined accountability, and coordinated action across Departments. Urban Local Bodies should establish and operationalise the following arrangements to ensure preparedness, prevention, and timely response to water quality risks.

Water Quality Cell

- Each ULB Should designate Water Quality Cell.
- Coordinate routine and emergency water quality monitoring plan.
- Maintain compliance with BIS 10500:2012 and applicable guidelines.
- Trigger corrective and preventive actions based on test outcomes.

Inter-Departmental Coordination

- Inter departmental coordination among Water supply department, Sewerage and septage management wing, Health department, and Disaster management or emergency response units.
- A predefined coordination mechanism should be activated to ensure rapid isolation, repair, public communication, and health surveillance during emergency.

Accountability and Documentation

- Clear accountability should be assigned at each stage of water quality management.
- Report on Incident detection, Actions taken,Chlorination and flushing logs, Laboratory tests for resumption of water supply
- Review post-incident emergency actions to identify systemic gaps and preventive measures.

For comprehensive planning, design, and detailed engineering of the entire water supply system, including source, treatment, transmission, storage, and distribution components, **Part A, Part B, and Part C** of ***CPHEEO Manual on Water Supply and Treatment Systems (Drink from Tap), March 2024***, may be referred to.

7 Annexures

i. Annexure-I

Water Contaminants and Associated Diseases

S. No.	Contaminant	Diseases or Impacts
1	Alkalinity	Gastrointestinal irritation and irritation to the eyes, skin, and mucous membranes
2	Hardness	Eczema; causes scaling and inability to form lather
3	Copper	Vomiting, diarrhoea, stomach cramps, nausea, liver damage, and kidney disease
4	Chloride	Chloride toxicity has been observed rarely in cases of impaired sodium chloride metabolism, such as congestive heart failure
5	Fluoride	Weakness, shallow respiration, spasms and convulsions, jaundice and urine suppression, discoloration of teeth, mottling in infants, and fluorosis
6	Nitrates (as NO_3)	Methaemoglobinaemia and congenital malformations
7	Sodium	Nausea, vomiting, muscular twitching and rigidity, convulsions, and cerebral and pulmonary oedema
8	Arsenic	Fatigue, nausea, vomiting, stomach pain, bloody diarrhoea, thickening or discoloration of the skin leading to skin cancer, numbness in hands and feet
9	Cadmium	Bone disease, osteomalacia, choking, vomiting, diarrhoea, abdominal pain, anaemia, and renal dysfunction
10	Cyanide	Unresponsive hypotension, slow respiration and gasping, cyanosis at high levels, and finally death

Source: World Health Organisation, 2017

Microorganisms and Associated Diseases

S. No.	Microorganism	Diseases or Impacts
Pathogenic protozoans		
1	Cryptosporidium hominis, *C. parvum*	Gastroenteritis
2	Acanthamoeba castellanii	Amoebic meningoencephalitis
3	Entamoeba histolytica	Amoebic dysentery
4	Balantidium coli	Dysentery
5	Giardia lamblia	Giardiasis (gastroenteritis)
Pathogenic bacteria		
6	Shigella spp.	Bacillary dysentery
7	Salmonella typhi	Typhoid fever
8	Salmonella paratyphi	Paratyphoid fever
9	Vibrio cholerae	Cholera
10	Leptospira spp.	Leptospirosis
11	*E. coli* O157:H7 (Pathogenic *E. coli*)	Gastroenteritis, ear and eye infections, diarrhoea, urinary tract infections, and skin diseases
Enteric viruses		
12	Polioviruses	Poliomyelitis
13	Rotaviruses	Gastroenteritis
14	Hepatitis A virus	Infectious hepatitis, jaundice
15	Hepatitis E virus	Infectious hepatitis, jaundice, miscarriage, and death

Source: World Health Organisation, 2017

Notes

Notes

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Disclaimer: The photographs and visual illustrations used in this advisory are for representational and illustrative purposes only. They are intended solely to support understanding of the subject matter and do not imply any association, endorsement, or attribution to any specific organisation, agency, or authority.

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Ministry of Housing and Urban Affairs
Government of India

Central Public Health and Environmental Engineering Organisation

Capacity Building Partner

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