



INDIAN WATER QUALITY ASSOCIATION

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Water Quality Assurance and Monitoring Plan for **Uttarakhand**

Suggested state framework following the
Jeolikote Nainital water contamination incident



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1 Document purpose

This report proposes a practical water quality assurance and monitoring system for rural and urban Uttarakhand. It responds to the September 2026 reports of illness and deaths in Jeolikote and neighbouring villages in Nainital district, while addressing the wider risks created by small hill supplies, springs, intermittent distribution, monsoon runoff, landslides, sewage leakage and long transport times to laboratories.

The central recommendation is a source to tap water safety system with an independent Chief Chemist led water quality monitoring division. Every scheme needs mapped source and distribution hazards, measured chlorine demand, verified disinfection contact time, risk based testing by competent laboratories, online operational alarms and documented corrective action. Decisions on chlorine dose and household sample coverage must be made from local measurements rather than a single statewide dose or fixed percentage alone.



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Acronyms and abbreviations

Abbreviation	Meaning
AI	Artificial intelligence
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
APHA	American Public Health Association
ASHA	Accredited Social Health Activist
BIS	Bureau of Indian Standards
CCTV	Closed circuit television
CMMS	Computerized maintenance management system
CMO	Chief Medical Officer
CPHEEO	Central Public Health and Environmental Engineering Organisation
CT	Disinfectant concentration multiplied by effective contact time
DMA	District metered area
DPD	N,N diethyl p phenylenediamine chlorine test reagent
DSO	District Surveillance Officer
DWQC	Drinking Water Quality Commissionerate
DWSM	District Water and Sanitation Mission
EPA	United States Environmental Protection Agency
FTK	Field test kit
GIS	Geographic information system
GPS	Global Positioning System
ID	Identifier
IDSP	Integrated Disease Surveillance Programme
IEC	International Electrotechnical Commission
IIoT	Industrial Internet of Things
IS	Indian Standard
ISO	International Organization for Standardization
IT	Information technology
JJM	Jal Jeevan Mission
LIMS	Laboratory information management system
MOIC	Medical Officer in Charge
NABL	National Accreditation Board for Testing and Calibration Laboratories
NCDC	National Centre for Disease Control
OT	Ortho tolidine chlorine test
PHC	Primary Health Centre



Abbreviation	Meaning
PHE	Public health engineering
PPE	Personal protective equipment
PRI	Panchayati Raj institution
PTI	Press Trust of India
QR	Quick response code
RWS	Rural water supply
SCADA	Supervisory control and data acquisition
SOP	Standard operating procedure
SWSM	State Water and Sanitation Mission
T10	Effective contact time determined from the first 10 percent of tracer exiting
TDS	Total dissolved solids
TSU	Technical support unit
UDD	Urban Development Department
ULB	Urban local body
USDMA	Uttarakhand State Disaster Management Authority
WHO	World Health Organization
WQMIS	Water Quality Management Information System
WQMS	Water quality monitoring and surveillance



Executive summary

Media reports dated 1 to 22 September 2026 describe jaundice, diarrhoea, vomiting and typhoid in Jeolikote and nearby villages. The figures vary by source. One report described three deaths and more than 60 cases; a later PTI based report stated that two deaths were linked to contaminated drinking water and that six engineers were suspended after an inquiry. The supplied ETV Bharat headline states that all tested water samples failed, but the laboratory reports, sample identifiers, analytical parameters, methods and chain of custody were not available for this review. The final causation assessment must therefore be made through a joint epidemiological, environmental and engineering investigation.

The incident indicates possible failures at several barriers: source protection, separation of water and sewage, treatment and chlorination, storage, distribution integrity, sampling, escalation of complaints, and coordination between water and health authorities. A result showing no bacterial contamination on a later date would not rule out intermittent contamination, particularly where supply is intermittent or a damaged pipe is exposed to sewage under negative pressure.

The proposed plan establishes an independent Drinking Water Quality Commissionerate led by a Chief Chemist, supported by district cells and scheme level water safety teams. It applies one data model to Uttarakhand Jal Sansthan, Peyjal Nigam, urban local bodies, Jal Jeevan Mission systems, Gram Panchayats and public institutions. Sampling, laboratory conclusions, alerts and result publication must be insulated from the treatment and operations chain; engineers remain accountable for corrective action but cannot suppress, delay or rewrite analytical findings.

Uttarakhand should move from storage dependent hypochlorite dosing to a risk based disinfection portfolio. Fresh onsite electrochlorination with automatic residual feedback is generally suitable for dispersed and medium sized schemes; properly safeguarded gas chlorination can remain an option for large plants with competent operators; ozone may be used as a primary oxidation or disinfection barrier but requires a downstream distribution residual. Nanobubble systems may enhance gas transfer, particularly for ozone, but must be independently piloted and validated and cannot be assumed to remove every contaminant or replace a measurable residual.

Free and combined residual chlorine should be measured by the DPD colorimetric or titrimetric method under IS 3025 Part 26:2021. The 2021 revision removed the stabilized neutral ortho-



tolidine method and added DPD methods. Bulk hypochlorite strength is measurable by an appropriate available chlorine assay; DPD residual testing is not a substitute for assaying concentrated stock.

The recommended immediate actions are to secure the affected Jeolikote systems, provide a verified safe alternative supply, inspect and pressure test water and sewer networks, superchlorinate only under an approved incident protocol, collect paired clinical and environmental samples, and publish daily status reports until the system meets clearance criteria. Statewide actions should begin with a 90 day baseline campaign, GPS inventory of every source and asset, risk classification of schemes, and a monsoon preparedness programme.

Priority	Action	Time	Required evidence
1	Activate joint Water Health Incident Command for Jeolikote and affected villages	Immediate	Signed incident log, line list, source and network map, sample register
2	Stop or isolate any unsafe supply and provide verified safe water	Immediate	Tanker or alternate source test certificate and residual chlorine log
3	Complete sanitary inspection, leak detection and cross connection survey	Within 48 hours	Geo tagged defects, pressure tests, repair records
4	Undertake repeat source to tap microbiological and viral risk investigation	Within 72 hours and repeated	E. coli and total coliform results, pathogen tests when indicated, chain of custody
5	Launch statewide high risk scheme review before the next heavy rainfall event	Within 30 days	Risk score for every scheme and district hotspot map
6	Pilot online chlorine, turbidity, pressure and flow monitoring with LIMS GIS and leak analytics	Within 6 months	Time stamped sensor data, validated alarms, laboratory linkage and closure records



Priority	Action	Time	Required evidence
7	Achieve NABL accreditation or formal recognition for the defined laboratory network	Within 18 months	ISO IEC 17025 scope, proficiency testing and audit closure
8.	Independent Audit of Laboratories with respect to facility, infrastructure, manpower,	Within 2 months	ISO IEC 17025



2 Incident context and evidence limitations

2.1 Reported sequence

Date	Reported event	How the report should be used
Late June 2026 onward	Residents reportedly began experiencing illness; later media accounts described diarrhoea, vomiting, typhoid and jaundice.	Media reporting; verify with IDSP line list and hospital records.
1 September 2026	A report described one death and nearly 15 critically ill persons across Jeolikote and eight neighbouring villages. Schools and Anganwadi centres were reportedly closed temporarily.	Times of India report.
7 September 2026	A report described three deaths and more than 60 reported cases. It also recorded allegations of leaking sewer lines, untreated sewage and a leaking pipeline.	Times of India report and reported PIL allegations; not a finding of causation.
September 2026	The supplied ETV Bharat headline stated that all tested water samples failed.	Full analytical reports were not available. Sample count and failed parameters require verification.
22 September 2026	A PTI based report stated that two deaths were linked to contaminated drinking water and six engineers were suspended after an inquiry.	Economic Times report citing officials and PTI.

2.2 Possible failure points at Jeolikote

The reported sequence does not establish causation. The following interpretations are hypotheses for the formal inquiry to test against authenticated engineering, laboratory and epidemiological records. Several barriers may have failed together; none of the observations alone proves a particular failure or misconduct.



Reported fact	Barrier(s) most consistent with this fact	Why this points there, and what remains to be verified
Sustained illness pattern from late June 2026 onward (diarrhoea, vomiting, typhoid, jaundice), not a single-day spike	Treatment and chlorination; separation of water and sewage	A prolonged pattern may reflect recurrent ingress, inadequate disinfection, multiple exposures or another source. Compare case onset and exposure histories with IDSP line lists, source and tap results, chlorine logs and supply schedules; reported symptoms alone cannot identify the pathway.
7 September 2026 report of leaking sewer lines, untreated sewage and a leaking pipeline in the vicinity of the supply	Distribution integrity; separation of water and sewage	A verified water pipe defect near a leaking sewer could permit faecal ingress, especially during pressure loss. Confirm locations and defects with utility records, inspections, pressure logs and paired upstream and downstream sampling before attributing the illnesses to this route.
September 2026 ETV Bharat report that all tested water samples failed	Verification testing; treatment and chlorination	The reported finding needs the original sample count, locations, collection dates, parameters, methods and acceptance criteria. A failed set could reveal a widespread problem within the sampled area and time, but cannot establish the cause or the condition of all supplies.
Weeks elapsed between the earliest reported illnesses (late June) and visible official response (school closures 1 September; suspensions 22 September)	Independent surveillance; escalation of complaints	The reported interval warrants an audit of complaint receipt, health alerts, sampling, result authorisation and response times. The date of visible action does not by itself establish when officials first acted. Independent adverse-result alerts would reduce escalation delays.



Reported fact	Barrier(s) most consistent with this fact	Why this points there, and what remains to be verified
22 September 2026 report that six engineers were suspended following inquiry	Institutional separation of testing from operations	The reported suspensions call for review of operational decisions and oversight against authenticated inquiry findings. Disciplinary action does not itself prove that laboratory reporting was delayed or suppressed; independent reporting should still be built into the proposed system.

2.3 Questions the formal investigation must answer

1. What were the exact case definitions, onset dates, residences, water exposure histories, clinical diagnoses and outcomes?
2. Which water supply schemes, private sources, tankers or household storage systems served each case and control household?
3. Were faecal indicator bacteria, pathogens, turbidity or deficient disinfectant residual detected, and were the samples representative of the contamination window?
4. Did sewage leakage, a cross connection, pipe break, low pressure, illegal connection, contaminated reservoir, unsafe source or household storage permit contamination?
5. Were complaints and abnormal operational readings received before the outbreak, and if so, who reviewed and acted on them?
6. Were sampling, preservation, transport, holding time, laboratory methods and quality controls adequate to support the reported conclusions?
7. What immediate repairs and longer term barriers are required to prevent recurrence?



3 Regulatory and technical basis

The plan uses the current Indian institutional framework and supplements it with risk based controls suited to a hill state. IS 10500 provides the drinking water specification. The Jal Jeevan Mission framework prescribes source testing, community surveillance, laboratory strengthening and WQMIS reporting. The 2025 joint NCDC and drinking water SOP requires coordination between water and health authorities at state, district, block and community levels. CPHEEO guidance extends source to consumer monitoring for urban systems. WHO guidance supports water safety planning, sanitary inspection and independent surveillance, particularly for small supplies.

Instrument	Application in this plan	Key requirement used
IS 10500 Drinking Water Specification	Compliance and verification criteria	E. coli or thermotolerant coliforms must not be detectable in a 100 mL sample; chemical and physical limits apply as specified.
NCDC SOP for Joint Action on Water Quality Monitoring and Health Outcomes	Joint governance and outbreak prevention	Water and health data sharing, hotspot identification, risk surveys, MIS reporting and coordinated action from state to village level.
CPHEEO Manual and 2025 AMRUT advisory	Urban source treatment distribution and household monitoring	Operational, verification and incident monitoring; priority parameters include turbidity, conductivity or TDS, pH, E. coli and free residual chlorine.
ISO IEC 17025 and NABL requirements	Laboratory competence	Validated methods, traceability, uncertainty where relevant, internal quality control, proficiency testing and controlled reporting.
WHO Water Safety Plan Manual 2023 and Small Water Supplies Guidelines 2024	Preventive source to tap control	System assessment, operational monitoring, management procedures, sanitary inspection and independent surveillance with climate resilience.



4 Uttarakhand water quality risk profile

Uttarakhand requires a different monitoring design from a compact city utility. Many schemes depend on springs, small streams, gravity lines, isolated tanks and intermittent distribution. Access can be blocked by landslides or snowfall, and samples may take hours to reach a laboratory. Heavy rain can rapidly change turbidity and microbial risk. Tourism creates seasonal demand and sewage loads. In the plains and valley areas, groundwater chemistry and urban or industrial contamination require a broader chemical programme.

Hazard	Typical pathway	Priority controls	Monitoring trigger
Faecal contamination	Sewage leak, open defecation, animal access, septic tank, drain crossing, contaminated storage	Source fencing, drainage diversion, sewer separation, filtration, verified chlorination, pressure maintenance	Any E. coli, disease cluster, low chlorine, high turbidity or complaint
Monsoon runoff	Rapid inflow to spring or surface source and damaged intake	Rainfall trigger, intake shutdown criteria, turbidity barrier, alternate source	Heavy rainfall, sudden turbidity rise or landslide
Intermittent and negative pressure	Ingress through cracked pipe when supply stops	Pressure zoning, leak repair, continuous positive pressure where feasible, flushing	Pressure below scheme limit or unplanned outage
Storage contamination	Open or damaged reservoir, poor cleaning, animal or human access	Secure covers, screened vents, cleaning SOP, residual chlorine	Failed inspection, sediment or zero residual
Geogenic chemicals	Natural groundwater rock interaction	Source selection or treatment and blending	Baseline exceedance or trend toward IS 10500 limit
Nitrate and anthropogenic chemicals	Septic leakage, agriculture, waste disposal or industry	Catchment protection, land use control and source substitution	Annual testing, land use change or pollution event



Hazard	Typical pathway	Priority controls	Monitoring trigger
Tourism and pilgrimage peak	Demand surge, temporary sources, overloaded sewage and storage	Seasonal readiness audit, additional sampling and tanker control	Festival, pilgrimage or occupancy threshold
Disaster damage	Flood, cloudburst, earthquake or landslide damages sources and lines	Pre identified alternate supply, mobile labs, emergency chlorination and boil water notice	USDMA alert or field damage report



5 Proposed assurance framework

The state should operate six linked controls. A break in any one control must generate a documented response, and failure at a critical microbial barrier must stop or restrict supply until safety is restored.



Figure 1 Routine source to tap water quality assurance

Control	Purpose	Required output
Scheme inventory	Know every source, intake, treatment unit, reservoir, pipeline crossing, valve and delivery point	Unique asset ID, GPS coordinates, photographs, ownership and condition
Water safety plan	Identify hazards and preventive barriers from catchment to consumer	Risk register, critical limits, monitoring plan and improvement schedule
Operational monitoring	Show continuously or frequently that treatment and distribution controls work	Turbidity, disinfectant, pH, flow, pressure and alarm records
Verification testing	Confirm supplied water meets IS 10500 and controls remain effective	NABL quality assured physical chemical and microbiological results
Independent surveillance	Provide public health oversight separate from supply operations	Sanitary inspections, risk audits, public institution checks and trend reports



Control	Purpose	Required output
Health linkage and response	Detect disease signals and stop exposure before an outbreak expands	Joint dashboard, trigger alerts, incident investigation and closure report



6 Institutional arrangement and accountability

6.1 Independent Drinking Water Quality Commissionerate

The Government of Uttarakhand should establish a formally notified Drinking Water Quality Commissionerate with functional independence for surveillance sampling, laboratory management, result authorisation, incident alerts and public reporting. Its Chief Chemist should be a senior water quality professional with a protected technical tenure, a separate budget and authority to issue directions across Jal Sansthan, Peyjal Nigam, urban local bodies and rural schemes. This implements the Jal Jeevan Mission policy principle of decoupling water quality monitoring and surveillance from service delivery and its recommendation for an autonomous Drinking Water Quality Commissionerate or equivalent structure.

- Approve the statewide monitoring plan, methods, sampling design, laboratory network and data rules.
- Maintain the state risk register and public water quality dashboard.
- Issue monsoon, disaster and outbreak sampling directions.
- Review every critical nonconformity and verify closure.
- Commission independent audits and inter laboratory comparisons.
- Submit a quarterly report to the Chief Secretary and an annual public assurance report.

6.2 Government of India policy basis and powers

The National Jal Jeevan Mission Drinking Water Quality Monitoring and Surveillance Framework (2021), chapter 5 institutional mechanism and institutional framework diagram, calls on States and UTs to decouple water service delivery from water quality testing to build trust, transparency and accountability. It proposes a Drinking Water Quality Commissionerate, with a Chief Chemist overseeing laboratories, testing, monitoring and surveillance. Its preface identifies an independent institution within the rural water supply agency, with funds, functions and functionaries, as a reform pillar. Uttarakhand should implement this architecture through a formally notified division or commissionerate whose chief is a qualified senior water quality professional, preferably Chief Chemist, rather than placing its analysts under the engineering officers whose supplies they test. [6]



Give the division its own sanctioned posts, budget, laboratory and field assets, sampling authority, instrument procurement, LIMS administration, direct escalation to the state mission and health department, and power to publish verified results. Treatment engineers retain responsibility for running plants, correcting failures and supplying safe water. The division independently chooses verification sites, controls sample custody and release of results, audits corrections and reports unresolved risks to the Chief Secretary or designated apex committee. District chemists must have a technical reporting line to the state Chief Chemist even when coordinating daily with district engineers. An independent quality manager must be able to stop invalid testing and issue a critical alert without prior operational sign off.

The attached framework retains village FTK surveillance as an early warning and community participation tool; this plan adds accredited or otherwise competent laboratory confirmation and expert interpretation. Neither an FTK result nor an AI flag alone should authorise an assertion of microbiological safety. The state laboratory should run referral testing and independent checks on a defined proportion of district laboratory samples, consistent with the JJM framework. [6]

6.3 Commissionerate under section 5.1.2.2 of the national framework

Section 5.1.2.2 of the National Jal Jeevan Mission Drinking Water Quality Monitoring and Surveillance Framework expressly recommends a Drinking Water Quality Commissionerate (DWQC) to separate water supply delivery from water quality testing. It observes that chemists often report to the engineers responsible for supply, and calls for autonomy of laboratory staff, with the Chief Chemist overseeing all levels of testing, monitoring and surveillance. The framework describes independent water quality functions backed by funds, functions and functionaries at state, regional, district and block levels. This is a direct policy basis for the proposed Uttarakhand division, rather than merely an organisational preference. [6, 22]

The same section specifies that the Chief Chemist report directly to the Secretary or Principal Secretary responsible for rural water supply on all water quality matters, with information copied to counterpart engineers. It calls for financial empowerment for laboratory strengthening and community engagement in the context of the framework's 2 percent WQMS funding provision; financial powers at par with the head of the rural water supply or public health engineering department; authority to communicate with relevant departments; and vehicles for laboratory



inspection. It also calls for monthly water quality and surveillance reports to be considered by the State Water and Sanitation Mission Apex Committee. Uttarakhand should translate these points into a government order, sanctioned posts and a budget that the operations division cannot veto. The framework's stated transition date of 2 October 2022 is historical, so a current state implementation timetable should be notified. [6, 22]

Assign the Commissionerate ownership of risk based sampling, laboratory upgrades, method selection, staff deployment and training, accreditation, interlaboratory comparisons, sample custody, raw data retention, report authorisation, public dashboards and adverse result escalation. Its technical support unit can coordinate with health and local governments. Supply engineers must receive each actionable result promptly and remain responsible for repair and safe service, while the Chief Chemist independently verifies closure. The laboratory should have protected authority to sample consumer taps and high risk locations without advance selection or exclusion by plant operations staff. This is needed to show the quality people actually receive, including intermittent ingress between periodic plant tests.

A field result must retain its original value and audit trail even if it indicates failure. A critical result should notify the district water quality officer, supply operator and health authority in parallel under a timed SOP; it should not wait for engineering approval, retesting or a favourable replacement sample. Rechecks establish the extent and cause of an event but do not erase the first result. The division should report the proportion of samples from household taps, unannounced checks, laboratory nonconformities, critical alerts, actions and independently verified closures each month. Staff need protection against interference or retaliation for a valid adverse finding, with an independent route to escalate pressure to alter or suppress a result.

6.4 International arrangements and lessons for Uttarakhand

Ontario, Canada: The Safe Drinking Water Act and laboratory guidance place direct duties on licensed laboratories to report adverse drinking water results promptly, including notification to authorities and the system owner or operator as applicable. A laboratory's adverse finding therefore follows a reporting route beyond an internal operational hierarchy. Uttarakhand could adapt this principle by requiring simultaneous electronic alerts to the Chief Chemist, district health officer and supply operator, with time stamped acknowledgement and no suppression by



either side. Ontario's regime does not mean every laboratory is publicly owned or institutionally detached from all suppliers; its useful lesson here is a direct legal duty to report. [23]

England and Wales: Water companies perform required monitoring, while the Drinking Water Inspectorate independently checks results and audits company laboratories. The Inspectorate works with the UK Accreditation Service so sampling and analytical practice can be independently verified. This is a model of external scrutiny and laboratory competence, not a claim that each utility laboratory has a separate employer. Uttarakhand should combine accreditation and external audits with its stronger JJM proposal for a separately empowered Commissionerate. [24]

United States: For drinking water compliance monitoring, the Environmental Protection Agency or states certify laboratories, require approved methods and annual proficiency testing for the methods and analytes in scope, and conduct periodic on site audits. Certification is a technical safeguard against unreliable results; it does not alone establish independence from a utility. Uttarakhand should pair NABL accreditation, proficiency testing and independent audits with direct result reporting and control of surveillance sampling by the Commissionerate. [25]

The common policy lesson is to secure technical competence, an unaltered record and an alert channel outside the team responsible for producing water. The exact legal models differ. Uttarakhand can make the separation more explicit because its national JJM framework already proposes the Commissionerate. International examples should inform its safeguards without being presented as identical organisational structures.

6.5 District and scheme level teams

Level	Lead	Core members	Decision responsibility
State	Chief Chemist	Drinking water, health, UDD, rural development, USDMA, pollution control, laboratory and IT representatives	Policy, standards, escalation, funding and public reporting
District	District Magistrate with District Water Quality Officer as technical lead	CMO, water agencies, ULBs, DSO IDSP, district laboratory, disaster management and PRI representatives	Hotspot control, joint response, resources and enforcement



Level	Lead	Core members	Decision responsibility
Block or city	Designated water quality engineer or chemist	MOIC, laboratory, JE, sanitary inspector, ULB or block and community representatives	Sampling roster, repair action, inspection and complaint closure
Scheme or village	Scheme operator and Pani Samiti or utility nominee	Jal Sakhi, ASHA, Anganwadi, school representative and local health worker	Daily controls, monthly surveillance, reporting and consumer advice

6.6 Separation of duties

Treatment and operations divisions should own process control, routine operator checks, maintenance and repairs. The independent Secretariat should own surveillance design, verification and regulatory sampling, laboratory custody, result authorisation, data publication and audit. Laboratory staff must report critical failures directly to the district and state water quality officers and the health authority. A failed result must never be withheld pending engineering approval. Engineers may record a technically reasoned comment or request a confirmatory sample, but the original result and alert remain visible. Water quality staff independently verify restoration after corrective action.

Function	Accountable unit	Independence control
Dose setting and plant operation	Treatment and operations division	Recorded in SCADA or logbook; changes time stamped and reviewable
Surveillance sampling and custody	Water Quality Assurance Secretariat	Sampler roster independent of the sampled plant; barcoded custody
Laboratory analysis and authorisation	Secretariat laboratory network	Technical reporting line to Chief Water Quality Officer; no operational veto



Function	Accountable unit	Independence control
Repair and corrective action	Engineering or scheme operator	Named work order, deadline and evidence in LIMS or CMMS
Clearance after failure	Water quality officer with health authority when required	Representative verification samples and signed decision
Public assurance and audit	Secretariat and designated public health authority	Versioned results, exceptions and closure evidence published

6.7 Laboratory staffing and competence

A stable regular cadre of qualified chemists, microbiologists, samplers, instrument technicians, quality managers and data officers is preferred for core public health functions. Where staff or services are contracted, procurement must specify education, relevant experience, method specific training and competency authorisation. Price alone must not determine selection, and contracts must not reward low failure rates, sample throughput without quality controls or suppression of nonconforming results.

- Define minimum qualifications for each role and verify certificates, experience and identity before deployment.
- Provide induction, supervised practice and witnessed competency assessment before independent work, followed by annual reassessment and after any major method change.
- Maintain trained alternates, adequate staffing by shift and continuity provisions so leave, road closure or contract transition does not stop testing.
- Require participation in proficiency testing or inter laboratory comparison, documented corrective action and continuing professional development.
- Give the laboratory quality manager authority to reject compromised samples, stop invalid work and release critical alerts without operational interference.

6.8 Staffing, qualifications and training

Create sufficient regular posts for chemists, microbiologists, laboratory supervisors, samplers, quality managers and field technicians. As a default entry requirement for an analyst, specify at



least a recognised bachelor degree in a relevant science discipline such as chemistry, microbiology, biotechnology or environmental science, with role specific practical experience in drinking water methods. Supervisors and authorising signatories need documented experience in water chemistry or microbiology, method quality control and interpretation; a degree alone is not evidence of competence. Define higher qualifications where a specialised role warrants them.

Require induction, supervised sample handling, witnessed method demonstrations, annual competency review, proficiency testing, biosafety, data integrity training and refresher courses after changes in standards or instruments. Train operators separately in chlorine demand, pH, turbidity, dose calculation, contact tank hydraulics, stock assay, DPD residual testing and emergency response. Maintain substitute staff for monsoon access disruptions.

Where a temporary outsourced service is unavoidable, the contractor must identify an experienced water chemistry or microbiology lead who supervises analysts and provides continuous training; provide verified degree certificates, employment records, approved method training, staffing levels, staff retention arrangements and independent quality controls. The government division must retain sampling oversight, data ownership, audit access and alert authority. Contract payments should depend on valid, timely and complete work, not a low rate of failed samples. The long term staffing objective should be an adequate permanent public laboratory cadre.



7 Scheme risk classification

Every scheme should receive a risk class that determines monitoring intensity. The score should be recalculated before and after monsoon, after major repairs and after any incident.

Risk factor	Score 0	Score 1	Score 2	Score 3
Source	Protected deep source	Protected spring	Surface source with adequate treatment	Unprotected or mixed source
Sanitary condition	No significant defects	Minor correctable defects	Several defects	Sewage or animal contamination pathway
Treatment	Validated multibarrier treatment	Adequate disinfection	Unreliable treatment or records	No effective treatment
Distribution	Positive pressure and sound network	Occasional outage	Frequent outage or leakage	Known cross connection or sewage contact
History	No failures in 24 months	One noncritical failure	Repeated microbial or chlorine failure	Outbreak or critical failure
Access and response	Lab under 2 hours	Lab under 6 hours	Remote or seasonal closure	No dependable sample transport

Suggested classification is Low 0 to 3, Moderate 4 to 7, High 8 to 12 and Critical 13 to 18. Any outbreak, E. coli detection, known sewage ingress or loss of treatment overrides the numerical score and makes the scheme Critical until formally cleared.



8 Monitoring programme

8.1 Minimum statewide schedule

The schedule below is a proposed operational standard for Uttarakhand. It retains the JJM minimum of twice yearly bacteriological source testing and annual chemical testing but increases testing at treated water and consumer points according to public health risk. Districts may increase frequencies; they should not reduce them without a documented risk assessment approved by the State Water Quality Assurance Cell.

Location	Parameters	Routine frequency	Event frequency
Raw source	Turbidity, pH, conductivity, temperature, visual and odour checks	Daily at treated schemes; each visit for small schemes	Continuous or hourly during high turbidity events
Raw source	E. coli and total coliform	At least pre and post monsoon and risk based	Weekly during incident; after heavy rainfall or sanitary failure
Raw source	Full chemical profile under IS 10500 and local risk parameters	Annually	After source change, pollution event or adverse trend
Treatment outlet	Turbidity, pH, free residual chlorine, flow and process controls	Each operating shift; continuous online for major WTPs	Alarm and immediate verification when outside operational limit
Treatment outlet	E. coli and total coliform	Weekly for large systems; monthly for small systems	Daily during incident until clearance
Service reservoir	Turbidity, free residual chlorine and sanitary condition	Daily or each filling cycle; inspection monthly	Immediately after cleaning, repair, intrusion or complaint



Location	Parameters	Routine frequency	Event frequency
Distribution and tail end	Free residual chlorine, turbidity, pH and conductivity	Risk based daily route for urban systems; at least weekly for high risk and monthly for others	After outage, low pressure, pipe repair, rainfall trigger or complaint
Distribution and tail end	E. coli and total coliform	Monthly rotation covering every zone; weekly for high risk schemes in monsoon	Immediate and repeated after any presumptive failure
Schools Anganwadi health facilities	Free chlorine, turbidity and E. coli	Monthly when open	Before reopening after closure or incident
Tankers and temporary supply	Source certificate, free chlorine, turbidity, E. coli	Each filling day for chlorine and turbidity; microbiology by risk and roster	Before deployment and after any cleaning or complaint
Household storage	Sanitary inspection, chlorine and selected microbial testing	Risk based quarterly sample and complaint driven	During cluster investigation or repeated network failure

8.2 Core parameter groups

Group	Parameters	Purpose
Operational	Turbidity, pH, free residual chlorine, flow, pressure, conductivity or TDS and temperature	Immediate control of treatment and distribution barriers
Microbiological	E. coli or thermotolerant coliforms, total coliforms and heterotrophic plate count where useful	Evidence of faecal contamination and distribution integrity



Group	Parameters	Purpose
Outbreak specific	Pathogen testing selected with health authority such as Salmonella Typhi, Vibrio cholerae, hepatitis A or E virus and protozoa	Support epidemiological linkage; not a substitute for indicator testing or control action
General chemical	TDS, alkalinity, hardness, chloride, sulphate, nitrate, fluoride, iron, manganese and ammonia where relevant	Source acceptability, treatment needs and contamination trends
Toxic and local risk	Arsenic, lead, cadmium, chromium, nickel, mercury, uranium, pesticides and industrial chemicals based on risk	Long term health protection and land use or geogenic risk
Treatment byproducts	Trihalomethanes and other relevant byproducts in chlorinated systems	Control chemical exposure while maintaining adequate disinfection

8.3 Critical microbial and operational criteria

Indicator	Target or trigger	Required action
E. coli or thermotolerant coliforms	Not detectable in 100 mL	Treat as critical. Notify immediately, isolate or restrict supply as necessary, provide safe alternative water, inspect and resample.
Total coliform in treated distribution water	Absence expected; any detection requires investigation under the applicable standard and system protocol	Check residual chlorine, pressure, storage and sampling integrity; collect confirmation samples without delaying protection.
Free residual chlorine at consumer end	Operational target at least 0.2 mg/L after adequate contact time; 0.5 mg/L minimum where protection against viral infection is required under IS 10500 context	Investigate below target, verify dose and contact time, flush or boost safely, and test microbial quality.



Indicator	Target or trigger	Required action
Turbidity after filtration	Scheme specific validated limit; any sudden rise is an alarm even if below the compliance limit	Check filters and source condition, consider shutdown or alternate supply, increase sampling.
Pressure	Positive pressure within the scheme operating envelope	If pressure is lost, treat the affected zone as vulnerable, inspect, flush, disinfect and verify before normal service.
Disease signal	Cluster above district alert threshold or unusual jaundice or diarrhoea pattern	Activate joint water and health investigation without waiting for routine water results.

8.4 Risk based coverage and expert field sampling

The incidents in Indore and Uttarakhand reinforce the need to detect unsafe water between routine laboratory visits. Uttarakhand should issue a provisional scheme specific field sampling rule, then revise it against a 90 day baseline, hydraulic maps and measured failure rates. Sample locations must be rotated across household taps and combined with fixed high risk sentinel points, including the furthest and highest taps, low pressure reaches, sewer crossings, schools and health facilities. Count and report households reached, samples tested, repeat failures and untested zones; sampling coverage is not the same as a guarantee that every house is safe.

For a small scheme serving fewer than 100 households, propose a minimum of 5 percent of households per monitoring round, rounded up to at least five distinct household taps, in addition to source, post contact, reservoir and sentinel points. For 100 to 999 households, propose 3 percent per round, rounded up to at least five, and distribute the sample across pressure zones and branches. For schemes with 1,000 or more households, do not automatically impose 3 percent of all households at every round: set a statistically and operationally justified sample size by district metered area, vulnerability and laboratory capacity, with a documented rotating schedule and extra sampling at critical locations. These percentages are proposed Uttarakhand programme design values, not BIS or JJM statutory minima.

The independent district chemist and the local authority should set the round frequency after considering whether the source is an exposed spring or stream, sanitary survey score, monsoon



runoff, pipe age and material, number of joints and repairs, proximity to drains and septic tanks, low or negative pressure, intermittent supply, tourism or other demand shocks, past E. coli failures, complaints and incident history. At minimum, specify routine dry season and intensified monsoon schedules in every scheme plan; sample promptly after a break, pressure loss, first supply following prolonged interruption, high turbidity alarm, source flood, reservoir contamination or illness cluster. In a critical scheme, daily or more frequent field checks and confirmatory laboratory microbiology may be needed until independent clearance. Record why the frequency was set and reassess it after each event.

Field DPD chlorine, turbidity, pH, temperature and pressure measurements should be made by trained staff using calibrated instruments and uploaded immediately. Collect sterile microbiological samples for a competent laboratory under controlled transport. FTKs remain useful for community screening, complaint triage and immediate warnings, but laboratory methods, quality control and qualified analysts must underpin confirmation, regulatory decisions, trends and reopening after an incident. [6, 11, 12]



9 Disinfection modernisation and chlorine control

9.1 Limitations of stored hypochlorite

Hypochlorite can be an effective disinfectant, but a nominal product strength cannot be treated as a constant dose. Sodium hypochlorite decomposes during storage; loss accelerates with higher concentration, heat, sunlight, long storage and catalytic impurities such as metals. Degradation lowers available chlorine and can increase chlorate. Uttarakhand hill logistics, warm stores, irregular turnover and manual dosing can therefore produce under dosing, while compensating without measurement can create over dosing and byproduct risk. The statement that every batch becomes ineffective within seven days is not technically supportable: stability varies by formulation and storage conditions.

Contrary to the assertion that strength cannot be measured, bulk hypochlorite available chlorine can and should be assayed by an approved iodometric or equivalent method at receipt and at a risk based interval during storage. Product age, batch, storage temperature and assay result must be recorded, and the metering pump setting recalculated from current strength, plant flow and chlorine demand. DPD testing measures low level free or combined chlorine residual in treated water; it is not the method for establishing the strength of concentrated hypochlorite stock.

Control point	Minimum requirement	Failure prevented
Procurement	Approved specification, certificate of analysis, batch traceability and maximum delivery age	Weak, contaminated or unsuitable product
Receipt	Available chlorine assay and visual container inspection before acceptance	Dose based only on label strength
Storage	Cool, shaded, ventilated, compatible bunded store; first in first out; temperature and age record	Accelerated decay, leakage and incompatible chemical contact
Dosing	Calibrated duty and standby pumps, flow pacing, residual feedback and verified contact time	Manual dose drift and single point failure



Control point	Minimum requirement	Failure prevented
Verification	DPD residual at plant outlet and sentinel points plus microbiological verification	False assurance from chemical feed alone
Byproducts	Risk based chlorate, chlorite and trihalomethane surveillance	Uncontrolled chemical exposure

9.2 Chlorine demand, dose and verified contact

Measure chlorine demand at representative raw water quality and peak and off peak flows, including wet season turbidity events. A bench scale demand test adds known chlorine doses, measures free residual after the intended contact time, and assesses pH, temperature, ammonia, organic matter and iron or manganese where relevant. Establish a dose response curve and revisit it after a source change, storm, long outage or complaint. The applied dose in mg/L is not the same as the measured residual: chlorine demand and reaction during contact consume part of the applied chlorine. Clarification and filtration must adequately remove particulate matter; simply raising chlorine cannot compensate for highly turbid or grossly contaminated water.

Use a scheme specific starting target at the treated source or post contact outlet that maintains at least 0.2 mg/L free chlorine at the most disadvantaged consumer tap in ordinary operation. A post contact residual around 0.5 mg/L is an established effective disinfection benchmark when at least 30 minutes of contact at pH below 8 is demonstrated. A working target as high as 1.5 mg/L at the source may be justified for a long or intermittent network only after measuring demand and network decay and checking taste, disinfection byproducts and applicable standards; it is not a universal prescribed dose or residual. During a public health emergency or after one or two days without supply, the operating authority may temporarily target a higher residual, commonly around 0.5 mg/L at delivery under an incident protocol, after inspecting, repairing, flushing and sampling the network. Raising chlorine alone must never be used to mask sewage intrusion. [20, 21]

Provide a baffled contact tank or verified storage volume between chlorine injection and the first consumer. Design for a minimum effective contact time of 30 minutes at the highest credible flow and relevant pH and temperature, with an allowance such as 30 to 40 minutes of actual effective contact where site conditions warrant; do not infer effective time by dividing tank volume by



average flow. Determine the conservative hydraulic contact factor or tracer based T10 and calculate CT (free chlorine concentration multiplied by effective contact time) against the required organism inactivation. Where pH is 8 or above, water is cold, turbidity is high or target organisms are chlorine resistant, treatment and contact requirements must be reassessed by a competent designer. Water that bypasses the contact stage must not be released as adequately disinfected. [20, 21]

The operational log must record flow, raw and filtered turbidity, pH, applied available chlorine mass, free residual after contact, contact tank level and T10 basis, reservoir outlet and representative near and far tap residuals. Use the DPD method to confirm online readings at defined intervals and whenever an alarm occurs. A downstream residual indicates continuing protection but cannot prove sufficient prior contact or the absence of pathogens in a later ingress event.



Figure 2 Chlorine dose contact and residual control

9.3 Technology selection for Uttarakhand

The Indian Water Quality Association proposals for automatic IIoT monitored electrochlorination, gas chlorination, ozonation and nanobubble assisted processes should be evaluated through scheme specific multi criteria assessment. Selection must consider raw water quality, required pathogen reduction, distribution length, residual demand, operator competence, road access, power reliability, hazardous chemical risk, life cycle cost, spare parts and byproducts. No technology should be procured only on a vendor claim or a single demonstration result.



Option	Principal advantages	Limitations and mandatory safeguards	Best fit
Bulk sodium hypochlorite	Simple equipment; familiar operation; leaves a measurable distribution residual	Strength decays in storage; requires stock assay, safe storage, calibrated feed, contact time and byproduct control	Small plants with rapid chemical turnover and strong quality control
Onsite electrochlorination	Generates fresh dilute hypochlorite from salt and water; reduces transport and ageing; supports flow paced dosing, residual feedback and IoT records	Still produces hypochlorite; needs brine quality control, power, cell maintenance, hydrogen ventilation, duty standby capacity and trained operators	Dispersed hill schemes and medium plants where chemical transport or storage is unreliable
Gas chlorination	Accurate controllable dose, economical at high throughput and proven residual protection	High consequence toxic gas risk; requires secure siting, leak detection, ventilation, scrubber, emergency plan, competent staff and regulatory approval	Larger staffed plants after formal quantitative safety assessment
Ozone	Powerful primary disinfectant and oxidant; may improve taste, odour, colour and selected organic contaminant control	No durable network residual; bromate and off gas risks; higher energy, process control and maintenance needs; usually followed by chlorine or another approved residual	Larger advanced plants with suitable raw water and skilled operation



Option	Principal advantages	Limitations and mandatory safeguards	Best fit
Ozone nanobubbles	Can increase gas liquid contact and ozone utilisation and may enhance oxidation under validated conditions	Performance depends on generator, water matrix and dose; ozone and bromate safety remain; no assumed distribution residual	Pilot scale advanced oxidation where a defined contaminant or process objective justifies it
Air oxygen or chlorine nanobubbles	May improve aeration or gas transfer; chlorine delivery may be intensified in a validated reactor	Air or oxygen alone is not a reliable drinking water disinfectant residual; broad claims of freshness or removal of all contaminants are not evidence; CT and residual must be demonstrated	Research or controlled pilot before any drinking water scale decision

9.4 Recommended deployment model

8. Audit every chlorination installation, hypochlorite store, contact tank and residual record; immediately correct stock age, storage, feed calibration, mixing and contact time deficiencies.
9. Pilot automatic onsite electrochlorination with flow pacing, outlet and network residual feedback, IIoT telemetry and duty standby equipment in representative gravity, pumped, remote and high demand schemes.
10. Retain or adopt gas chlorine only at plants that pass a documented process safety and emergency response assessment and can maintain competent staff around the clock.
11. Use ozone only where treatability testing identifies a primary disinfection or oxidation benefit and where bromide, bromate, off gas, downstream biological stability and a distribution residual are controlled.
12. Evaluate nanobubble systems through independent pilot protocols with baseline comparison, energy and maintenance data, accredited analyses, defined contaminant removal claims and at least one monsoon cycle before scale up.



13. Award performance based contracts using verified dose, contact time, uptime, residual profile, microbiological performance, byproducts and whole life cost; do not accept proprietary dashboards without raw data export.

9.5 DPD testing for free residual chlorine

All compliance and operational residual chlorine measurements should use the DPD colorimetric or titrimetric methods in IS 3025 Part 26:2021 or another method formally accepted by the competent authority. The 2021 second revision removed the stabilized neutral ortho-tolidine method and added DPD titrimetric and colorimetric methods. OT kits should therefore be withdrawn from compliance and operational release decisions. OT is less suitable for distinguishing free chlorine from combined oxidants, is subject to interference and involves a hazardous aromatic amine; an apparent colour response can give false assurance.

- Measure free residual chlorine immediately at the sampling point because the value changes during transport and standing.
- Use in date DPD reagents, clean matched cells and an instrument or comparator with the correct range; protect reagents from heat and moisture.
- Verify photometers and comparators with traceable standards or manufacturer checks and perform blanks, duplicates and periodic side by side laboratory checks.
- Record free chlorine, total chlorine where relevant, pH, turbidity, time, temperature, location, sampler and instrument ID in LIMS.
- Treat any below limit, sudden drop or implausible reading as an operational alarm and confirm promptly; a chlorine residual does not by itself prove microbiological safety.

9.6 Bulk hypochlorite verification and automatic dosing

For each new bulk hypochlorite batch and each dosing shift or dosing episode, verify available chlorine strength from the in use stock by an approved iodometric or equivalent assay, or use a validated rapid stock method cross checked against that assay. At a continuously fed plant, document a risk based recheck at least daily and after dilution, replenishment, extended heat exposure or prolonged downtime; a fresh result is required before calculating a new batch setting. Do not use a low range DPD residual test to measure concentrated stock. Recalculate pump output from measured strength, treated flow, current chlorine demand and desired post contact



residual; confirm the delivered dose by pump calibration and residual readings. The exact interval may be tightened by the independent Chief Chemist according to storage stability and operations. Prefer flow paced metering with duty and standby pumps and feedback from independently checked post contact free chlorine and network sensors. Software may forecast demand from turbidity, pH, source, weather and flow, but its operating envelope, limits, override rules and model changes must be approved and audited by a qualified water quality officer. Loss of sensor validity, communications or power must trigger a safe fixed setting or operator attended fallback, alarm and increased manual sampling; never allow an unvalidated AI model to issue unrestricted chemical feed commands. A sensor setpoint alone cannot verify contact time or microbiological safety.



10 Sampling design

10.1 Sampling locations

A sample roster should represent the entire pathway and not only convenient taps. Each scheme must have fixed sentinel points and rotating points. Sentinel points should include the raw source, treatment outlet, each service reservoir, a near point, a hydraulically disadvantaged tail end, high elevation and low pressure zones, sewage or drain crossings, high complaint areas and vulnerable institutions. Rotating household points prevent blind spots and help identify local plumbing or storage contamination.

10.2 Sample collection and chain of custody

14. Generate a unique sample ID in LIMS before collection and print or scan a tamper resistant barcode.
15. Record scheme and asset ID, GPS coordinates, date and time, sample type, collector, weather, recent outage or repair, chlorine dose and field measurements.
16. Use the correct sterile or chemically prepared bottle for the parameter. Microbiology bottles for chlorinated water must contain an appropriate chlorine neutralizer such as sodium thiosulphate.
17. Disinfect the outlet and flush for the prescribed time unless the purpose is to test the tap or storage condition itself. Record the exact sampling protocol used.
18. Use field blanks, trip blanks, duplicates and equipment blanks at a frequency defined in the quality plan.
19. Seal the bottle and custody container. Every transfer must record the person, time, condition and temperature.
20. Reject or qualify samples when identity, preservation, container, holding time, temperature or custody requirements are not met. Do not issue an unqualified compliance conclusion from a compromised sample.

10.3 Sampling transport vans

Uttarakhand should deploy dedicated sample transport and mobile testing vans by district and terrain cluster. Ordinary field vehicles are unsuitable when samples remain unrefrigerated, bottles



break during rough transport, routes are not documented or samples cannot reach the laboratory within the method holding time. The van is part of the measurement system and should be covered by SOPs, calibration and audit.

Component	Minimum specification	Reason
Temperature controlled storage	Validated 2 to 8 degree C compartment with continuous data logger, alarms and backup power	Preserves samples and creates an auditable temperature record; freezing must be prevented unless a method requires it.
Shock control	Padded bottle racks, restraint system and smooth driving protocol	Reduces breakage and agitation on hill roads. The term without jerks should be translated into measurable secure transport controls.
Automatic sampler	Programmable sampler for composite or event sampling with suitable tubing and cleaning protocol	Captures short contamination events where grab sampling may miss them.
Bottle inventory	Sterile microbiology bottles, preserved chemical bottles and separate clean storage by parameter	Prevents cross contamination and ensures correct preservation.
Onsite testing	Calibrated pH, turbidity, conductivity, temperature and DPD free chlorine instruments plus bacteriological screening where authorised	Measures unstable parameters immediately and supports incident decisions.
Digital system	GPS, offline LIMS application, barcode printer and scanner, photographs, electronic custody and secure synchronization	Proves location and time and eliminates transcription delays.



Component	Minimum specification	Reason
Safety and hygiene	PPE, hand hygiene, spill kit, waste segregation, first aid, fire extinguisher and communication equipment	Protects staff and samples during remote work.
Power and communications	Battery and inverter, solar or alternator charging where suitable, mobile and satellite communication for dead zones	Maintains cooling and reporting when grid or network service is unavailable.

10.4 Holding time and transport control

The laboratory must maintain a parameter specific sampling and preservation table based on the approved BIS, IS 3025, IS 1622, APHA or other authorised method. Microbiological samples should reach analysis as soon as possible under controlled cooling. A single generic holding time should not be printed on all bottles because requirements vary by organism and method. LIMS should calculate the expiry time automatically and block late samples from being reported as valid compliance results.

10.5 Source protection for hill streams and springs

Register every source, including local mungera streams or channels, waterfalls, springs, spring boxes and seasonal intakes, with GPS, catchment map, downstream users, upstream activities and a sanitary risk assessment. Verify each local name and hydrology with the community and district survey; a waterfall is not inherently protected drinking water. Map and control upstream latrines, septic tanks, grazing and animal access, dumping, roadside drains, tourism camps, landslide debris, construction, fuel storage and pesticide use. Fence intakes and spring chambers, repair covers, drainage, vents and overflows, and divert dirty surface runoff away from collection points without damaging spring recharge.

Establish a locally workable source protection zone and upstream inspection route, coordinate with forest, panchayat, sanitation and road authorities, and create monsoon and post landslide inspection triggers. Compare raw source turbidity and microbiology before and after rain, do not bypass treatment because water looks clear, and shut or switch an unsafe source where barriers fail. Protecting the catchment reduces sudden microbial and chlorine demand shocks and makes



downstream disinfection more reliable; it does not remove the need for filtration, disinfection and distribution surveillance.



11 Laboratory network and quality assurance

11.1 Tiered laboratory network

Tier	Role	Suggested capability
State reference laboratory	Reference methods, complex contaminants, outbreak support, method validation and external quality assurance	Full IS 10500 scope including advanced metals, pesticides, byproducts and pathogen testing through authorised capability
Regional or divisional laboratory	Confirmatory testing and support to districts	Broad physical, chemical and microbiological scope with emergency capacity
District laboratory	Routine verification and incident response	Core IS 10500 parameters, membrane filtration or validated microbiological methods, rapid reporting
Block or mobile laboratory	Field and basic screening in remote areas	Turbidity, pH, conductivity, chlorine, selected chemicals and authorised microbial screening
Community surveillance	Indicative testing and sanitary inspection	FTKs and presence absence vials used only within their stated purpose, with confirmatory referral

11.2 Quality controls

- NABL accreditation to ISO IEC 17025 for the actual methods and parameters reported, not only institutional registration.
- Approved methods, method verification or validation, measurement traceability and documented detection limits.
- Daily media, sterility, positive and negative controls for microbiology; blanks, duplicates, spikes and certified reference materials for chemistry.
- Participation in proficiency testing or inter laboratory comparison for each major discipline and timely corrective action.



- Equipment calibration, intermediate checks, preventive maintenance and temperature mapping of incubators, refrigerators and transport coolers.
- Competency assessment of samplers and analysts at authorisation and at defined intervals.
- Internal audit, management review, nonconformity control and uncertainty evaluation where relevant.
- Electronic result authorisation with audit trail; no deletion or alteration of failed results without visible version history.

11.3 Result turnaround and alerts

Result type	Maximum notification time	Recipient and action
Field loss of chlorine or critical turbidity	Within 15 minutes	Operator, engineer, water quality officer and health focal point for immediate control check
Presumptive microbial positive	Immediately on observation	Do not wait for final report to begin protection and confirmation
Confirmed E. coli detection	Within 15 minutes of authorisation	District incident group, affected utility, CMO and state cell; public advice where exposure may continue
Chemical exceedance with acute risk	Immediately	Stop or restrict source as directed and provide alternate water
Routine compliant microbiology	Same day as completion	LIMS and scheme record
Routine chemistry	Within the laboratory service standard	Trend analysis and corrective action tracking

11.4 Cross contamination and distribution integrity

Cross contamination occurs when unsafe water or sewage enters a drinking water main, tank or household connection through a leak, joint, illegal connection, shared trench, backflow or open storage. During intermittent service, pressure can fall to zero or below surrounding groundwater pressure; a later pressure recovery can carry faecal material over a broad network even though



treatment outlet water was satisfactory. Direct cross connections and unprotected tanker filling or hose connections create additional backflow hazards. Residual chlorine may be exhausted locally, especially by a concentrated ingress, and a passing source sample may miss a short event.

Map mains beside and across drains, sewers, septic tanks and flood channels; log minimum pressure and interruptions, test for leaks and cross connections, protect crossings and fit and maintain backflow prevention where needed. After repairs or a suspected intrusion, isolate the affected zone, provide safe alternative water, repair, flush and disinfect under SOP, verify pressure integrity and take near and far end chlorine and microbiological samples before independent clearance. Do not issue a blanket safe water notice from a single negative sample.



12 Digital monitoring and public reporting

The state should establish one water quality data layer linked to scheme and asset IDs. Existing JJM WQMIS and urban systems should exchange data rather than create duplicate records. A smart LIMS should receive field, laboratory, SCADA or IIoT sensor, complaint, maintenance, leak detection and health alert data. It should preserve raw results and audit history, calculate compliance and trends, and create tasks with named owners and deadlines. Artificial intelligence may prioritise anomalies and likely locations, but validated rules and authorised professionals must make public health and potability decisions.

Data element	Minimum rule
Identity	Unique scheme, source, asset, sample and case cluster identifiers with controlled master data
Location	GPS coordinates and photographs for each source and sample point
Time	Automatic timestamps for collection, receipt, analysis, authorisation and notification
Quality	Method, laboratory, analyst, controls, detection limit, accreditation status and sample condition
Alert	Rule based severity, automatic recipient list, acknowledgement and escalation timer
Corrective action	Defect, owner, due date, evidence, verification sample and independent closure
Public view	Plain language scheme status, latest valid results, date tested, meaning and current advisory without personal data

12.1 Source to endpoint online monitoring

Major treatment plants and high risk distribution zones should use online turbidity, free chlorine, pH, conductivity, flow and pressure instruments where they can be maintained. Minimum nodes should cover the raw source or intake, treatment outlet, contact tank outlet, each major service reservoir, booster or pressure zone, critical branch, sewage crossing or recurrent leak hotspot, hydraulically disadvantaged tail end and vulnerable public institution. A nominal interval of about 2 to 3 km may be used as a preliminary planning rule on selected long trunk mains, but final spacing must be set by hydraulic model, travel time, terrain, branching, pressure zones, risk and



communications. Blind uniform spacing can miss a vulnerable branch and waste instruments on low risk pipe.

Sensors do not replace laboratory microbiology or field verification. Their value is early warning, event reconstruction and proof that treatment and hydraulic barriers remained within limits. Each instrument must have a maintenance owner, calibration and cleaning schedule, verified measurement range, data quality flag, secure time synchronisation, local display, backup power and manual fallback. Critical alarms require an immediate DPD or grab sample check and an operational inspection; persistent or corroborated alarms trigger incident procedures without waiting for a routine laboratory result.

Signal pattern	Likely concern	Automated action	Required human response
Chlorine falls while turbidity rises	Contamination ingress, high demand or treatment breakthrough	Critical geofenced alert; identify upstream and downstream nodes; open incident ticket	Verify by DPD and grab sample, inspect source and network, protect consumers as risk requires
Chlorine falls without turbidity change	Dose failure, long residence, biofilm demand or sensor drift	Compare plant dose, flow, water age and adjacent sensors	Check feed and contact time, calibrate sensor, flush or boost only under approved SOP
Turbidity rises after pressure transient	Ingress through leak, repair or cross connection	Correlate pressure, flow, valve, repair and complaint data	Isolate affected zone where necessary, locate defect and sample source to endpoint
Flow imbalance or night flow increases	Leak, unauthorised use or meter error	Create leak probability and ranked inspection route	Conduct field and acoustic confirmation before excavation
Single implausible sensor spike	Fouling, bubble, power or communications fault	Flag suspect data; compare redundant and laboratory information	Clean, calibrate or replace sensor; do not silently delete raw data



12.2 Integrated LIMS and AI governance

- Integrate LIMS, GIS, SCADA or IIoT, hydraulic model, CMMS work orders, complaint system and authorised health alerts through documented interfaces and common asset IDs.
- Use rules and machine learning to detect rate of change, spatial gradients, chlorine decay, turbidity excursions, pressure transients and combinations that are more informative than a single threshold.
- Train and validate models on quality controlled local data, display confidence and data quality, monitor false positives and missed events, and require named approval for model changes.
- Keep raw sensor and laboratory data immutable, record every correction, preserve model and rule versions and provide a complete audit trail for inquiries and court review.
- Apply role based access, encryption, secure device identity, network segmentation, backups, incident response and offline operating procedures; water control commands must never be exposed through an unvalidated analytics interface.

12.3 Advanced leak detection and network integrity

Leakage is a water quality risk as well as a water loss problem. Under intermittent or low pressure conditions, a cracked main near a drain or sewer can draw contaminated water into the network. Uttarakhand should combine district metered areas, inlet and outlet flow balance, pressure loggers, minimum night flow analysis, acoustic loggers and correlators, transient monitoring, smart valves and targeted condition assessment. Technology must be matched to pipe material, diameter, terrain, background noise and communications; no single leak detector is universally reliable.

Layer	Function	Integration output
District metered area	Detect abnormal water balance and locate the affected zone	Flow imbalance and minimum night flow alarm in GIS
Pressure and transient sensors	Detect low pressure, bursts, valve events and intrusion opportunity	Time matched risk event passed to LIMS and SCADA
Acoustic loggers and correlators	Screen and pinpoint pressurised leaks	Ranked field investigation with confidence and pipe context



Layer	Function	Integration output
Chlorine and turbidity nodes	Show whether hydraulic event coincides with water quality deterioration	Combined contamination risk score and sampling route
CMMS and field verification	Confirm, excavate, repair, flush and disinfect	Work order, photographs, repair data and clearance samples
Hydraulic and AI analytics	Estimate propagation, affected consumers and optimal isolation valves	Decision support reviewed by competent engineer and water quality officer

12.4 Complaint surveillance

Every odour, colour, illness or low pressure complaint should receive a geocoded ticket. Repeated tickets in a zone must trigger a cluster alert even before a routine test fails. The utility should publish a toll free number and QR code, acknowledge complaints immediately and record inspection, sampling, repair and closure. Illness details must be handled by health authorities with privacy protection.

12.5 Real time sensors and decision support

Prioritise continuously logged free chlorine, turbidity, flow and pressure at treatment and post contact points, service reservoirs and high risk field nodes. In small schemes, start with robust outlet and tail end nodes and expand after field validation. Time stamped alerts should identify abrupt loss of residual, turbidity peaks, pump starts after outage, abnormal pressure and spatial patterns consistent with ingress. Integrate these with GIS, LIMS and maintenance records so trained staff can identify affected branches and dispatch confirmed sampling quickly.

Pilot AI and machine learning for prediction of chlorine decay, demand shifts, pressure losses and anomalous combinations, comparing performance against simple rules and independently labelled events. Require validated calibration, false alarm and missed event review, explainable alert reasons, cybersecurity, human approval of safety critical changes, and manual fallback. The case for procurement should rest on faster detection and closure of verified events, not claims that software makes water safe.



13 Health surveillance integration

District Surveillance Units should exchange daily line list summaries with water quality teams during an alert. The joint dataset should compare onset date, residence, water zone, source, travel, food exposure, clinical diagnosis and laboratory findings. Spatial and time clustering is more informative than a simple count. Environmental and clinical laboratories should agree on specimen and water sampling before field deployment so that results can be compared.

Trigger	Joint action
Unusual diarrhoea vomiting jaundice or typhoid cluster	Create case definition, line list and epidemic curve; map cases to water zones; inspect and sample immediately.
Hospital or PHC reports common locality	Alert the district water quality officer and scheme operator within one hour.
Water sample critical failure	Ask health teams to review recent cases and vulnerable institutions in the affected zone.
Shared clinical and water pathogen finding	Undertake molecular or advanced comparison where available and epidemiologically justified.
No pathogen found in later water sample	Continue investigation; intermittent contamination, late sampling and pathogen die off must be considered.
Incident closure	Jointly document cause, evidence, repairs, clearance samples, remaining uncertainty and prevention actions.



14 Incident and outbreak response plan



Figure 3 Response to a critical water quality alert

14.1 Activation levels

Level	Condition	Response
Green	Controls and results within limits	Routine monitoring and preventive maintenance
Amber	Low chlorine, abnormal turbidity, pressure loss, sanitary defect or complaint cluster	Immediate operational correction, targeted sampling and supervisor review
Red	E. coli detection, known sewage ingress, treatment failure or disease cluster	Activate district incident command, isolate or restrict supply, safe alternate water, public advice and intensive investigation
Black	Widespread outbreak, multiple schemes, disaster or inability to provide safe supply	State incident command, health emergency coordination, mutual aid, mobile laboratories and daily public briefing

14.2 First 24 hours after a red trigger

21. Protect consumers first. Stop, isolate or restrict the suspected supply when exposure cannot be controlled. Arrange tested alternate water and issue a clear boil water or do not use notice as advised by health authorities.



22. Activate the district Water Health Incident Command and appoint one incident lead, one technical lead and one public information lead.
23. Preserve evidence. Secure operational logs, SCADA data, complaints, repair history, rainfall data, treatment records, CCTV where relevant and original laboratory records.
24. Map the affected zone and hydraulics. Identify every source, tank, valve, sewage crossing, recent excavation, leak and low pressure area.
25. Collect coordinated samples from source, treatment, reservoir, network, tail end, case households, control households and alternate supplies using proper chain of custody.
26. Undertake clinical surveillance and case finding. Provide treatment and referral; do not delay health action pending environmental confirmation.
27. Repair, flush and disinfect under an approved engineering protocol. Verify contact time, chlorine demand and residual; manage disinfection byproducts and safe disposal of chlorinated water.
28. Publish the known facts, affected area, safety advice, water distribution arrangements and next update time. Do not claim causation before evidence supports it.

14.3 Clearance criteria

Normal supply should resume only after the physical defect is corrected, treatment and pressure are stable, reservoirs and affected mains are cleaned or disinfected as required, operational limits are achieved, and a defined series of representative samples meets microbiological and other relevant criteria. The District Water Quality Officer and CMO should sign the clearance. The number and timing of samples should reflect system size, contamination extent, disinfectant contact and pathogen risk; one convenient compliant sample is insufficient after a serious event.



15 Monsoon and disaster preparedness

Period	Required action
Before monsoon	Inspect every source, intake, spring chamber, reservoir, drain crossing and vulnerable main; clean assets; stock disinfectant and test kits; service generators, sensors and mobile vans; test alternate sources.
During heavy rainfall	Increase source turbidity and chlorine monitoring; apply intake shutdown criteria; inspect landslide and sewage risks; sample high risk tail ends; issue advice promptly.
After landslide flood or cloudburst	Assume affected sources and lines are unsafe until inspected. Provide alternate supply, repair and disinfect, and use mobile laboratories.
Winter or road closure	Pre position bottles, reagents, disinfectant, spare sensors and communication equipment; train local personnel for interim field monitoring.
Tourism and pilgrimage peak	Review demand, treatment capacity, tanker sources, temporary toilets, sewage loads and public institution monitoring before the event.

15.1 Emergency drinking water continuity

Uttarakhand Jal Sansthan and the responsible rural authority should maintain a documented alternative supply plan for remote villages and isolated road corridors. When contaminated supply is confirmed or credible, issue a clear advisory and supply tested drinking water by sealed tanker, packaged water or another controlled source, using clean disinfected containers and verifying chlorine and microbiology at loading and delivery points. Maintain tanker route, source, cleaning and custody records.

Portable point of use or community hollow fiber membrane purifiers may support short term access where logistics permit, but only units with validated pathogen reduction for the hazards present, trained operators, intactness or performance checks, safe storage and a suitable downstream disinfectant residual or equivalent protection should be deployed. A nominal hollow fiber rating does not establish virus removal; contaminated water with dissolved chemicals also requires appropriate separate treatment. Prioritise tanker or other verified safe supply if the



purifier cannot be validated and maintained. Restore the piped supply only after source, treatment and distribution clearance.



16 Community surveillance and risk communication

Five trained women or other suitable community members per village, consistent with the JJM model, should conduct monthly sanitary inspections and authorised FTK testing. Their role is early warning, not certification of potability. Any presumptive failure must be referred to a competent laboratory and acted on according to risk. Results should be displayed at the Gram Panchayat, school, health facility and online in Hindi and, where useful, local languages.

- Explain that clear water may still contain pathogens and that later compliant samples do not always exclude earlier contamination.
- Publish the meaning of residual chlorine, turbidity and E. coli in plain language.
- Provide practical instructions for boiling, safe storage and cleaning household containers during an advisory.
- Identify the official source of updates and correct rumours quickly.
- Provide accessible reporting channels for remote villages, persons with disabilities and people without smartphones.



17 Infrastructure assurance and preventive maintenance

Asset	Assurance activity	Frequency
Spring or source	Sanitary inspection, fencing, drainage, catchment protection and contamination pathway survey	Monthly and after heavy rain
Treatment unit	Process audit, chemical dose verification, filter performance and contact time validation	Daily controls and quarterly technical audit
Reservoir	Cover vent overflow drain security, sediment, structural integrity and cleaning record	Monthly inspection and risk based cleaning
Water main	DMA water balance, continuous pressure and flow review, acoustic leak survey, illegal connection and sewage crossing inspection	Continuous analytics; field confirmation by risk and after every alarm
Sewer and septic systems	Leakage and overflow survey near water assets	Pre monsoon and after complaints or construction
Disinfection equipment	Duty standby readiness, dosing calibration, hypochlorite strength assay, contact time and DPD residual verification	Each shift; stock assay by risk; monthly preventive maintenance
Public institution storage	Tank condition, cleaning record, residual chlorine and tap hygiene	Monthly and before reopening



18 Implementation roadmap

Phase	Period	Main deliverables
Emergency stabilisation	0 to 30 days	Jeolikote joint investigation and repairs; high risk scheme list; monsoon emergency testing; alternate water controls; public reporting.
State baseline	31 to 90 days	GPS inventory; risk scoring; hypochlorite stock and chlorinator audit; OT kit withdrawal; DPD rollout; laboratory governance and staffing gap assessment.
System build	3 to 6 months	Independent Secretariat; electrochlorination and sensor pilots; LIMS GIS SCADA integration; mobile vans; DMA and acoustic leak pilots; joint health alerts.
Scale and accreditation	6 to 18 months	Risk based technology rollout; laboratory accreditation scope; qualified staffing; proficiency testing; online monitoring at priority nodes; independent audits.
Assurance maturity	18 to 36 months	Hydraulic model optimised sensor network; validated AI alerts; annual public assurance report; water safety plans for every scheme; third party evaluation.



19 Indicative resource and budget heads

A detailed cost estimate requires the verified number of schemes, laboratories, staff, vehicles, instruments and existing contracts. The annual action plan should nevertheless ring fence the following heads so that monitoring is not reduced when construction budgets are under pressure.

Budget head	Items
People	Regular qualified chemists, microbiologists, samplers, data analysts, sensor and instrument technicians, epidemiology liaison and drivers
Laboratories	Civil improvement, microbiology separation, instruments, calibration, reference materials, media, reagents and waste management
Field system	Sampling kits, temperature controlled vans, mobile laboratories, automatic samplers, FTKs, GPS and PPE
Digital system	LIMS, GIS, SCADA and IIoT integration, hydraulic and AI analytics, dashboards, cybersecurity, connectivity, devices and data validation
Operations	Fuel, cold chain, consumables, repairs, proficiency testing, accreditation, training and audits
Emergency reserve	Alternate water, disinfection materials, rapid logistics, surge laboratory capacity and public communication
Disinfection modernisation	Stock assay, DPD instruments, onsite electrochlorination pilots, gas safety upgrades, ozone or nanobubble treatability pilots and contact tanks
Network integrity	DMA meters, pressure and flow loggers, acoustic equipment, online chlorine and turbidity nodes, leak repair, sewer separation and smart valves
Infrastructure correction	Reservoir rehabilitation, chlorination redundancy, pressure management, pipe renewal and source protection



20 Performance indicators

Indicator	Suggested target after full rollout
Schemes with current water safety plan and risk score	100 percent
Sources tested for bacteriological parameters before and after monsoon	100 percent
Sources tested annually for required chemical parameters	100 percent
Critical results notified within 15 minutes of authorisation	At least 95 percent
Critical failures with protective action recorded within one hour	100 percent
Samples meeting identity temperature holding time and custody requirements	At least 98 percent
High risk schemes with weekly monsoon microbial surveillance	100 percent
Public institutions meeting monthly monitoring schedule	At least 95 percent
Laboratory proficiency testing satisfactory or corrective action closed	100 percent
Corrective actions closed by risk based deadline and independently verified	At least 95 percent
Operational residual chlorine tests performed by approved DPD method	100 percent
Bulk hypochlorite batches accepted and dosed using current available chlorine assay	100 percent where bulk hypochlorite is used
Critical online sensors within calibration and data availability target	At least 95 percent uptime, excluding approved maintenance
Priority leak and water quality alarms field verified within the risk based service time	At least 95 percent
Outbreaks with joint after action report within 30 days of closure	100 percent



21 Recommendations for government decision

29. Constitute a Chief Chemist led Drinking Water Quality Commissionerate under section 5.1.2.2 of the JJM WQMS Framework, with a direct reporting line to the Secretary or Principal Secretary, dedicated funds, staff and financial authority, control of the laboratory network, direct adverse result alerts and monthly reports to the State Water and Sanitation Mission Apex Committee. The engineering division should receive results and implement corrective actions, with independent verification of closure.
30. Order a 90 day statewide source to tap baseline and sanitary survey, beginning with critical and high risk schemes.
31. Adopt the monitoring matrix and critical alert protocol in this report as an interim standard pending detailed departmental notification.
32. Mandate IS 3025 Part 26:2021 DPD methods for free and combined residual chlorine, withdraw OT kits from compliance use, and require available chlorine assay of stored hypochlorite.
33. Approve a risk based disinfection modernisation programme prioritising automatic IloT monitored onsite electrochlorination, while allowing safeguarded gas chlorine and validated ozone or nanobubble applications where site assessment supports them.
34. Direct the health and drinking water departments to implement the NCDC joint action SOP and exchange daily alerts through a common LIMS GIS SCADA dashboard.
35. Procure and deploy temperature controlled sampling vans and mobile laboratory capacity for remote hill districts, with GPS and LIMS enabled custody.
36. Deploy risk and hydraulic model based online chlorine, turbidity, pressure and flow nodes, using approximately 2 to 3 km spacing only as a preliminary rule on selected trunk mains.
37. Integrate district metered areas, acoustic leak detection, transient monitoring and repair work orders with LIMS, while requiring field confirmation and independent clearance.
38. Require scheme specific water safety plans, monsoon readiness certificates and verified alternate water arrangements.
39. Publish valid water quality results and incident advisories in plain language and maintain an auditable corrective action register.



40. Commission an independent technical review of the Jeolikote incident, including engineering, laboratory and epidemiological evidence, and publish the findings after protecting personal data.

The state should approve a chlorine demand and effective contact time verification protocol, risk based tap sampling coverage with the proposed small scheme household thresholds, and an independent laboratory staffing and accreditation plan. It should fund source protection surveys, priority online residual and turbidity nodes, calibrated automatic dosing and electrochlorination pilots, and documented tanker or validated portable purifier continuity plans. All numerical targets must be confirmed against source quality, hydraulics, incident conditions and current applicable standards.



Annex A Detailed response checklist

Area	Check	Evidence
Activation	Incident level assigned and command group notified	Time, sender, acknowledgement
Public protection	Unsafe supply isolated and alternate safe water provided	Valve log, supply certificate, distribution map
Public advice	Advisory issued in affected language and channels	Approved message and publication record
Health	Case definition, line list, active case finding and clinical specimens	IDSP records and laboratory plan
Engineering	Hydraulic map, defect survey, pressure and leak tests	Geo tagged inspection and repair evidence
Sampling	Source to tap and case control sampling with custody	LIMS IDs, GPS, temperature and receipt
Laboratory	Priority analysis and quality controls	Raw data, controls, authorisation and notification
Remediation	Repair, flushing and disinfection completed safely	Work order, dose, contact time and residual record
Clearance	Representative samples compliant and controls stable	Joint signed clearance
Learning	Root cause and after action review completed	Published report and tracked prevention actions



Annex B Sample field record

Record section	Required fields
Sample identity	Sample ID, scheme ID, asset ID, sample type and purpose
Location	Village ward, address, GPS, point description and photograph
Collection	Date, time, collector, bottle type, preservative or neutralizer and seal number
Context	Weather, rainfall, source condition, outage, repair, complaint and observed sanitary risk
Operations	Flow, pressure, treatment status, disinfectant dose and contact conditions
Field results	Temperature, pH, turbidity, conductivity or TDS and free residual chlorine
Transport	Cooler ID, dispatch time, continuous temperature record and custody transfers
Receipt	Laboratory receipt time, condition, temperature, acceptance or reason for rejection
Analysis	Requested parameters, method, analyst, start time and completion time
Notification	Result severity, persons notified, time and corrective action ticket



Annex C Sanitary inspection questions

41. Is faecal waste, a drain, septic tank, latrine, animal area or waste dump close enough to contaminate the source or main?
42. Can surface runoff enter the spring chamber, intake, well, reservoir or valve chamber?
43. Are covers, vents, overflows, drains and access hatches intact, locked and protected from animals and insects?
44. Has the source or pipeline been damaged by a landslide, excavation, road work, flood or tree fall?
45. Does the water main cross or share a trench with a sewer or drain, and is the water main protected?
46. Are there visible leaks, illegal connections, negative pressure events or frequent interruptions?
47. Is treatment operating, is disinfectant available, and are dose, contact time and residual records complete?
48. Was the reservoir cleaned and disinfected under an approved SOP, and is the date documented?
49. Do schools, Anganwadi centres, health facilities or households use tanks that may recontaminate water?
50. Have recent complaints, illness clusters or failed samples been reviewed and closed with evidence?



Annex D Proposed district monthly dashboard

Dashboard item	Display
Coverage	Schemes and sources due, tested and overdue by risk class
Compliance	Microbial, chemical, chlorine and turbidity status by scheme and zone
Alerts	Open critical and amber alerts, age, owner and escalation status
Health	Water related disease signals by block and mapped water zone
Operations	Low pressure, outage, repair, reservoir cleaning and chlorination failures
Laboratory quality	Rejected samples, holding time breaches, control failures and proficiency testing
Complaints	Clusters, response time, sampling and closure
Public information	Advisories active, update time and alternate water points



Annex E Disinfection and sensor verification checklist

Area	Verification question	Evidence
Hypochlorite	Was available chlorine assayed, dose recalculated and stock age and temperature reviewed?	Assay worksheet, batch record and pump calculation
Electrochlorination	Are brine quality, cell output, hydrogen ventilation, duty standby status and residual feedback satisfactory?	Generator log, gas safety check, alarm test and DPD comparison
Gas chlorine	Are leak detector, scrubber, ventilation, emergency kit, trained roster and drills current?	Safety inspection, calibration and drill record
Ozone or nanobubbles	Does validated performance meet the defined treatment objective without uncontrolled bromate or off gas risk?	Pilot protocol, accredited results, mass balance and risk assessment
DPD measurement	Are reagent, range, instrument check, blank, timing and sample details valid?	Field record and instrument quality control
Online sensor	Does the online value agree with a verified grab measurement within acceptance criteria?	Calibration or verification record and data quality flag
AI alarm	Were source data, rule or model version, confidence and human decision retained?	Immutable event record and authorised response
Leak event	Was the suspected location confirmed, repaired, flushed and independently cleared?	Work order, photographs, pressure test and clearance samples



References

1. Economic Times 22 September 2026 report based on PTI. https://m.economictimes.com/news/new-updates/2-die-due-to-contaminated-drinking-water-in-nainital-6-uttarakhand-engineers-suspended-due-to-negligence/amp_articleshow/134404213.cms
2. Times of India 1 September 2026 Jeolikote report. <https://timesofindia.indiatimes.com/city/dehradun/jaundice-outbreak-in-jeolikote-sparks-anger-drinking-water-contamination-suspected/articleshow/133689094.cms>
3. Times of India 7 September 2026 Jeolikote report. <https://timesofindia.indiatimes.com/city/dehradun/3-dead-60-reported-cases-jeolikote-residents-seek-action-over-illness-outbreak/articleshow/133891431.cms>
4. ETV Bharat link supplied for this report. <https://www.etvbharat.com/hi/state/amid-pandemic-caused-by-contaminated-water-in-villages-of-nainital-jyolikot-block-all-water-samples-failed-uts26091900933>
5. Amaayu link supplied for this report. <https://www.amaayu.com/blog/nainital-jeolikote-jaundice-outbreak-contaminated-water-2026>
6. Jal Jeevan Mission Drinking Water Quality Monitoring and Surveillance Framework. https://jaljeevanmission.gov.in/sites/default/files/manual_document/WQMS-Framework.pdf
7. NCDC Standard Operating Procedures for Joint Action on Water Quality Monitoring and Health Outcomes. https://ncdc.mohfw.gov.in/uploads/resource/1769334703_SOP-for-Joint-Action-on-Water-Quality-Monitoring-Health-Outcomes_Jan25.pdf
8. MoHUA Advisory on Strengthening Water Quality Monitoring in Cities through Community Participation. <https://amrut.mohua.gov.in/assets/Water-Quality-Monitoring-WQMIS-Advisory-Final.pdf>
9. Bureau of Indian Standards Product Manual listing DPD methods under IS 3025 Part 26. <https://www.bis.gov.in/wp-content/uploads/2024/07/PM-14543-July-2024-Approved.pdf>
10. IS 3025 Part 26:2021 Methods of Sampling and Test for Water and Wastewater, Chlorine Residual, second revision. https://www.services.bis.gov.in/php/BIS_2.0/bisconnect/pow_new/Pow/download_pow_pdf_dept_commtt/62/351/
11. WHO Water Safety Plan Manual Second Edition 2023. <https://www.who.int/publications/i/item/9789240067691>
12. WHO Guidelines for Drinking Water Quality Small Water Supplies 2024. <https://www.who.int/publications/i/item/9789240088740>
13. Central Ground Water Board Publications Repository. <https://cgwb.gov.in/cgwbpnrm/>
14. Jal Jeevan Mission National Conference on Drinking Water Quality 2022. <https://jaljeevanmission.gov.in/sites/default/files/proceedings-of-one-day-national-conference-on-water-quality.pdf>



15. NCDC Public Health Guidelines for Flood Events.
https://ncdc.mohfw.gov.in/uploads/resource/1769333008_95276575411596609841.pdf
16. US EPA Alternative Disinfectants and Oxidants Guidance Manual.
<https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=2000H045.TXT>
17. US EPA Drinking Water Treatability Database Ozone.
<https://tdb.epa.gov/tdb/treatmentprocess?treatmentProcessId=-1467636837>
18. US EPA Control and Mitigation of Drinking Water Losses in Distribution Systems.
<https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P1009VCZ.TXT>
19. US EPA Condition Assessment Technologies for Water Transmission and Distribution Systems.
<https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P100E3Y5.TXT>
20. WHO Guidelines for Drinking water Quality, chemical fact sheet on chlorine and effective disinfection: <https://www.ncbi.nlm.nih.gov/books/NBK579467/table/ch8.tab17/>
21. WHO Technical Note 11, Measuring chlorine levels in water supplies: <https://www.who.int/docs/default-source/wash-documents/wash-in-emergencies/technical-notes-on-wash-in-emergencies/who-tn-11-measuring-chlorine-levels-in-water-supplies.pdf>
22. National Jal Jeevan Mission Drinking Water Quality Monitoring and Surveillance Framework (2021), attached copy, especially preface and institutional mechanism on printed pages 19 to 20 and institutional diagram on printed page 26; URL as reference 6.
23. Government of Ontario, Safe Drinking Water Act, 2002, and Drinking water testing requirements for laboratories (adverse result reporting): <https://www.ontario.ca/laws/statute/s02032> ; <https://www.ontario.ca/page/drinking-water-testing-requirements-laboratories>
24. Drinking Water Inspectorate, Our work and Working with stakeholders (independent inspection, laboratory audit and accreditation): <https://www.dwi.gov.uk/what-we-do/our-work/> ; <https://www.dwi.gov.uk/what-we-do/annual-report/drinking-water-2024/drinking-water-2024-summary-of-the-chief-inspectors-report-for-drinking-water-in-england/working-with-stakeholders/>
25. United States Environmental Protection Agency, Learn About Laboratory Certification for Drinking Water (approved methods, proficiency testing and audits): <https://www.epa.gov/dwlabcert/learn-about-laboratory-certification-drinking-water>



Source note

The news reports and links establish the context for this proposed plan but are not substitutes for authenticated government orders, clinical records or laboratory reports. Technology references support general engineering principles; every disinfection or nanobubble application requires scheme specific design, treatability testing and competent approval.