CHAPTER 9

DRINKING WATER QUALITY MONITORING AND SURVEILLANCE

9.1 INTRODUCTION

Drinking water quality monitoring and surveillance is the continuous monitoring of public health along with vigilant assessment and control of safe potable water supply.

9.2 IMPORTANCE OF WATER QUALITY

Safe potable water is the first step to promote good health of the community. Experience has shown that community health and water quality is directly related to each other and an improvement of drinking water quality is followed by an improvement in the community's health. Man made activities; rapid industrialization and agrochemical contamination increasingly affect the quality of water resources. Moreover, infant mortality, mostly from diarrhoeal and other water borne and water related diseases (*Annexure 9.1*) are of great concern in underdeveloped as well as developing countries. Inspite of significance achievements in water supply and sanitation coverage, many factors render good quality water unsafe by the time it reaches the consumer. Poor operation management and unsatisfactory sanitary practices are the major key areas responsible for water contamination. Water quality management and surveillance practices ensure safe water supply to consumers.

9.3 DEFINITION

While describing water quality, certain terms are frequently used, which are to be clearly understood and correctly used. Some of the definitions are given below:

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

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

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

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

Parts per million (ppm) or milligrams per litre (mg/l) these terms are used to express the concentrations of dissolved or suspended matter in water. The parts per million (ppm) is a weight to weight or volume to volume relationship. Except in highly mineralized water, this

quantity would be same as milligram per litre. This is preferable, since it indicates how it is determined in the laboratory.

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

Toxic is harmful, destructive or deadly poisonous.

Physiological effect having effect on the normal functions of the body.

Pathogens disease-producing organisms.

Bacteria a group of universally distributed, essentially unicellular microorganisms lacking chlorophyll.

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

Coliform Bacteria group of bacteria predominantly inhabiting the intestine of human beings and animals, but also occasionally found elsewhere. Used to indicate presence of faecal pollution.

Enteric having its normal habitat in the intestinal tract of human beings or animals.

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

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

9.4 WATER SUPPLY AND SURVEILLANCE AGENCIES

Water supply agency is responsible for safe water supply to consumers. The main objectives of water quality monitoring are:

1. To determine the quality of water in its natural state in view of its present and future needs
2. To assess the suitability of water for required use
3. To find out the pathways for pollution, if any

Monitoring of water quality by water supply agency involves laboratory and field testing of water samples collected from various points in the water supply system, including the source, water purification plants, service reservoirs distribution systems and consumer end, representative of the condition of water at the point and time of collection. Continuous water quality monitoring involves good operating practices and preventive maintenance, as well as the regular routine testing, and monitoring of water quality to ensure compliance with standards.

Surveillance is an investigative activity undertaken by a separate agency, to identify and evaluate factors posing a health risk to drinking water. Surveillance requires a systematic program of surveys that combine water analysis and sanitary inspection of institutional and community aspects, and reporting system. Sanitary inspection of water supply system should cover the whole system including water sources, rising mains, treatment plants, storage reservoirs, and distribution systems; to identify most common risks and shortcomings in the water supply. Moreover, surveillance is concerned with all sources of water used for domestic purpose by the population, whether supplied by a water supply agency or collected from other

individual sources. So it is important to inspect and analyze all sources of water used and intend to be used for human consumption.

Surveillance agency should communicate to the water supply agency and pinpoint the risk areas and give advice for remedial action. It should also maintain good communication and cooperation with water supply agency for detection of risk areas and remedial action for betterment of water supply. *Annexure 9.2* gives functions and responsibilities of agencies for water quality monitoring and surveillance.

9.5 PLANNING AND IMPLEMENTATION

Systematic planning, keeping in view the fundamental objectives, is necessary for successful implementation of drinking water quality control program.

9.5.1 GENERAL CONSIDERATION AND STRATEGIES

Quality control activities should be initiated as per the norms of national guidelines for each water supply system on a continuous basis.

Surveillance agency should carry out periodic surveillance of all aspects of water quality safety including sanitary inspection and spot checks and result should be reported to the concerned water supply agency to implement remedial action when and where necessary.

Water supply surveillance can be planned in progressive manner considering the availability of resources. It should start with a basic program, which could generate useful data to plan advanced surveillance as resources, and conditions permit. The initial pilot scale program should cover minimum basic strategies including fewer water quality parameters that provide reasonable degree of public health protection and should be widely applicable. Careful planning of training and resource provision is very essential right from the beginning of the project.

9.5.2 LEGAL AND INSTITUTIONAL BASIS

9.5.2.1 Legislative Framework

Laws and bylaws prevailing in local bodies should be strictly implemented.

9.5.2.1 Institutional Framework

Water-quality surveillance requires an institutional framework that reflects its objectives and functions and gives key responsibilities to the relevant bodies. At the center of this framework major responsibility for monitoring and surveillance is shared between two agencies whose activities should be mutually exclusive and complementary.

Intersectoral cooperation is required in all activities related to the promotion and surveillance of water quality, from the planning stage, to the actual supply of water, the monitoring and surveillance of water quality, and the implementation of preventive and remedial measures. In the beginning itself, both the agencies should, in consultation with one another, agree on a program on drinking water quality monitoring and surveillance.

9.6 SURVEILLANCE PROGRAM

Surveillance activities differ from region to region; between urban and rural communities; and according to the types of water supply. They should be adapted to local conditions; availability

of local finances, infrastructure and knowledge. Water supply provider and surveillance agencies, depending on resources available with them, will develop the program for monitoring and surveillance of drinking water quality. Following factors should be taken into consideration while implementation of surveillance activities.

- The type and size of water supply systems.
- The existing and available equipment.
- Local employment practices and the level of training.
- Opportunities for community participation.
- Accessibility of systems keeping in view of geographical and climatological conditions.
- Communication and transport facilities available.

Surveillance program can be phased out in three distinct phases - Initial, Intermediate and Advance.

Initial phase

- Identify agencies and develop collaboration.
- Finalize institutional requirements.
- Prepare inventories of water supply system.
- Preliminary training for staff.
- Assess and identify priority areas for sample collections.
- Develop methodologies for water quality analysis.
- Commence routine surveillance in priority areas.
- Limit water analysis to critical parameters only.
- Establish reporting, filling and communication systems.
- Identify community roles and promote participation.

Intermediate phase

- Establish and expand systematic routine surveillance.
- Expand analytical capability.
- Train staff.
- Use draft standard methods for analysis and field works.
- Establish data based archive.
- Identify common problems and improve activities accordingly.
- Use legal enforcement where possible.
- Involve community.

Advanced phase

- Establish routine surveillance for all health parameters at defined intervals.
- Use guidelines as given in Manual on Water Supply and Treatment.
- Give advance training to staff.

- Use full network of local, regional and central laboratories.
- Improve water services on the basis of local priorities, hygiene awareness and enforcement of standards.
- Involve communities.
- Disseminate data at local, regional and national level.

9.7 INFORMATION MANAGEMENT

The flow of information between and within the water supply and surveillance agencies is necessary to maximize the quality of service to consumer and protection of public health. The report provided by the surveillance agency to water supply provider should include:

1. The summary reports of condition of water supply and water quality analysis.
2. Highlight those aspects, which are considered inadequate and needs action.
3. Recommendation of remedial action in case of emergency.

The report should not be limited to complain about failures but the water supply and surveillance agencies should coordinate their activities to ensure good quality of water to consumers. Such a report should specify actions in order of priorities for intervention based on public health criteria. If consistently, unsatisfactory results are reported in a particular area, the cause for the same should be investigated and remedial measures taken, such as repair of leakage, replacement of corroded and leaking consumer pipes etc.

Local laboratory under surveillance agency should maintain detailed field reports regarding inspections and water analysis of all water supplies available in the area. It should include the results of all inspections and analysis. The local surveillance office should report to the relevant supply agency as soon as possible after field visits. The information should also be passed on to regional authorities to allow follow-up; if recommendations for remedial action are not implemented. However, there must be a rapid means of reporting in case of emergency.

The consumers have the right to know about the quality of water being supplied to them. Therefore, the agencies responsible for monitoring should develop strategies for informing public the health-related results obtained by them along with recommendations for action (e.g. boiling during severe faecal contamination, household water storage education etc.) through publicity, pani-panchayats etc.

Local government should ensure that the agency that supplies drinking water to the area complies with the quality standards.

9.8 SUPPORT STRUCTURE

Monitoring and surveillance programmes require laboratory network, offices, transport, financial support and adequate staffing.

9.8.1 COMMUNITY BASED MONITORING AND SURVEILLANCE

Community participation is an essential component of the monitoring and surveillance framework. As the primary beneficiaries community can play an important role in surveillance activity. They are the people who may first notice the problems in water supply and report it to concern agency or take remedial action if possible. Establishing a genuine partnership

with the community creates a climate of trust and understanding, which generates interest and enthusiasm. It also provides a good foundation for other educational activities such as promotion of good hygiene practices.

The community based monitoring and surveillance can be carried out in two ways:

1. Selection of community volunteers, including women, to undertake surveillance activities after training.
2. Providing encouragement to local worker to carry out certain jobs pertaining to surveillance.

In both the cases, preliminary training is necessary for field workers to identify sanitary hazards associated with the water supply, as well as regarding reporting system. Health department or water supply agency should help in providing necessary training while community water committee or health committee can supervise the work. The community participation includes:

- Assisting field workers in water sample collection, including sample location points, existing damaged net works, causing/likely to cause contamination of drinking water.
- Assisting in data collection.
- Monitoring water quantity, quality, and reporting findings to surveillance staff regularly.
- Ensuring proper use of water supply.
- Setting priorities for sanitation and hygiene and educate community members.
- Under take simple maintenance and repair work.
- Refer problems which require special attention.
- Disseminate results and explain the implications with respect to health with the objective to stimulate involvement in actions to keep water clean, safe and wholesome.

9.8.2 TRANSPORT

The preferred means of transport varies widely depending on climatic condition, distance, and road condition. The main factor to be taken into account in choosing transport is to send samples to the laboratory as quickly as possible in ice, never exceeding 24 hours.

In remote areas motorcycle and in developed areas four-wheelers may be used.

9.8.3 LABORATORY NETWORK

Water quality laboratory is the main backbone of water quality surveillance. A well-located and well-equipped analytical laboratory with competent staff is very essential to evaluate the efficiency of water utility services in terms of water quality. Water samples should be analyzed for priority parameters as per local problems.

In principle, water samples should be analyzed as fast as possible to avoid deterioration of sample quality, especially for microbiological analysis. For more effective coverage laboratory facilities can be categorised in two stages; Basic laboratories, State/Regional laboratories. (*Annexure 9.3*)

9.8.4 FINANCIAL SUPPORT

Sufficient allocation of fund should be made for maintaining/monitoring water quality and its surveillance, keeping in view, size of water works, area covered, etc.

9.8.5 STAFFING

Staff requirements for water supply monitoring and surveillance program vary widely according to the plant size, ecological and economical conditions. *Annexure 9.4 (a) and 9.4(b)* shows the possible suggestions for water quality monitoring and surveillance staff.

9.9 SURVEILLANCE ACTION

Surveillance action comprise of:

1. Investigative action to identify and evaluate all possible factors associated with drinking water, which could pose a risk to human health.
2. Ensure preventive action to be taken to prevent public health problem.
3. Data analysis and evaluation of surveys.
4. Reporting to concerned authorities.

9.10 SANITARY SURVEY

Sanitary survey is periodic audit of all aspects of all water supply system. Systematic program of sanitary survey includes sanitary inspection, water quality analysis, and evaluation of data and reporting.

9.10.1 NATURE AND SCOPE

Sanitary survey is an on-site inspection and evaluation of all conditions, devices and practices used in water supply system, which pose an actual or potential danger to the health and well-being of consumer by trained persons. It is a fact-finding activity, which identifies actual sources of contamination as well as point out inadequacies in the system that could lead to contamination.

The two important activities of sanitary survey are sanitary inspection and water quality analysis; which are complementary to one another. The inspection identifies potential hazards, while analysis indicates actual quality of water and intensity of contamination.

9.10.2 SANITARY INSPECTION

Sanitary inspection covers the inspection of water system, including the source, transmission mains, treatment plants, storage reservoirs and distribution system. Basically it is a fact-finding review to uncover deficiencies and inadequacies, which could lead to contamination of water. Sanitary inspection is indispensable for the adequate interpretation of laboratory results. It provides essential information about the immediate and ongoing possible hazards associated with a community water supply. It is an essential tool to pinpoint target areas for remedial action, required to protect and improve the water supply system.

9.10.3 SANITARY INSPECTION REPORT

The sanitary inspection report shall cover the following:

1. Identify potential sources and points of contamination of the water supply.
2. Quantify the hazards attributed to the source and supply.
3. Provide a clear, graphical means of explaining the hazards to the operator/user.

4. Provide clear recommendations for taking remedial actions, to protect and improve the supply.
5. Provide basic data for use in systematic, strategic planning for improvement.

Moreover inspection report should not be restricted to water quality but should take into account other service condition such as coverage, cost, condition and quantity. Such surveys are important form the point of view of operation and maintenance. *Annexure 9.5* shows suggested inspection forms for different water sources.

9.10.4 WORK CHART FOR SANITARY SURVEY

For collection of adequate information and follow-up work, proper work chart should be prepared considering local requirement. Following should be taken care of:

1. Prior knowledge of source, and type of water supply; and map of distribution system.
2. Notify the visit in advance, where the assistance of community members is needed.
3. Carry prescribed forms and necessary accessories, like sample bottle, sample carry box, analysis kit etc.
4. Verify basic data with community.
5. Interview community members for drinking water supply service.
6. Verify information gathered by observation during survey.
7. Inspection and water sampling should not be haphazard, should follow specific guideline.
8. Water samples should be analyzed immediately for residual chlorine and thermotolerent coliform, or transported quickly to laboratory in iced boxes.
9. Complete the sanitary report on site, and send it immediately to appropriate authority for follow-up remedial action if necessary.
10. Undertake appropriate small repairs at the time of survey in remote areas such as washer changing for leaking taps.
11. For pictorial forms, each risk point should be circled and given to member of water committee for follow-up action.

9.10.5 TIME AND FREQUENCY

No new public water supply should be approved without sanitary inspection', to provide sufficient information to indicate the suitability of the source and the amount of treatment required before the water can be considered suitable for human consumption. Physical, bacteriological, and chemical analysis should be carried out initially. The physical and bacteriological analysis can be followed at regular intervals, while chemical analysis can be carried out after fairly long time, as the substances are unlikely to be changed with time.

Water quality analysis of surface sources should be carried out frequently through out the year as its parameters vary greatly due to rainfall, man made as well as industrial activities, seasonal changes etc.

Sanitary surveys should be undertaken frequently by water supply department. The frequency of inspection and analysis largely depends on community size and local water

quality problems. *Annexure 9.6a, 9.6b, 9.6c(1) and 9.6c(2)* suggests the minimal round of surveys by water supply and surveillance agency.

9.11 WATER SAMPLING AND ANALYSIS

Periodic drinking water analysis is necessary to ensure safe quality water supply. Water samples should be analyzed for various microbiological and physicochemical contaminants. However, the authenticity of water analysis greatly depends on the sampling procedure.

The objective of sampling is to collect a small portion of water which can be easily transported to laboratory, without contamination or deterioration and which should accurately represent the water being supplied. It should cover locations which are most venerable in the supply system.

For recommended sampling procedures and guideline values regarding physical and chemical parameters, kindly refer to Manual on Water Supply and Treatment, III Edition, May 1999, Government of India, Ministry of Urban Development, New Delhi.

9.12 DATA ANALYSIS, INTERPRETATION AND REPORTING

Data analysis and interpretation are fundamental components of surveillance process. It aims at generation of data, which contributes to protect public health by promoting adequate, safe, potable water supply to communities.

9.12.1 DATA ANALYSIS

Evaluation of community water supply requires consideration of number of factors, such as quality, quantity, coverage, continuity of water supply and never the least, its production cost.

9.12.1.1 QUALITY

Quality of water supplied to communities is an important consideration for human health and well being. Remedial and preventive measures also form an important part of water supply quality maintenance. *Annexure 9.7* gives details about the suggested guidelines for the same. Water quality data, generated and summarized by surveillance agencies are useful tools to promote improvement and design action strategies for quality water supplies in compliance with national standards.

9.12.1.2 QUANTITY

Along with quality, quantity of supplied water to the community plays an important role for maintenance and improvement of public health. Personal and domestic hygiene greatly depends on per capita quantity of water supply to the consumers. In case of inadequate quantity of water supply, community may use alternate source of water, some of which may be not be safe and affect the public health.

9.12.1.3 COVERAGE

Coverage, from the point of view of the water supply agency, is expressed as the percentage of the total population served; it may be by domestic connection, by public standposts, and by point sources such as wells, handpumps and springs.

Therefore, it is essential to undertake wider survey of the various water sources, the estimated population served by each source, and relative risk associated with each of source. Such information is a useful guideline for water supply program and funding strategies.

9.12.1.4 COST

Cost plays a vital role for adequate quality water supply. In periurban areas as well as some pockets of urban and metropolitan cities, water is purchased from vendors to cater the shortage of water supply, and in such cases the public health is at risk. As the cost involved in monitoring is very little in comparison to total cost of operation and maintenance, there should not be any financial restraint for this activity.

9.12.1.5 CONTINUITY

In most of the piped water supply system, continuous 24 hrs water supply is not feasible due to constrain of many factors. Generally twice a day water supply at full pressure to consumers is adequate; keeping the main line charged for 24 hrs to take care of in pipe-recontamination, which may be potentially hazardous to the consumers. Surveillance data regarding bacteriological analysis at non-peak hours is a good indicator of the in-pipe recontamination due to leakage.

Household storage is necessary for intermittent water supply, which may lead to an increase risk of contamination during such storage and associated handling. In such cases surveillance data on hygiene and subsequently hygiene education is important.

Information collected during surveillance will be of greater use for planning of hygiene awareness program.

9.13 DATA INTERPRETATION

Assessment of sanitary situation as well as microbiological analysis data together, gives an overall picture of health risk assessment.

9.13.1 ASSESSMENT OF SANITARY SITUATION

Sanitary surveillance data generates the information regarding specific points of risk to the water supply. Such information can be used in various ways to facilitate the improvement of community water supplies.

Sanitary inspection data interpretation can be used to:

1. Identify most important source(s) of pollution amongst the number of noted potential sources.
2. Identify simple remedial measures that can be undertaken on the sight or at local level.
3. Identify recurrent problems, which require repeated remedial action and define strategies, which provide permanent solution to the problem, which may need external assistance.
4. Pinpoint the importance of adequate training requirement related to water supply practices in the locality or region concerned.

9.13.2 ASSESSMENT OF MICROBIOLOGICAL WATER QUALITY

Microbiological quality data can be divided into number of categories depending on the level

of contamination associated. *Table 9.1* below shows the suggested classification scheme based on increasing order of magnitude of faecal contamination. Suggested color scheme will be useful for pictorial inspection forms.

The level of faecal contamination may vary widely between successive samples due to seasonal influence such as rainfall where water supplies are unchlorinated. In piped water supply, the samples taken at various points in the whole system sometimes may defer in water quality. The point showing, higher faecal coliform count (>100/100ml) is a sure indication of a sewer water contamination, which may be due to cross contamination or caused by leak in the pipe line. Sanitary inspection data may support the suspicion. Remedial action should be taken immediately.

TABLE 9.1: EXAMPLE OF CLASSIFICATION AND COLOUR-CODE SCHEME FOR THERMO-TOLERANT COLIFORM OR E. COLI IN WATER

Count per 100 ml	Category and Colour code	Remarks
0	A (blue)	In conformity with WHO guidelines
1-10	B (green)	Low risk
10-100	C (yellow)	Intermediate risk
100-1000	D (orange)	High risk
> 1000	E (red)	Very high risk

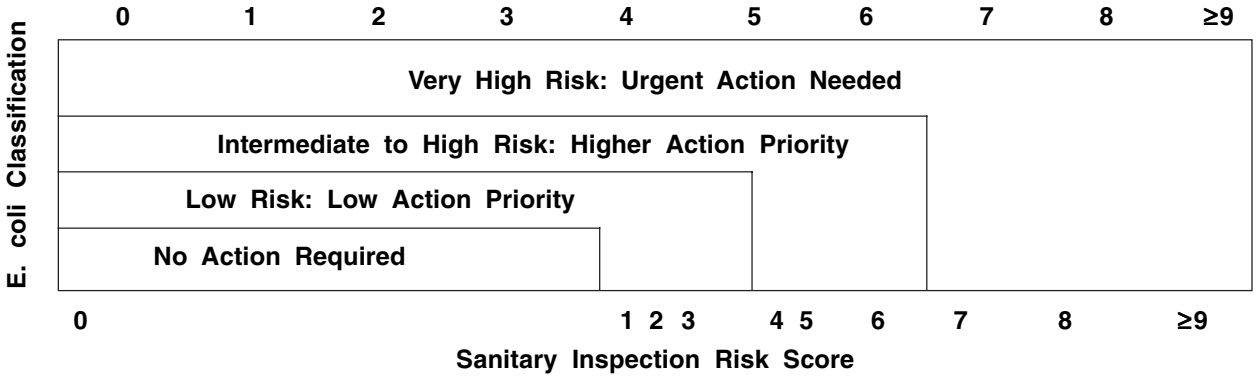
9.13.3 RISK ASSESSMENT

Microbiological analysis represents the single time moment whenever sanitary inspection takes account of the previous history as well as the present situation. Therefore, the examination of the faecal grading together with the sanitary inspection risk score gives a meaningful risk assessment.

Fig. 9.1 illustrates risk analysis keeping in view combined faecal coliform grading and sanitary inspection risk score.

It is expected that greater risk of contamination is likely to be associated with higher grade of contamination. However, a high sanitary risk score associated with low level of faecal contamination still requires urgent action, as it indicates the outburst of contamination any time and preventive action is needed immediately.

FIG. 9.1: EXAMPLE OF ASSESSMENT OF PRIORITY OF REMEDIAL ACTIONS BY RISK ANALYSIS SANITARY INSPECTION RISK SCORE



ANNEXURE 9.1

WATER RELATED DISEASES AND PREVENTIVE STRATEGIES

Classification	Transmission	Examples	Preventive Strategies
Water-borne (Water-borne diseases can also be washed)	Disease is transmitted by indigestion (Faecal – Oral route)	• Diarrhoea • Cholera • Typhoid • Hepatitis (A & E)	- Improve quality of drinking water. - Prevent casual use of other unimproved sources. - Improve sanitation.
Water washed (Water scarce)	• Infections of the intestinal track. • Skin or eye infections. • Infections caused by lice or mites.	• Scabies • Trachoma • Conjunctivitis • Amoebiasis • Giardiasis	- Increase water quantity. - Improve accessibility and reliability of domestic water supply. - Improve hygiene. - Improve sanitation.
Water based	The pathogen spends part of its life cycle in an animal, which is water based. The pathogen is transmitted by indigestion or by penetration of the skin.	• Guinea worm • Schistosomiasis	- Decrease need of contact with infected water. - Control vector host populations. - Improve quality of water (for some types) - Improve sanitation (for some types)
Water related Insect-vector	Spread by insects that breed or bite near water.	• Malaria • Filariasis • River blindness	- Improve surface water management. - Destroy insect breeding sites. - Use mosquito netting. - Use insecticides

Source: 'Water – Quality or Quantity?', "Running Water", International Technology Publication 1999, Page 77.

ANNEXURE 9.2

FUNCTIONS AND RESPONSIBILITIES OF AGENCIES FOR WATER QUALITY MONITORING AND SURVEILLANCE

Agency	Function	Responsibilities
Surveillance Agency 1. Ministry of Health/Rural Development 2. State PHED/Rural Development 3. Local Health Authority, CMO/Health Officer 4. Pollution Control Board	Surveillance of drinking water quality	- To ensure that the drinking water is free from heath hazards. - To find out what is wrong. - Assist in setting things right for both rural and urban systems.
Water Supplying Agency 1. State PHED/Water Boards/Urban Development 2. Urban Local Bodies/Authority 3. Autonomous Agencies	Supply of potable water	- To provide water in sufficient quantity and potable quality to the population at sufficient pressure.
Pollution Control Board, Central/State	Controlling pollution at water source	- To protect the raw water sources from being unduly polluted at Country/ State level.

ANNEXURE 9.3

SUGGESTED WATER QUALITY MONITORING LABORATORY NETWORK AND THEIR ACTIVITIES

S.N.	Level	Activities
1.	**Basic laboratory** a. Primary health centre/Village level	1. Residual chlorine 2. Turbidity 3. Priority parameters as per local water quality problems, preferably through field kits.
	b. Municipal/District level (Plant capacity > 200 mld)	1. Bacteriological tests (Routine) 2. Physico-Chemical tests (Routine) 3. Biological tests (Routine) 4. Other laboratory testing works
2.	**State/Regional level laboratory**	1. Bacteriological tests (Advanced) 2. Physico-Chemical tests (Advanced) 3. Biological tests (Advanced) 4. Other laboratory testing works

Note: For the capacity less than 200mld, Refer to Manual on Water Supply and Treatment, III Edition (Revised and up dated), 1999.

ANNEXURE 9.4a

SUGGESTED LABORATORY SERVICE INFRASTRUCTURE FOR MONITORING WATER QUALITY

S.No.	Level	Minimum Recommended Staff	Remarks
1.	**Basic Laboratory** a. Primary Health Center/Village Level	1. Lab. Assistant/Technician 2. Lab. Attendant	For routine bacteriological and physico-chemical tests, the samples should be sent to municipal/district level laboratory periodically.
	b. Municipal/District Level (Plant capacity >200 mld)	1. Chief Analyst 2. Chemist 3. Bacteriologist 4. Assistant Chemist 5. Lab. Assistant/Technician 6. Lab. Attendants 7. Driver 8. Helper	Wherever Water Treatment Plant Laboratory is existing
2.	**State/Regional Level Laboratory**	1. Chief Analyst (Higher Scale) 2. Chemist 3. Bacteriologist 4. Biologist 5. Assistant Bacteriologist 6. Assistant Biologist 7. Lab. Assistant/Technician 8. Lab. Attendants 9. Driver 10. Helper	

Note: 1. Kindly refer to Manual on Water Supply and Treatment, III Edition, May 1999.
2. The level and the no. of the personnel shall be decided by the respective agencies depending on magnitude of problems and resources available.

ANNEXURE 9.4b

SUGGESTED WATER QUALITY SURVEILLANCE TEAM

S.No.	Level	Minimum Recommended Staff	Remarks
1.	**Basic Laboratory** a. Primary Health Center/Village Level	3. Health/Sanitary Inspector 4. Laboratory Assistant/Technician 5. Lab. Attendant	For periodical testing, samples shall be sent to District or State Health Laboratory
	b. Municipal/District Level (Plant capacity >200 mld)	A – Class (5-10 lakhs or greater) 1. Senior Health Officer 2. Zonal Health Officer 3. Chief Health/Sanitary Inspector 4. Health/Sanitary Inspector 5. Chemist 6. Bacteriologist 7. Lab Assistant 8. Lab Attendant	
		B – Class (1-5 lakhs) 1. Health Officer 2. Health/Sanitary Inspector 3. Chemist 4. Lab. Assistant/technician 5. Lab. Attendant	
		C – Class (< 1 lakhs) 1. Chief Health/Sanitary Inspector 2. Health/Sanitary Inspector 3. Lab. Assistant/technician 4. Lab. Attendant	For periodical testing, samples shall be sent to District or State Health Laboratory
2.	**State/Regional Level Laboratory**	Staff as per existing State Medical and Health Deptt. norms	

Note: 3. The level and the no. of the personnel shall be decided by the respective agencies depending on magnitude of problems and resources available.

ANNEXURE 9.5a

CHECK POINTS

Type of facility **Protected Spring Source**

1. General information: Health Center .....

   Village .....

2. Address .....

3. Water authority/community representative signature .....

4. Date of visit .....

5. Water sample taken ..... Sample no. ..... Total Coliform/faecal Coliform .....

S.N.	Particulars for Assessment	Risks
1.	Is the spring source unprotected and therefore open to surface contamination?	Y/N
2.	Is the masonry protecting the spring source faulty?	Y/N
3.	If there is a spring box, is there an unsanitary inspection cover in the masonry?	Y/N
4.	Does the spring box contain contaminating silt or animals?	Y/N
5.	If there is an air vent in the masonry, is it unsanitary?	Y/N
6.	If there is an overflow pipe, is it unsanitary?	Y/N
7.	Is the area around the spring unfenced?	Y/N
8.	Can animals have access to within 10 m of the spring source?	Y/N
9.	Does the spring lack a surface water diversion ditch above it or if present, is it nonfunctional?	Y/N
10.	Are there any latrines uphill of the spring?	Y/N

Total score of risks……../10

Contamination Risk Score: 9-10 = Very High, 6-8 = High, 3-5 = Intermediate, 0-2 = Low

Results and Recommendations

The following important points of risks were noted: ..... (list no. 1-10)
And the authority advised on remedial action

Name and Signature of Inspector: .....

ANNEXURE : 9.6a

SUGGESTED MINIMUM SAMPLING FREQUENCY AND NUMBER FROM DISTRIBUTION SYSTEM

Population Served	Maximum interval between successive sampling	Minimum no. of samples to be taken from entire distribution system
Upto 20,000	One month	One sample per 5,000 of population per month
20,000-50,000	Two weeks	
50,000-1,00,000	Four days	
More than 1,00,000	One day	One sample per 10,000 of population per month

ANNEXURE : 9.6b

SUGGESTED MINIMUM ANNUAL FREQUENCY OF SANITARY INSPECTIONS

Source and mode of supply	Community	Water supply agency	Surveillance agency
Dug well (without windlass)	6	–	1
Dug well (with windlass)	6	–	1
Dug well (with hand pump)	4	–	1
Shallow and deep tube well with hand pump	4	–	1
Rainwater catchment	4	–	1
Gravity spring	4	–	1
Piped supply: ground water sources (springs and wells) with or without chlorination	–	1	1
Treated surface source of piped supply, with chlorination			
< 5,000 population	12	1	1
5,000-20,000 population	–	2	1
20,000-50,000 population	–	12	1
50,000-1,00,000 population	–	24	2
>1,00,000 population	–	48	2

ANNEXURE : 9.6c(1)

SUGGESTED MINIMUM SAMPLING FREQUENCY FOR WATER QUALITY CONTROL MONITORING

S.L.	Size and Source	Frequency	PARAMETERS					Heavy Metals & Pesticides	Problem Parameters As, Cr^{+6}, Fe & Mn, Fluoride	Remarks
			Residual Chlorine	Physical	Chemical	Bacteriol-ogical	Biological			
1	2	3	4	5	6	7	8	9	10	11
1.	< 50,000 Population	i. Daily	√							From source & distribution system
	a. Ground Water (Tube Well, Sanitary Well, Bore Well)	ii. Quarterly		√	√	√			√	
	b. Ground Water (Hand Pump)	Twice a year		√	√	√			√	In summer & rainy season
2.	>50,000 upto 1,00,000 Population	i. Daily	√							From source and distri-bution system
	a. Ground Water (Tube Well, Sanitary Well, Bore Well)	ii. Monthly				√				
		iii. Quarterly		√	√				√	
	b. Ground Water (Hand Pump)	Twice a year		√	√	√			√	In summer & rainy season
3.	>1,00,000 Population a. Ground Water (Tube Well, Sanitary Well, Bore Well)	i. Daily	√							From source & distribution system
		ii. Monthly				√				

1	2	3	4	5	6	7	8	9	10	11
		iii. Quarterly		√	√				√	
		iv. Annually						√		
	b. Ground Water (Hand Pump)	i. Twice a year		√	√	√			√	In summer & rainy season
		ii. Annually						√		
4.	Surface water a. Raw water, source and intake point	i. Daily		√	√					
		ii. Weekly				√				
		iii. Annually						√	√	
		iv. Occasi-onal (As & when required)					√			
	b. Sedimentation tank after clarifier	i. Daily		Turbidity only						
		ii. Weekly				√				
		iii. Occasi-onal (As & when required)					√			
	c. Filtered water	i. Daily		Turbidity only						
		ii. Weekly				√				
	d. Clear water storage reservoirs	i. Daily	√	√	√					
		ii. Weekly				√				
	e. Distribution system	i. Daily	√							
		ii. Weekly				√				
		iii. Monthly		√	√					

Note: 1. Refer to the Manual on Water Supply and Treatment, III Edition, Ministry of Urban Development, New Delhi, May 1999, Appendix 15.9, for minimum tests to be performed.

2. Parameters and frequency are general in nature and in case of special situations, they can be altered according to the local conditions by the local authority.

ANNEXURE : 9.6c(2)

SUGGESTED MINIMUM SAMPLING FREQUENCY FOR WATER QUALITY CONTROL SURVEILLANCE

S.L.	Size and Source	Frequency	PARAMETERS					Heavy Metals & Pesticides	Problem Parameters As, Cr^{+6}, Fe & Mn, Fluoride	Remarks
			Residual Chlorine	Physical	Chemical	Bacteriol-ogical	Biological			
1	2	3	4	5	6	7	8	9	10	11
1.	< 50,000 Population									From source & distribution system
	a. Ground Water (Tube Well, Sanitary Well, Bore Well)	i. Weekly	√							
		ii. Twice a year		√	√	√			√	In summer & rainy season
	b. Ground Water (Hand Pump)	Twice a year		√	√	√			√	Preferably in summer
2.	>50,000 upto 1,00,000 Population									From source and distri-bution system
	c. Ground Water (Tube Well, Sanitary Well, Bore Well)	i. Weekly	√							
		ii. Quarterly				√				
		iii. Twice a year		√	√				√	In summer & rainy season
	d. Ground Water (Hand Pump)	Annually		√	√	√			√	Preferably in summer
3.	>1,00,000 Population									From source & distribution system
	e. Ground Water (Tube Well, Sanitary Well, Bore Well)	i. Weekly	√							
		ii. Quarterly				√				

1	2	3	4	5	6	7	8	9	10	11
		iii. Twice a year		√	√				√	In summer & rainy season
		iv. Annually						√		
	f. Ground Water (Hand Pump)	Twice a year		√	√	√		√	√	In summer & rainy season
4.	Surface water g. Raw water, source and intake point	i. Fortnig-htly				√				
		ii. Quarterly		√	√					
		iii. Annually						√	√	
		iv. Occasi-onal (As & when required)					√			
	h. Filter	i. Monthly		Turbidity only		√				
	i. Clear water storage reservoirs	ii. Fortni-ghtly	√			√				
		iii. Monthly		√	√					
	j. Distribution system	i. Weekly	√							
		ii. Monthly iii. Quarterly		√	√	√				

Note: Refer to the Manual on Water Supply and Treatment, III Edition, Ministry of Urban Development, New Delhi, May 1999, Appendix 15.9, for minimum tests to be performed.
Parameters and frequency are general in nature and in case of special situations; they can be altered according to the local conditions by the local authority.

ANNEXURE 9.7

REMEDIAL AND PREVENTIVE MEASURES FOR PROTECTION OF WATER SUPPLIES

Source and Mode of Supply	Evidence or Information available	Immediate remedial measures available	Preventive action
1	2	3	4
Open dug wells	Pollution usually expected to occur	a. Clean well if necessary and disinfect with bleaching powder. b. Boiling of drinking water, use of chlorine tablets or bleaching powder and/or filters in the home is recommended.	Well is protected by raising a pucca wall all around and cover. It is preferable to provide hand pumps and promote community education and participation.
Unpipped supplies from tube well or hand pumps	Findings of sanitary inspection, unsatisfactory localized epidemic of enteric infection	Confirm bacteriological quality analysis and if necessary, recommend use of disinfectant (Bleaching powder) or a. Recommend use of boiling water, chlorine tablets or bleaching powder and/or filters in the home b. Confirm bacterial quality c. Conduct a detailed sanitary inspection to ensure effectiveness of remedial measures against shortcomings found earlier	Eliminate pollution source and/or repair tube wells and/or hand pumps if found necessary in sanitary inspection. a. Promote community education and participation. b. Feedback information on remedial action and sanitary survey results to the water supply agency, to check whether the remedial actions followed are appropriate.
Untreated pipe water supply	Findings of sanitary inspection unsatisfactory	Confirm bacteriological quality and if necessary recommend boiling of water or use of disinfectant or filters	Eliminate pollution sources and/or repair systems if found necessary in sanitary inspections
	Unsatisfactory bacteriological quality of water at source	a. Disinfect (chlorinate) water supply if feasible, recommend boiling or use of chlorine tablets at home b. Conduct a detailed sanitary inspection and correct the shortcomings found	Protect the source and its catchment area

1	2	3	4
	Unsatisfactory bacteriological quality of water in the distribution system	a. Disinfect (chlorinate) water supply or recommend boiling or use of chlorine tablets at home b. Conduct a detailed sanitary inspection of distribution system and rectify the shortcomings	Frequent and improved supervision of the distribution system and prompt repair and good maintenance are essential, especially for intermittently operated system.
	Localized epidemic of enteric infection	a. Take samples for bacteriological analysis. Without waiting for its result, immediately chlorinate water supply so that the tail end has minimum 0.5 mg/l of free residual chlorine. Recommend boiling and use of chlorine tablets at home b. Conduct a detailed sanitary inspection of source and distribution system and rectify the shortcomings found.	
Treated pipe water supply	Findings of sanitary inspection of source, treatment plant, distribution systems is unsatisfactory	Confirm bacteriological quality and if necessary, recommend boiling or use of disinfectant (Bleaching powder) home	a. Frequent and improved supervision of the whole system is necessary, careful operations and maintenance is essential, especially for intermittent systems. b. Ensure routine sanitary inspections and feedback information to the water supply agencies.

1	2	3	4
	Unsatisfactory bacteriological quality of water after treatment or in the distribution system	a. Ensure 0.5 mg/l free residual chlorine at tail end. Recommend boiling and use of chlorine tablets b. Conduct a detailed sanitary inspection of whole water supply system and rectify the shortcomings found	a. Frequent and improved supervision of the whole system is necessary, careful operations and maintenance is essential, especially for intermittent systems. b. Ensure routine sanitary inspections and feedback information to the water supply agencies.
	Localized epidemic of enteric infection	a. Take samples for bacteriological analysis. Without waiting for its result, immediately chlorinate water supply so that the tail end has minimum 0.5 mg/l of free residual chlorine. Recommend boiling and use of chlorine tablets at home b. Conduct a detailed sanitary inspection of source and distribution system and rectify the shortcomings found.	a. Eliminate pollution source b. Frequent and improved supervision of the whole system is necessary, careful operations and maintenance is essential, especially for intermittent systems. c. Ensure routine sanitary inspections and feedback information to the water supply agencies.