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Draft

GUIDELINES FOR PREPARATION OF LEGISLATION FOR FRAMING DRINKING WATER REGULATIONS

(December, 2007)

Department of Drinking Water Supply
Rajiv Gandhi National Drinking Water Mission
Ministry of Rural Development
Government of India

PART – I

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Draft Prepared by :

Prof. (Dr.) Arunabha Majumder

PART – I

Introduction :

The primary aim of framing Legislation on regulation of drinking water is the protection of public health. As water is essential to sustain life, so a satisfactory supply must be made available to consumers. The water should be clear as a resource and safe for drinking. Providing clear and safe drinking water, therefore, has been recognized as a key element in our development efforts.

The potability of drinking water is guided by national standard that, if properly implemented, will ensure the safety of drinking water supplies through the elimination or reduction to a minimum concentration, of constituents of water that are known to be hazardous to health. The drinking water quality standards, therefore, defines such limits in the context of national, environmental, social, economic and cultural conditions.

In order to maintain potability of drinking water every effort should be made by water supply agencies to achieve a drinking water quality as high as practicable conforming to the standard. Protection of water supplies from contamination is the first line of defense. Source protection is almost invariably the best method of ensuring safe drinking water and is to be preferred to treating a contaminated water to render it suitable for consumption. Once a potentially hazardous situation has been recognized, however, the risk to health, the availability of alternative sources, and the availability of suitable remedial measures must be considered so that a decision can be made about the acceptability of the supply.

Availability of fresh non-saline water is limited in the country. The ground water too, is also limited. Abundant use of ground water is to be restricted. The detrimental environmental consequences of over exploitation of ground water need to be effectively prevented by the concerned agencies. The geological problems associated with over exploitation of ground water have caused serious water quality problem

in many parts of the country. Almost 85% of rural sector and majority of cities and towns are dependent on ground water.

The surface water bodies are threatened from point as well as non-point sources of pollution from different activities resulting in deterioration in bacteriological quality as well as chemical quality of water. Protection of surface water bodies from pollution is of prime importance. There is a necessity for more dependence on surface water sources for public water supply both in urban and rural areas.

Rain water harvesting , conservation and use, ground water recharging need to be practiced more as an alternative water source. Enforcement of regulatory bindings on rainwater harvesting could improve the situation of ground water resources.

The water supply system should be sustainable and reliable in terms of quality as well as quantity. It is a serious challenge to the country. A holistic approach need to be taken by all concerned departments to counter the detrimental impacts exercised due to lack of water management, on the ground water status, availability and quality. Dependence on surface water, as far as practicable must be more. There is a necessity to create enough rainwater harvesting structures for water conservation.

Mobilization of human resources is necessary for sustainability of water supply systems. Community participation and involvement need to be ensured in managing water supply in rural sector. The sustainability depends on water demand and supply management and accordingly community should be associated with the water supply programme to understand the importance of quantity and quality of water.

Water is not an unlimited resource; it cannot be created but it is available as a renewed resource as rainfall. Sustainable use of water calls for self-discipline and an understanding of the limited resource of nature.

What is safe and how is it achieved ?

Defining Safe Drinking Water :

It is difficult to define 'safe drinking water'. But 'safe drinking water' is that water which will not cause any injury to the health of consumers. This is an important point, because it touches on two of the central questions asked during the engagement process : what should be regulated and to what standard ? These questions required consideration of the threats to safe drinking water. In other words, what contaminants, and how much of them, might take water from safe to unsafe ? Answering these questions effectively, however, called for a definition of safe drinking water. From the point of view of drinking water supply agencies responsibility, it has to ensure that drinking water systems deliver water with a level of risk so negligible that a reasonable and informed person would feel safe drinking the water.

Safe does not mean Risk-free :

A definition of safe drinking water must allow for the reality that risks cannot be completely eliminated. The Walkerton report (Ireland) for example, points out that "it is not possible to utterly remove all risk from a water system". The World Health Organization (WHO) guidelines for Drinking Water Quality, 3rd Edition, 2004 define safe drinking water as water that "does not represent any significant risk to health over a lifetime of consumption". The word "significant" acknowledges that there is always some degree of risk, even if very small, in providing drinking water 'safe' then, does not mean 'completely without risk'.

A Comprehensive Approach :

Health risks from unsafe drinking water can be reduced to a negligible level by the following approaches :

- ☑ Protecting water sources from pollution

- ☑ Preventing contaminants from reaching consumers. This can be achieved through preventive and curative measures at different stages.
- ☑ Prioritizing safety of drinking water.
- ☑ Ensuring rational water quality management and sound operating system through water supply agencies.
- ☑ Providing effective legislation / regulation.

In order to prevent contamination of drinking water supply from reaching consumers following approaches, where applicable, should be considered.

- ☑ Protection of water at source
- ☑ Effective drinking water treatment, if necessary.
- ☑ Secure spot sources of water supply or distribution of treated water to consumers.

These steps rely on effective monitoring of drinking water quality, as well as enlightened management of the various systems involved in producing, protecting and delivering drinking water.

All of this must, of course, take place against a background of good governance, suitable legislative and policies, clear guidelines, standard and objectives, effective research and technology development and meaningful public involvement and awareness.

Sources of Water :

Rainwater :

Rainwater may be used by small communities which do not have any other source of water supply or in areas where there is shortage of water or in areas where water quality problems are existing. Rainwater could be collected from roofs of buildings and stored in cistern / reservoirs for domestic use. Rainwater can be collected as run-off from

catchment area and stored in traditional water bodies. Rainwater may require simple treatment before consumption where necessary.

Surface water :

Surface water originates mostly from rainfall and is a mixture of different surface runoffs. It includes large rivers, ponds and lakes, and the small upland streams which may originate from springs and collect the runoff from the watersheds. The quantity of runoff depends upon a large number of factors, the most important of which are the amount of and intensity of rainfall, climate and vegetation, geological, geographical and topographical features of the area under consideration. It varies widely, from about 20% in arid and sandy areas where the rainfall is scarce to more than 50% in rocky regions in which the annual rainfall is heavy. Of the remaining portion of the rainfall, some of the water percolates into the ground and the rest is lost by evaporation, transpiration and absorption.

The quality of surface water is governed by the content of living organisms and by the amount of mineral and organic matter, which it may have picked up in the course of its formation. As rain falls through the atmosphere, it collects dust and absorbs oxygen and carbon dioxide from air. While flowing over the ground, surface water collects silt and particles of organic matter, some of which will ultimately reach the ground water or even the consumers directly. It also picks up more carbon dioxide from vegetation and micro-organisms and bacteria from top soil and decaying matter. In inhabited watersheds, pollution may include faecal material and pathogenic organisms as well as other human and industrial wastes which have not been properly disposed of. In most instances, surface water is subject to pollution and contamination by pathogenic organisms and cannot be considered safe without treatment. However, the extent and method of surface water treatment depends on the quality of surface water.

Ground water :

Only three per cent of all water in the world is considered to be fresh and 75% of this is fixed as ice. Of the remaining 25%, more than 24% is ground water; surface and atmospheric water making up the remaining one per cent. In developing countries and especially in rural areas where the majority of people live, ground water is the only possible source of good drinking water. Surface water rapidly becomes polluted and is subject to evaporation losses. Ground water also has the advantage that it is frequently and widely available in quantities sufficient to meet the needs of scattered communities. Therefore, for long time to come, ground water will be the most important source of supply for most rural communities in the country.

However, a major problem with ground water is the possibility of chemical pollution. This can originate either from solution of the source rock itself or from artificial sources such as industrial wastes, agricultural fertilizers or seepages from pit-latrines and rubbish. Nitrates in concentrations greater than 45 mg/l can cause death by methaemoglobinaemia (blue baby syndrome) in babies under six months age. Nitrates enter the ground water either from the use of excess fertilizer or the incorrect setting of pit-latrines. Fluorides from source rocks in concentrations greater than 1.5 mg/l can produce dental fluorosis or non-skeletal or skeletal fluorosis with skeletal deformities. Arsenic, if present beyond 0.05 mg/l, could cause arsenicosis. Chemical pollution, except for iron, which can be removed by aeration, causes the greatest problem in using ground water since its removal costs are often very high for rural communities.

Table – 1 : Criteria for Evaluating Raw Water Quality and Its Treatment

Quality of Raw Water	Criteria	Example
Water requiring no treatment	Limited to underground waters not subject to any possible contamination and conform to drinking water quality standards	Deep tube well, spring
Water requiring simple chlorination	Includes both underground and surface water subject to minimal pollution and meeting physico-chemical quality requirements	Dug well, spring, hill stream etc.
Water requiring complete treatment	All waters containing organic and inorganic contaminants	Water of river, lakes, ponds etc.
Water requiring special treatment	Water having excess fluoride, arsenic, iron, brackishness etc.	Ground water

Source Water Protection :

Source water protection involves managing the release of contaminants from human activities into water sources (rivers, lakes and ground water). Effective source water protection must deal with a range of threats to water, including sewage, industrial effluents, farming, forestry and urban development.

Regulation requiring waste water from municipal areas and industrial activities to be treated to reduce contaminants to levels low enough to prevent harm to aquatic ecosystems are existing for the country (Water Pollution Control Act, 1974; Environment Protection Act 1986, Hazardous Waste (Management and Handling) Rule 1989 and Amendments etc.

There are non-point sources of pollution, such as, surface runoff carrying pesticides, insecticides, organic waste etc. Control of pollution from non-point sources should come within the regulatory framework.

Drinking Water Treatment :

Usually surface water requires treatment for upgradation of water quality to conform to the drinking water quality standard. The extent of

treatment depends on raw water quality. A main focus of drinking water treatment is to remove microbial pathogens by filtration and inactivate them by disinfection. Conventional water treatment uses chemicals to clump together particles of the water (flocculation) and sand to remove them (filtration). Newer technologies use membranes for filtration, but these technologies are not suitable for every water source. The effectiveness of filtration is reflected in the turbidity of drinking water. Turbidity is a sensitive measure of small particles that, in high concentration, make water cloudy. The pre-treatment before filtration, could be prolong storage or use of roughing filtration technique.

Chlorine, either in the form of gas or in solution, is the most commonly used disinfectants. Ultraviolet rays and Ozone are used mostly by the package drinking water manufacturers. As treated water leaves the plant, it should contain a small amount of chlorine, which is called the 'Chlorine residual' and is a vital marker to show that enough chlorine is dosed to achieve adequate disinfection.

Rainwater, if collected from roof top in proper manner and stored in protected reservoirs does not require treatment, except low dose chlorination at wide interval. Rainwater harvested as surface runoff from catchment area and stored in traditional water bodies requires treatment for removal of suspended and colloidal solids including pathogenic organism.

Dug well water requires disinfection before drinking. Bore well water normally does not require treatment. However, bore well water requires treatment, where necessary, for removal of iron, arsenic, fluoride etc.

It has been found that chemical contaminants are highly localized, unlike the pathogens from human and animal wastes. Decision about whether to treat water to remove chemical contaminants or routinely monitor for them in treated water must therefore be based on an assessment of whether any of them are found in source water, and at what levels.

Waste Water Treatment :

Waste waters generating from cities / towns, industrial activities and surface runoff from agricultural lands leads to water pollution. Many water sources are under serious threat from such waste water discharge. Hence, abatement of water pollution, treatment / recycle / reuse of waste water need to be addressed effectively. The Water Pollution Control Act 1974, Environment Protection Act 1986 and other related regulations are to be exercised rationally through Statutory Authorities in order to protect water sources from deterioration in quality.

Monitoring :

Sampling and testing drinking water for contaminants is an important part of the multiple barrier approach. But routine monitoring of treated water against contaminant standard does not by itself guarantee safety.

Any monitoring programme must consider a number of issues —

- how often to take samples, if monitoring is not continuous, because contamination can be intermittent;
- location where the sample is taken, because contamination can occur at any number of points in the system, possibly beyond a sampling point;
- timeliness, because results may not be known until after the water has been consumed; and
- which contaminants pose a significant risk, because trying to monitor for everything is futile.

To be as effective as possible, monitoring must be strategic : the monitoring programme should include the regular assessment of the risks that might arise from various sources of contamination. It may not be necessary to monitor for some contaminants because they simply do not occur in the community's source water. In addition to monitoring treated water quality, there should be monitoring of —

- raw water quality, to understand the seasonality and frequency of contamination episodes and to help develop a monitoring programme based on known threats to drinking water;
- the performance of the treatment process, with such measures as chlorine residual and turbidity, bacteriological quality etc.;
- distributed water quality, using a consistent sampling programme in the distribution system;
- water quality (both chemical and bacteriological) of spot sources, specially dug wells, tube wells, bore wells, rainwater harvesting structures, etc.;
- any reports of adverse water quality from consumers.

Along with water quality monitoring, surveillance programme should be initiated to assess any risk associated with drinking water contamination. The surveillance programme includes sanitary survey, preventive and remedial measures, data recording & analysis and capacity building. All the laboratories under water quality monitoring and surveillance programme should be recognized by the competent authority.

Training :

Human Resources Development is essential for rational implementation of any developmental programme. All personalities with the stakeholders dealing with public water supply must be trained properly so that they can deliver goods by assuring safe water supply to the consumers. Presently CCDUs have been set up in all the states with a goal not only to develop manpower for planning, implementation, quality control, quality assurance in water and sanitation sector but also to aware and motivate communities to participate in the water and sanitation programme.

Regulatory Framework :

The responsibility of Rural Water Supply in most of the States lies with the Public Health Engineering Departments / Water Authority / locally named Statutory Agency / Panchayati Raj Institutions. The urban water supplies are mostly entrusted with Municipal Corporation / Municipal Authority / Water Authority / Water Board / Developmental Authority, etc. The public water supply both in rural and urban area must ensure safety for human consumption. Accordingly, all agencies should follow appropriate guidelines for managing drinking water. Part – II of the report provides guidelines for framing regulations for drinking water.

Unregulated System :

No unregulated water supply system would be allowed to function in the country by any agency. All unregulated water supply systems must, therefore, come under regulated water supply system and shall function within the regulatory framework.

Conclusion :

Regulation alone will not be effective in assuring safe drinking water unless the other requirements : a multiple barrier approach for water pollution control, cautious decision making and effective management system are met. These other requirements depend on adequate investment in both human resources and physical assets. Regulation without the investment needed to build capacity may even put drinking water safety =at risk by diverting badly needed resources in other sectors. There is a strong relationship among regulation, resources and the goal of safe drinking water.

PART – II

GUIDELINES FOR PREPARATION OF LEGISLATION FOR FRAMING DRINKING WATER REGULATIONS

(December, 2007)

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1. THE DRINKING WATER REGULATION (DRAFT GUIDELINES)

1.1. INTRODUCTION

In India, laws related to use of water date back to the period when Code of Manu was prescribed, over 3000 years ago. Water is considered public property, subject to public administration; several penalties were prescribed for unauthorized use and for causing harm to water holding structure and for causing pollution of water. Upstream points along a river were reserved for drawing drinking water and in-situ uses of water such as washing clothes, bathing, etc. were permitted only at the down stream.

According to the Constitution of India, Water is in the 'State list'. Therefore, States can enact any legislation regarding water that is to say, water supplies, irrigation and canals, drainage, embankments, water storage and water power excepting the regulations and development of Inter-state River and river valleys.

According to national water policy water is a prime natural resource, a basic human needs and precious national asset. Planning, development and management of water resources need to be governed by national perspectives.

In order to prevent and control of water pollution, the Parliament enacted Water (Prevention and Control of Water Pollution) Act, 1974 as per provision of Article 249 and 250 of the Constitution as well as Clause 1 of Article 252 of the Constitution. It is an Act to provide for the prevention and control of water pollution and the maintaining or restoring of wholesomeness of water, for the establishment, with a view to carrying out the purposes aforesaid, of Boards for the prevention and control of water pollution, for conferring on and assigning to such Boards powers and functions relating thereto and for matters connected therewith.

Water is essential to sustain life, and a satisfactory supply must be made available to consumers. The water should be clean as a resource and safe for drinking. The disease burden from unsafe water supply need to be minimized to a maximum extent possible. Providing clean and safe drinking water, therefore has been recognized as a key element in our developmental efforts. The primary aim of framing Legislation on Regulation of Drinking Water is the protection of public health.

The Drinking Water Regulation means a regulation which —

a) applies to public water systems;
b) specifies contaminants which may have any adverse effect on the health of consumers;
c) specifies for each such contaminants either a maximum desirable limit and maximum permissible limit;
d) contains criteria and procedure to assure a supply of drinking water which dependably complies with the maximum contaminant levels (maximum desirable and maximum permissible limit), including the accepted method for quality control, water quality monitoring and surveillance, source protection, water conservation, risk assessment, operation and maintenance, community participation and sustainability.

1.2. SCOPE AND PURPOSE

The scope of the Regulation is reflected in the key definition :

1(1) "Water intended for human consumption" *means*

a) all water, either in its original state or after treatment, intended for drinking, cooking, food preparation or other domestic purposes regardless of its origin and whether it is supplied from hand pump fitted tube wells, distribution piped network or from a tanker.

b) All water used in any food production undertaking for the manufacture, processing, preservation or marketing of products or substances intended for human consumption unless the relevant authority is satisfied relevant that the quality of the water cannot affect the wholesomeness of the food stuff in its finished form other than —

- *Packaged drinking water (other than packaged natural mineral water) as specified in Indian Standards IS14543 : 2004.*
- *Packaged natural mineral water as specified in Indian Standards IS13428 : 2005.*

The purpose of the Regulations is to protect human health from deleterious effects resulting from any contamination of drinking water. This objective is to be achieved by means of detailed requirements in regard to Drinking Water — Specification, Indian Standard IS : 10500 : 1991 and indicator parameter values, monitoring (sampling and analysis) and surveillance to determine compliance with

the Indian Standards and the indicator parametric values, with minimum per capita water supply as prescribed by the Department of Drinking Water Supply, Ministry of Rural Development for rural areas and CPHEEO, Ministry of Urban Development for cities / towns and investigations for remedial actions when non-compliance with the Indian Standard on Drinking Water specification is found including the provision of advice to consumers.

The Regulations apply to drinking water supplied by different authorities / agencies / department of State Governments and Central Government, wherever applicable in the country. The Regulations also apply to water supplied by Non-Government or Private Agencies for human consumption in any place of the country. The Regulations further apply to drinking water supplied during disasters and emergencies through any means.

The agencies entrusted with the implementation of the Regulation shall be **'Drinking Water Supply Regulatory Authority'** and to be set up at National and State level. The Central Government under the Regulation shall appoint, constitute (by notification in the Official Gazette) Central Drinking Water Supply Regulatory Authority to exercise the powers conferred on and perform the functions assigned to that Authority under this Regulations. The State Governments shall appoint, constitute (by notification in the Official Gazette) **State Drinking Water Supply Regulatory Authority** to exercise the powers conferred on and perform the functions assigned to the Authority under this Regulation. The organisations responsible for supply of drinking water shall be termed as **Water Supply Agency**.

1.3. THE DUTIES OF DRINKING WATER SUPPLY REGULATORY AUTHORITIES

It is the duty of the State Drinking Water Supply Regulatory Authorities, henceforth be known as **'Authority'** to take the necessary measures to ensure that water intended for human consumption is wholesome and clean and meets the requirements of the Regulations. This prime responsibility is amplified by the key provisions that :

1(2) *Water shall be regarded as wholesome and clean if —*

a) *it is free from any micro-organisms and parasites and from any substances which in numbers or concentrations constitute a potential danger to public health, and*

b) *it meets the quality standards specified in Indian Standard for drinking water IS10500 – 1991.*

However the Authority and Water Supply Agency shall not be in breach of its obligations in the case of —

1(3) *Water supplied to a premises (other than a premises where water is supplied to the public including schools, hospitals) where non-compliance with a parametric value is due to the domestic distribution system in that premises or the maintenance there of and the distribution system is not in the charge or control of the water supply agency.*

In the case of water supplied through domestic distribution system as mentioned in 1(3) above, and there is a risk that the drinking water would not comply with the parametric natures specified in Indian Standard IS10500 :1991, the Drinking Water Supply Agency must nevertheless ensure that

1(4)

a)

i) *appropriate measure are taken to reduce or eliminate the risk of non-compliance with the parametric values, such as directing / advising property owners / occupiers of any possible remedial action which could be taken by them, or*

ii) *other measures, such as appropriate treatment techniques are taken to upgrade the quality of the water before it is supplied so as to reduce or eliminate the risk of the water not complying with the parametric values after supply, and*

b) The consumers are duly informed and advised of any possible additional remedial action that should be taken by them.

In the Regulation, it is permissible for a Water Supply Agency to seek a departure — a limited exemption — from certain requirement under strictly defined conditions. Such application for departure (e.g. Iron, Hardness, etc.) must be made to the State 'Authority' which will decide the matter.

1.4. DEPARTURE FROM STANDARDS IN THE REGULATION

Upon application by the water supply agency, departure from Drinking Water Standards laid down in the Regulation may be granted by the State Authority, subject to the over-riding provision that,

1(5) *no such departure constitute a potential danger to public health and provided that the supply of water intended for human consumption in the area concerned cannot otherwise be maintained by any other reasonable means.*

The following detailed conditions also apply to the application for and granting of departures :

1(6)

a) *An application to the State Authority for the grant of a departure under this article in respect of water supply shall be made by a water supply agency in whose area a water supply is located.*

b) *An application for a departure under this article shall contain such information as may be specified by the State Authority.*

c) *A departure granted under this article shall —*

   i. *be subject to such conditions as may be specified by the Agency,*

   ii. *have effect for as short a period of time as possible, which shall not exceed five years,*

   iii. *be reviewed by the Authority prior to the end of the period of the departure on request from State Agency through application for granting extension for departure,*

   iv. *be allowed to continue beyond five years, subject to the condition that the Authority is satisfied with the reasoning furnished by the State Agency for continuation of the departure, but for a specified period. The extension for departure period could be of continued for multiple terms of period at the discretion of the Authority.*

1.5. THE POINT OF COMPLIANCE OF THE QUALITY STANDARD

The compliance of the quality standard at the consumer point is the essence of the Drinking Water Regulation. Given that the objective of the Regulations is the protection of Public Health, the logical sampling point is at the consumer point. Normally the consumer points are considered as hand pump fitted tube wells (spot source), public stand posts (pipe water supply), consumer taps (piped water supply). In addition it is also vital to maintain water quality conforming to Indian Standard for Drinking Water (IS10500 : 1991) in finished (treated) water at water treatment plant before supply through pipelines to the consumers; in abstracted aquifer water through bore wells and before supply through pipelines to the consumers with or without treatment. The water supplied from a tanker or through any other means, not mentioned above, during emergency or disaster must conform qualitatively with the Indian Standard of Drinking Water IS10500 : 1991.

1(7) *The Water Supply Agency shall ensure that the parametric values specified in Indian Standard of Drinking Water 10500 : 1991 are complied with in the case of :*

a) ground water for human consumption is supplied through hand pump fitted tube wells (spot sources),

b) ground water for human consumption is supplied through piped water supply system including at public taps / private taps,

c) surface water after treatment but before supply to the consumers for human consumption'

d) surface water for human consumption is supplied through piped water supply system including at public taps / private taps,

e) water supplied from a tanker; at the point at which it emerges from the tanker;

f) water used in a food production unit; at the point where the water is used in the unit.

1.6. MONITORING OF DRINKING WATER QUALITY

The detailed considerations of the requirements for and of monitoring the quality of drinking water are covered in Chapter – 3. However, the broad duties of water supply agencies in this regard are summarized here.

In brief, the duties of the Water Supply Agencies in regard to monitoring of water quality are as follows :

- All measures necessary shall be taken to carry out monitoring that at least meet the minimum frequencies specified in the tables in Chapter – 3 according to the population served at the points selected for testing compliance.
- Agencies shall specify the sampling points and establish a monitoring programme.
- Samples taken must be representative of the quality of water consumed throughout the year.
- Agencies must undertake the water quality surveillance programme which would include monitoring, sanitary survey, data processing, evaluation, remedial and preventive measures and institutional analysis. Authorities will do the needful in planning, implementing, coordinating the water quality monitoring and surveillance programme in the state. The Central Drinking Water Regulatory Authority will coordinate with the State Authorities for implementation of the water quality monitoring and surveillance as national programme.
- All water sample collection, preservation and analysis should be carried out as per BIS / APHA (Current Edition)

Water supply Agencies, if necessary, may carry out water quality monitoring case by case basis of substances (solids) and micro-organisms for which no parametric values has been specified in the Indian Standard for drinking water (IS10500 : 1991), if there is reason to suspect that such substances (solids) or micro-organisms may be present in amounts or numbers which constitute a potential danger to human health.

In the event of an unfamiliar problem situation causing risk to the public health, it is recommended that a water supply agency / state authority should without delay seek extent advice on an appropriate cause of monitoring action.

Water Supply Agencies will ensure peoples participation in the water quality monitoring and surveillance programme. Active involvement and participation of Panchayati Raj Institutions (Zilla Parishad, Panchayat Samity, Gram Panchayat) in rural areas and municipal ward committees would be necessary for the success of water quality monitoring and surveillance programme.

1.7. THE PROTECTION OF HUMAN HEALTH

Underlining the primary aim of protecting human health the Regulations contain further provisions defining duties of the water supply agencies, as follows :

1(8)

a) *Where a Water Supply Agency considers that a supply of water intended for human consumption constitute a potential danger to human health the Agency shall ensure that —*
   i. *the supply of such water is prohibited or the use of such water is restricted, or such other action is taken as is necessary to protect human health, and*
   ii. *consumers shall be informed properly there of, and given the necessary advice.*

b) *A Water Supply Agency shall decide what action should be taken under the above provision having due regard to the risks to human health which would be caused by an interruption of the supply or a restriction in the use of water intended for human consumption.*

c) *A Water Supply Agency, where applicable, shall inform the consumers the nearest drinking water spot sources (hand pump attached tube well) which conforms to Indian Standard for Drinking Water (IS10500 : 1991). This condition applies to spot sources (hand pump attached tube wells) which are chemically contaminated.*

1.8. PREVENTIVE AND REMEDIAL MEASURES

Water supply services need to be of consumer satisfaction and in order to achieve this objective, preventive and remedial measures are to be taken, where necessary, in time and in appropriate manner. Such measures may be technical as well as social interventions designed to improve water supply services.

Preventive measures, if properly undertaken could reduce contamination of water sources, provide protection of water sources, provide safeguard to water supply system against deterioration in water quality.

Central and State Pollution Control Boards shall take appropriate action to prevent / arrest / minimize pollution of all water sources.

Following guidelines are suggested.

1(9)

a) *All water supply agencies shall keep watch on water supply sources so that water quality at the sources do not get deteriorated to such an extent so that the water quality could create problem for supply to the consumers even after treatment.*

b) *In case of water quality at the sources are getting polluted due to discharge / mixing of liquid waste, mixing of leachate from solid waste the Water Supply Agency shall inform to Central or State Water Pollution Control Board, as the case may be, for taking immediate remedial measures as per Statutory Regulations e.g. Water Pollution Control Act. 1974, Environment Protection Act 1986, Municipal Solid Waste (Management and Handling) Rule 2000.*

c) *All Water Supply Agencies shall take preventive measures to protect spot sources (hand pump attached tube wells) against chances of pollution from toilet-leach pits, manure pits, cattle excreta dumps etc.*

d) *All water supply agencies shall take all measures as per guidelines so that hand pump attached tube wells, and power pump attached bore wells are not get contaminated anthropogenically.*

e) *All water supply agencies shall take all remedial measures as per Water Quality Monitoring and Surveillance (WQMS) to maintain water quality for human consumption.*

1.9. OTHER MATTERS

The provisions relating to the quality of water treatment has been presented in Chapter - 4. However, following issues are relevant to mention hereunder.

1(10)

a) *A water supply agency shall take all measures necessary to ensure that no substances or materials used for water supply system including bore well. Pipes, distribution pipes, chemical or media do not cause any deterioration in water quality so that water become unfit for human consumption.*

b) *A water supply agency shall ensure that the efficiency of disinfection treatment is verified and that any contamination from disinfection by products is kept as low as possible without compromising disinfection.*

c) *Measures taken by a water supply agency to apply the provisions of these Regulations shall in no case have the effect of allowing directly or indirectly, either any deterioration in the existing quality of water intended for human consumption so far as that is relevant for the protection of human health or an increase in the pollution of waters used for the production of drinking water.*

2. WATER QUALITY : PARAMETERS AND PARAMETRIC VALUES

2.1.

Indian Standard on Drinking Water Specifications (IS10500 : 1991) was adopted by the Bureau of Indian Standards, after the draft finalized by the Water Sectional Committee (CHD13) had been approved by the Chemical Division Council. The Standard was prepared with the following objectives :

a) To assess the quality of water resources, and
b) To check the effectiveness of water treatment and supply by the concerned authorities.

While preparing this Standard, the Committee had taken note of the limited testing facilities available in the country. This Standard, therefore, categories various characteristics as essential or desirable. The standards also mention the desirable limit and indicate its background so that the implementing authorities may exercise their discretion, keeping in view the health of the people, adequacy of treatment etc. All essential characteristics should be examined in routine. Besides, all desirable characteristics should be examined either when a doubt arises or the potability of water from a new source is to be established.

The standard has categorically made relaxation in the specification when no alternate resources are available and therefore, to enable the Water Supply Agencies to exercise their discretion a maximum permissible limit has also been given to certain parameters.

In formulation of the standard for drinking water BIS referred the following publications :

a) International Standards for Drinking Water issued by World Health Organization, 1984.
b) Manual of Standards of Quality for Drinking Water Supplies. Indian Council of Medical Research 1971.
c) Manual on Water Supply and Treatment (third revision) CPHEEO, Ministry of Urban Development, 1989.

The Drinking Water Regulations include the Indian Standard for Drinking Water Specification (IS10500 : 1991) for compliance by the Water Supply Agencies and others for supplying water for human consumption.

2(1)

c) It is mandatory on the part of a Water Supply Agency to adhere to Indian Standard on Drinking Water Specification (IS10500 : 1991) while supplying water for human consumption.

d) Before supplying water for human consumption, a water supply agency shall analyse the water and compare with the Indian Standard on Drinking Water Specification to judge whether the water is fit or unfit for human consumption.

e) A Water Supply Agency shall refrain from supplying water which may cause deleterious effect on human health.

2.2. PARAMETER CATEGORIES AND CHARACTERISTICS

The Regulations defines parameters for micro-biological and chemical quality of drinking water. The test characteristics for drinking water as per IS10500 : 1991 have been included as a part of Regulation to be complied by all water supply agencies before supplying water for human consumption. The test characteristics for drinking water consists of the following components :

- Substances or characteristics
- Requirement (Desirable limit)
- Undesirable effect outside the desirable limit
- Permissible limit in the absence of alternate source
- Method of test
- Remarks, where applicable.

2.2.1. Microbiological Parameters

2.2.1.1. Water in Distribution System :

Ideally all samples taken from the distribution system including consumers' premises and street taps, should be free from coliform organisms. However,

following standard need to be maintained in water distribution system when tested in accordance with IS1622 :1981.

2(2) *A water supply agency shall maintain the following bacteriological quality in the water distribution system including consumers taps and street taps when tested in accordance with IS1622 : 1981.*

g) Throughout any year, 95% of samples should not contain any coliform organisms in 100 ml;

h) No sample should contain E. coli in 100 ml;

i) No sample should contain more than 10 coliform organisms per 100 ml; and

j) Coliform organisms should not be detectable in 100 ml of any two consecutive samples.

2(3) *If any coliform organisms are found in water sample, the minimum action required is immediate re-sampling. If repeated finding shows presence of coliform organisms between 1 and 10 per 100 ml or in higher numbers in individual sample then the water supply agency shall take immediate measures to discover and remove the source of the pollution.*

2.2.1.2. Un-piped Water Supply :

Where it is impracticable to supply water to consumers through a piped distribution network, the water is supplied mostly from spot-sources. These include dug wells, hand pump attached tube wells, mechanical pump attached bore-wells, springs, rain water (via roof catchment and land catchment) water treatment units attached to traditional source, water tankers etc. Bacteriologically, in these water supply systems, the objective should be to reduce the coliform count to less than 10 per 100 ml, but importantly, to ensure the absence of faecal coliform organisms. If these organisms are repeatedly found, or if sanitary inspection reveals obvious sources of pollution which cannot be avoided, then an alternative source of drinking water would be sought, wherever possible.

2(4) *In case of un-piped water supplies, the water supply agencies shall ensure absence of faecal coliform (E. coli) and shall restrict coliform count to less than 10 per 100 ml. If these organisms are repeatedly found in water then water supply agencies shall undertake sanitary inspection to detect the*

pollutional source for remedial measure but if the pollutional sources cannot be avoided, then alternative source of drinking water would be sought, wherever possible.

Although private sources of drinking water may be outside the jurisdiction of water supply agencies, such supplies should still be of potable quality. The results of bacteriological tests and those of sanitary surveys should therefore be used to encourage improvement.

2.2.2. Microbiological Standard

All water supply agencies shall strictly adhered to the following standard before supplying water for human consumption.

Table – 2.1 : Microbiological Quality

Water Supply System	Supply Points	Total Coliform per 100 ml	Faecal Coliform per 100 ml	Remarks
Piped water supply : water in distribution system	Street taps Consumer connected (house) taps	Not more than 10/100 ml	Absent	- TC should not be detectable in any two consecutive samples. - Repeat sample is to be tested if TC is found - 95% of samples tested per year in a scheme should not contain TC
Un-piped Water Supply	- Dug wells - Hand pump attached tube wells - Mechanical pump attached bore wells - Springs - Rain water (Roof catchment system) - Rain water upgraded (land catchment system) - Water treatment units attached to traditional water sources - Water tankers	Not more than 10/100 ml	Absent	- Strict surveillance is necessary to keep water free from FC and TC. - In all cases FC must be absent - If TC is found, repeat sample is to be tested. - If TC/FC are repeatedly found, preventive measures are to be taken after detecting the source of pollution.

2.2.3. Physical and Chemical Parameters

This is a significant class of substances, ranging from the general to the very specific. A few physical parameters are also should be considered along with chemical parameters for drinking water.

The Indian standard for Drinking Water Specification (IS10500 : 1991) is to be strictly followed by all water supply agencies while supplying water for human consumption. The parameters in the standard have been divided in two parts; e.g. Essential Characteristics and desirable characteristics.

Table – 2.2 : Physical and Chemical Characteristics for Drinking Water

Sl. No.	Substances or Characteristics	Requirement (Desirable Limit)	Permissible Limit in the Absence of Alternate Source	Methods of Test (Ref. to IS)	Remarks
1	2	3	4	5	6
Essential Characteristics					
i)	Colour, Hazen units, Max	5	25	3025 (Part 4) : 1983	Extended to 25 only if toxic substances are not suspected, in absence of alternate sources
ii)	Odour	Unobjec-tionable	-	3025 (Part 5) : 1983	a) Test cold and when heated b) Test at several dilutions
iii)	Taste	Agreeable	-	3025 (Part 7 & 8) : 1984	Test to be conducted only after safety has been established
iv)	Turbidity, NTU, Max	5	10	3025 (Part 10) : 1984	—
v)	pH value	6.5 to 8.5	No relaxations	3025 (Part 11) : 1984	—
vi)	Total Hardness (as $CaCO_3$) mg/l, Max	300	600	3025 (Part 21) : 1983	—
vii)	Iron (as Fe) mg/l, Max	0.3	1.0	32 of 3025 : 1964	—
viii)	Chlorides (as Cl) mg/l, Max	250	1000	3025 (Part 32) : 1988	—
ix)	Residual, Free Chlorine, mg/l, Min	0.2	-	3025 (Part 26) : 1986	To be applicable only when water is chlorinated. Tested at consumer end. When protection against viral infection is required, it should be Min 0.5 mg/l
Desirable Characteristics					
x)	Dissolved solids mg/l, Max	500	2000	3025 (Part 16) : 1984	—
xi)	Calcium (as Ca) mg/l, Max	75	200	3025 (Part 40) : 1991	—

Sl. No.	Substances or Characteristics	Requirement (Desirable Limit)	Permissible Limit in the Absence of Alternate Source	Methods of Test (Ref. to IS)	Remarks
1	2	3	4	5	6
xii)	Copper (as Cu) mg/l, Max	0.05	1.5	36 of 3025 : 1964	—
xiii)	Manganese (as Mn) mg/l, Max	0.1	0.3	35 of 3025 : 1964	—
xiv)	Sulphate (as SO_4) mg/l, Max	200	400 (see col 6)	3025 (Part 24) : 1986	May be extended upto 400 provided (as Mg) does not exceed 30
xv)	Nitrate (as NO_3) mg/l, Max	45	45	3025 (Part 34) : 1988	—
xvi)	Fluoride (as F) mg/l, Max	1.0	1.5	23 of 3025 : 1964	—
xvii)	Phenolic compounds (as C_6H_5OH) mg/l, Max	0.001	0.002	54 of 3025 : 1964	—
xviii)	Mercury (as Hg) mg/l, Max	0.001	No relaxation	(see note) Mercury ion analyzer	To be tested when pollution is suspected
xix)	Cadmium (as Cd), mg/l, Max	0.01	No relaxation	(see note)	To be tested when pollution is suspected
xx)	Selenium (as Se) mg/l, Max	0.01	No relaxation	28 of 3025 : 1964	To be tested when pollution is suspected
xxi)	Arsenic (as As), mg/l, Max	0.05	No relaxation	3025 (Part 37) : 1988	Te be tested when pollution is suspected
xxii)	Cyanide (as CN), mg/l, Max	0.05	No relaxation	3025 (Part 27) : 1986	Te be tested when pollution is suspected
xxiii)	Lead (as Pb), mg/l, Max	0.05	No relaxation	(see Note)	To be tested when pollution / plumbosolvency is suspected
xxiv)	Zinc (as Zn), mg/l, Max	5	15	39 of 3025 : 1964	Te be tested when pollution is suspected
xxv)	Anionic detergents (as MBAS) mg/l, Max	0.2	1.0	Methylene-blue extraction method	Te be tested when pollution is suspected
xxvi)	Chromium (as Cr^{6+}) mg/l, Max	0.05	No relaxation	38 of 3025 : 1964	Te be tested when pollution is suspected
xxvii)	Polynuclear aromatic hydrocarbons (as PAH) g/l, Max	—	—	—	—
xxviii)	Mineral Oil, mg/l, Max	0.01	0.03	Gas Chromato-graphic method	Te be tested when pollution is suspected
xxix)	Pesticdes mg/l, Max	Absent	0.001	—	—
xxx)	Radioactive Materials :			58 of 3025 : 1964	
	a) Alpha emitters Bq/l,	—	0.1	—	—

Sl. No.	Substances or Characteristics	Requirement (Desirable Limit)	Permissible Limit in the Absence of Alternate Source	Methods of Test (Ref. to IS)	Remarks
1	2	3	4	5	6
	Max				
	b) Beta emitters pci/l, Max	—	1	—	—
xxxi)	Alkalinity mg/l, Max	200	600	13 of 3025 : 1964	—
xxxii)	Aluminium (as Al), mg/l, Max	0.03	0.2	31 of 3025 : 1964	—
xxxiii)	Boron, mg/l, Max	1	5	29 of 3025 : 1964	—
Note : Atomic Absorption Sepctrophotometric Method may be used.					

The Indian Standard for Drinking Water Specification (IS10500 : 1991) shall be a part of Drinking Water Regulation. As and when any changes / revisions are made by the BIS for IS10500 : 1991 the same would be automatically be a part of the Regulations.

3. POLLUTION AND WATER SOURCE PROTECTION

3.1. INTRODUCTION

Water is one of the most abundant compounds found in nature, covering approximately three-fourth of the surface of the earth. In spite of this apparent abundance, several factors serve to limit the amount of water available for human use. Around 97% of total water is contained in the Oceans and other saline bodies of water and is not readily usuable for most purposes. Of the remaining 3%, a little over 2% is tied up in ice-caps and glaciers and along with atmosphere and soil moisture is inaccessible. Actually human activities utilize 0.35 to 0.4% of water from fresh water lakes, river, ground water etc. The water is used for public water supply, irrigation, industries and power generation.

Normally water is mixed with solids and gases. Dissolved solids are present in water in ionic and molecular stage having sizes less that 1mμ. The colloidal particles having sizes between 1mμ and 1μ remain in suspension in water. The suspended particles are of sizes more than 1μ. The presence of gases in water depend on the solubility of the respective gas which is dependent on temperature, partial pressure, gas co-efficient and impurities in water.

Water is in a constant state of motion according to hydrological cycle. Atmospheric water condenses and falls to earth as rain, snow or some other form of precipitation. Once on the earth's surface, water flows into stream, lakes and eventually the oceans or percolates through the soil and into aquifers.

3.2. WATER POLLUTION

Water pollution is an alteration of physical, chemical, biological properties of water in a water body which renders it unsuitable for use as drinking water source or renders it unsafe for human and animal health, for industry, agriculture, pisciculture or recreation. The sources of contamination of natural waters are classified hereunder as —

- Natural
- Agriculture
- Mining
- Municipal

- Industrial.

Qualitatively the sources of pollution are as follows :

i. Sources of Organic Pollution

k) Domestic sewage or sullage from human settlements, open defecation

l) Trade wastes from dairy, food and agro-industries, distilleries, paper and pulp industries etc.

m) Run-off from agricultural land

n) Leachate from uncontrolled solid waste dumps.

ii. Sources of Bacterial Pollution

a) Domestic sewage or sullage, open defecation

b) Dairy and agricultural waste.

iii. Sources of Inorganic and Mineral Pollution

a) Trade waste from mining / mineral based industries

b) Metallurgical industries

c) Chemical fertilizer industry.

iv. Sources of Toxic Pollution

a) Trade waste from chemical and petro-chemical, pharmaceuticals, pesticides, fertilizers, metallurgical, tanneries, refineries, electro-plating etc.

b) Radio-active nuclides from nuclear fuel complexes, atomic power plants.

v. Sources of Mechanical and Physical Pollution

a) Domestic sewage / dairy waste / agricultural run-off

b) Soil erosion

c) Thermal power plants

d) Industrial wastes in general.

3.2.1 Ground Water Pollution

Ground water pollutions are causing from natural and anthropogenic sources. The natural pollutions are mostly inorganic in nature and are caused due to mixing of released toxic chemicals from the sedimentary deposits situated at different depth. The sedimentary deposits are caused due to geo-morphological changes for many thousands of years. Excess fluoride, arsenic, iron, hardness etc. could be seen in ground water as natural contamination in many places of the country. The sources of ground water pollution are generalized below.

- Inorganic chemical contamination from sedimentary deposits
- On site sanitation
- Open defecation
- Leachate from land fill sites
- Industrial solid waste dumps
- Pesticides / fertilizers use
- Agricultural use of untreated municipal sewage.

3.2.2. Surface Water Pollution

Surface water sources receive waste water from different sources and as a result get deteriorated physically, chemically as well as bacteriologically. Normally surface water require upgradation in quality through treatment before human consumption. The common sources of pollution of surface water sources are :

- Discharges of sewage / sullage
- Discharges of liquid waste water from industries
- Surface run-of carrying pesticides, insecticides, agricultural waste
- Open defecation
- Dumping of solid waste or leachate entering from solid waste dump.

3.3. Water Pollution Control

In order to protect all water sources there is a need to control pollution. To protect water from being contaminated, Parliament in 1974 passed the water (Prevention and Control of Pollution) Act. The Act seeks to provide legal deterrent against the spread of water pollution. The Act is a comprehensive piece of

legislation. It provides for the constitution of Central and State Pollution Control Board and Joint State Board endowed with powers for controlling pollution.

Water (Prevention and Control of Pollution) Act 1974 : An Act to provide for the prevention and control of water pollution and the maintaining or restoring of wholesomeness of water, for the establishment, with a view to carrying out the purposes aforesaid of Boards for the prevention and control of water pollution, for conferring on and assigning to such Boards powers and functions relating thereto and for matters connected herewith.

Section 24, of Water Pollution Control Act prohibits a person from knowingly causing pollution or impeding proper flow of the water of the stream in a manner causing aggravation of pollution. Section 25 of the Act enables the State Pollution Control Board to give its consent for the discharge of sewage or trade effluent into a stream or give its consent for the discharge of sewage or trade effluent into a stream or well subject to such condition as it may impose. Section 32 of the Act enables the State Pollution Control Board to take emergency measures in cases of pollution of stream or well. Act empowers the Board to take legal measure against any person violating the pollution control norm and direction. The Act lays down the punishment for the failure to comply with any direction issued by the Pollution Control Boards.

The Water (Prevention and Control of Pollution) Cess Act, 1977 is to provide for the levy and collection of Cess on the water consumed by persons carrying on certain industries and by local authorities, with a view to augment the resources of the Central Pollution Control Boards and the State Pollution Control Board for the prevention and control of water pollution constituted under the Water (prevention and control of pollution) Act, 1974.

3.4. Protection of Water Sources

All water sources presently used for supply to the consumers for drinking purposes must be protected from external pollution. Municipal sewage / sullage need to be treated or recycled by maintaining ecologically balanced condition so that it would, not only in one hand reduce and control pollution but also return back the nutrient to the soil. In the process it can generate non-conventional energy, fish, poultry feed etc.

The industrial liquid wastes required treatment and treated waste water quality must conform to the standard laid down by CPCB before discharge in inland surface water, public sewers, land for irrigation and marine coastal areas.

The environmental sanitation condition of both rural and urban areas need to be improved for minimizing both surface water and ground water pollution. All spot sources (hand pump attached tube wells) should be protected from bacterial contamination by providing impervious apron and lead drain, sanitary sealing to the tube wells, appropriate hand pump and keeping latrine pits and manure pits away maintaining a safe distance from the tubewells.

All water sources, treatment units, reservoirs, distribution network etc. must be kept free from bacteriological and chemical contamination. In case of surface water sources e.g. rivers, lakes, traditional ponds, tankas, nadis, ahars etc the contamination level must be kept at minimum so that the water can be treated through conventional system at an affordable cost. The ground water must be kept free from anthropogenic pollution and if ground water is contaminated by natural / geological reasons the concerned aquifers with respect to their actual extent and depth must be identified and mapped.

In order to strengthen water sources, new reservoirs (earthen impounding) may be created or existing reservoirs may be upgraded and renovated for storage of rainwater through surface run-off harvesting.

Where necessary, rainwater harvesting structures are to be built for conservation of rainwater. These surface water sources must be protected as far as practicable from pollution, so that the technique of treatment of water remains to be simple and water treatment cost also remains to be within the affordability of the consumers.

Thus in the Regulations following could be incorporated.

3(1)

a) *Any surface water bodies, flowing or static, used as a source for supply of water for human consumption or contemplated to be used as a source for supply of water for human consumption must be protected from pollution and in carrying out the same Statutory Regulations under Water Pollution Control Act 1974 and Environment Protection Act 1986 are applicable.*

b) *All traditional rainwater harvesting structures used as lifelines for local people by providing water for basic requirement must be protected from contamination and water supply agencies shall take adequate measures to protect the water bodies from contamination including generation of awareness of the user groups for protection of water sources.*

3(2) *The ground water aquifers being used or contemplated to be used for water supply for human consumption must be protected from any contaminations caused due to dumping or burying of municipal solid waste, biomedical waste, hazardous solid waste and disposal of liquid wastes in low-lying lands. The Statutory Regulation under Water Pollution Control Act 1974, Environment Protection Act 1986, Hazardous Waste (Management and Handling) Rules 1987, Bio-medical Waste (management and handling) Rules 1998 and Municipal Solid Waste (Management and Handling) Rules 2000 are applicable for Control of Pollution. Water Supply Agencies shall keep surveillance to identify above mentioned pollutional sources, if any, causing pollution to ground water aquifers and refer such cases immediately to State Pollution Control Boards for action as per existing statutory regulations to control pollution.*

3(3) *All water supply agencies shall identify specific surface water bodies being used for supply of water for human consumption for protection from any pollution and accordingly Water Authorities shall declare through notification the identified specific water bodies as 'Protected Water Bodies' so that no discharge of liquid effluent or dumping of garbage and hazardous waste will be allowed by any person in the said protected water bodies. The State Pollution Control Board strictly shall not allow any person to discharge effluent in the said protected water bodies. The protected water body shall be limited to non-flowing water body but used for supply of water for human consumption.*

4. WATER PURIFICATION

4.1. INTRODUCTION

The water qualities of surface water sources mostly do not conform to Indian Standard for Drinking Water (IS10500 : 1991) and accordingly requires purification to make it fit for human consumption. Water intended for human consumption should be wholesome and accordingly it should be free from disease causing organisms in amounts that would constitute health hazard, aesthetically attractive — clear, colourless and palatable and it should not contain chemical substances in such concentrations as to cause a health hazard or economic loss when consumed over a long time. Normally if contaminations in water remain in the form of suspended particle and colloidal particles then these can be removed through different conventional processes at affordable cost. Removal of contaminants remaining in dissolved form in water requires special purification process which are costly and as such if not subsidized then it may not be affordable to the consumers.

The ground water drawn from confined or semi-confined aquifers mostly do not require treatment. However, ground water may require purification for removal of certain chemical contamination e.g. Arsenic, excess Fluoride, Iron etc.

4.2. TREATMENT OPTIONS

The following treatment options are generally available for treatment of water.

i. Disinfection
ii. Aeration
iii. Plain Sedimentation
iv. Slow Sand Filtration
v. Coagulation-Flocculation-Sedimentation
vi. Rapid Sand Filtration
vii. Roughing Filter — Up-flow, Down-flow and Horizontal
viii. Co-precipitation
ix. Adsorption
x. Ion-Exchange

xi. Electrodialysis

xii. Reverse Osmosis

xiii. Membrane Filtration.

The primary factors that influence the selection of treatment process are :

i. raw water quality and its variations.

ii. treated water specification (as per Standard under Regulation)

iii. Local Constraints

iv. Relative Costs of different treatment process.

It is vital to ensuring drinking water quality that water treatment works are designed, operated and maintained properly. This means that Water Supply Agencies should adopt a quality management system approach to the management, operation and maintenance of water treatment works. As part of a quality management system, water supply agencies should have written procedures that set out how each part of the process and other related matters are to be operated and maintained at each treatment works so that the water leaving the treatment works meets the drinking water quality standards and other requirements of the Regulations. Operators should be fully trained in each part of the process that they are expected to operate.

The Regulations require that a Water Supply Agency take all necessary measures to ensure that no substances (including any impurities in these substances) used in the treatment of water remain in concentration higher than is necessary for the purpose of use and that they do not directly or indirectly reduce the protection of public health provided for in the Regulations. They also require a water supply agency to verify the efficiency of disinfection, where disinfection is practiced, and ensure that concentration of disinfection by products is kept as low as possible and also ensure that residual effect of disinfectants at consumer points remain within the maximum desirable limit without compromising disinfection.

The water treatment works as mentioned above are applicable to all types of surface water treatment units, ground water treatment units including only disinfection.

4.3. RAW WATER QUALITY

The Water Supply Agency should have —

a) appropriate arrangements to ascertain raw water quality including operational monitoring;
b) carried out a risk assessment of the catchment to determine whether there is a significant risk to the quality of drinking water supplies;
c) determined the treatment processes, if needed to treat raw water;
d) to ensure compliance with the Indian Standard for Drinking Water Specification before supply to the consumers;
e) to ensure disinfection;
f) criteria and arrangements for ceasing obstruction of raw water if its quality gives rise to, or is likely to give rise to, a risk to public health.

4.4. WATER TREATMENT WORKS OPERATION

Each water treatment work site should be secure from unauthorized access. The immediate surroundings of the site should not present a potential risk to the operation of the treatment processes or to drinking water quality.

The Water Supply Agency should have a detailed map of the site showing clearly the location of each treatment process and the routes of pipe work connecting each process and the location of ancillary equipment such as pumps. There should be a schematic diagram of each process showing the equipment, such as pumps and valves and chemical dosage system, needed to operate the process.

The Water Supply Agency should have detailed procedure for the operation of each process that set out what the operator should do in normal circumstances and how the operator should respond to unusual circumstances. There should be criteria that describe the satisfactory operation of each process, such as a physical or chemical measurement. These procedures should set out the tests to be carried out and also frequency of testing. The unusual circumstances may be a significant change in raw water quality, a problem with the operation of a particular process, a result from a process monitor that is outside the specified criteria, or a failure to meet the drinking water quality standard.

The Water Supply Agency should have detailed schedules for the maintenance of all key items of process equipment and a system for recording maintenance and ensuring that these schedules are meet.

The Water Supply Agency should have robust procedures controlling the use of substances (chemicals), products and materials at treatment works including :

a) that the substances (chemicals) to be used for water treatment must have approval of Bureau of Indian Standard under reference to Code number;
b) that the products and materials to be used in the treatment works must have approval of Bureau of Indian Standard under reference Code number;
c) that all substances (chemical), products and equipment to be purchased must have 'BIS' mark with reference Code number and have been manufactured as per BIS specification given in relevant IS-code.

4.5. MINI WATER TREATMENT WORKS OPERATION

Mini water treatment works include bore well attached treatment units (disinfection arrangement, defluoridation, arsenic removal, iron removal etc.) with piped water supply system, hand pump attached treatment units (iron removal, arsenic removal, defluoridation etc.), small surface water treatment units (Sedimentation and Slow Sand Filtration with disinfection, Horizontal Roughing Filter and Slow Sand Filtration with disinfection etc.), Gravity fed water supply unit for hilly areas (sedimentation and disinfection, sedimentation and slow sand filtration with disinfection etc.)

Each of the above mentioned mini-water treatment works site should be secure from unauthorized access. The immediate surroundings of the site should not present a potential risk to the operation of the treatment processes or to drinking water quality.

The Water Supply Agency should have a detailed map of the site showing clearly the location of water treatment works.

The Water Supply Agency should have detailed procedure for operation of each process including schematic diagram of the treatment works. The operational

procedure should include parameters for testing and frequency of testing, chemical dosing determination, media regeneration or changing schedule and sludge storage.

In areas where the above types of mini-water treatment works are operated and maintained by the community. The water supply agency should extend all support to the community groups to operate and maintain as per guidelines. The support includes providing O&M guidelines, water quality monitoring, training etc.

4.6. TRAINING OF OPERATORS

All operators should be trained in the processes that they are expected to operate. The training should include normal process of operation, identification of faults in the process, how to rectify faults, and how to react in emergency situations.

4.7. SLUDGE MANAGEMENT

In case of Arsenic and excess Fluoride removal units, the sludge as well as exhausted media are hazardous in nature. The existing Hazardous waste (Management and Handling) Rules 1989 are applicable for the said sludge and exhausted media for safe disposal so that these will not cause any deleterious effect to the environment and public health. Scientific approaches should be taken for treatment and safe disposal of sludge and exhausted media. Accordingly, capacity need to be built, specially in the rural areas for proper management of the same. In case of conventional water treatment works the sludge which is rich with Aluminum also need to be managed through environment friendly manner.

5. WATER QUALITY MONITORING AND SURVEILLANCE

5.1. INTRODUCTION

The precise meaning of 'Surveillance' in relation to the control of drinking water quality is the keeping of a careful watch at all times, from the public health point of view, over the safety and acceptability of drinking water supplies. Surveillance requires a continuous and systematic programme of sanitary inspection and water quality testing, carried out at different points of the water distribution system. A surveillance programme aimed at ensuring a consistently acceptable level of drinking water quality and to make it fully effective, it requires legislation supported by regulatory standards and core of practice along with institutional arrangement.

5.2. KEY ELEMENTS OF SURVEILLANCE PROGRAMME

All water supply agencies shall undertake water quality monitoring and surveillance programme for all types water supply systems meant for supplying water for human consumption. If any rural water supply system is operated and maintained through community based management system, the said water supply system must be in the water quality monitoring and surveillance. The State Water Authority shall act as state nodal unit for organizing the water quality monitoring and surveillance programme.

5(1) *Under the Regulation Water Quality Monitoring and Surveillance Programme shall be a mandatory component of public water supply system.*

5(2)

f) A water supply agency responsible for supplying water for human consumption must include the Water Quality Monitoring and Surveillance (WQM&S) Programme to ensure safe water supply to the consumers.

g) The key elements of a WQM&S programme should include

- *Monitoring*
- *Sanitary Survey*
- *Data Processing*

- *Evaluation*
- *Remedial and Preventive Action*
- *Institutional Analysis.*

h) *If any water supply system meant for supplying water for human consumption is operated and maintained by a community group under the active support of a water supply agency, then the said water supply system must be a part of WQM&S programme run by the water supply agency.*

5.3. WATER QUALITY MONITORING

Monitoring involves the laboratory and/or spot testing of water samples collected from different locations in the water supply system including sources, water treatment plants, distribution system and house reservoirs.

5.3.1. Water Sampling and Analysis

Periodic drinking water analysis is necessary to ensure safe quality water supply. Water samples should be analysed for various microbiological and physico-chemical 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 mostly venerable to the supply system.

Water samples collected from public water supply system should be analysed in accordance with the method of testing for different parameters as referred in different Indian Standards with relevant Code number.

5(3)

a) *Water supply agencies supplying water for human consumption shall carry out period sampling as per guideline and analyse the same in the laboratories for different parameters as referred in different Indian Standards with relevant Code number.*

b) *Where laboratory facilities are not available, specially in rural areas, field testing kits can be used by the water supply agencies or community groups for water quality testing of certain parameters.*

5.3.2. 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. Regular water quality monitoring is a mandatory for any type of public water supply system. Water samples should be analysed for priority parameters as per local problems.

In principles, water samples should be analysed as fast as possible to avoid deterioration of sample quality, especially for microbiological analysis.

Suggested water quality monitoring laboratory network and their activities are furnished below :

Table – 5.1 : Rural Water Supply

Sl. No.	Level	Activities
1.	Village based water testing unit — ▪ Village level WATSAN Committee ▪ Primary Health Centre	▪ Water testing using field kits ▪ Parameters to be tested - Faecal coliform (H_2S Strip method) - pH - Turbidity - Chloride - Hardness - Iron - Fluoride - Nitrate - Arsenic (Optional) - Residual Chlorine
2.	Block Level Water Testing Laboratory	▪ Water testing using standard instrument and equipment ▪ Parameters to be tested - Faecal coliform (Multiple Tube Fermentation Technique / H_2S Strip) - Total coliform (MTFT) - pH - Turbidity - Chloride

		- Total Dissolved Solids (TDS) - Hardness - Iron - Fluoride - Nitrate - Arsenic (optional) - Residual Chlorine.
3.	District Level Water Testing Laboratory	▪ Water testing using standard instrument and equipment ▪ Bacteriological tests (Routine) ▪ Physico-Chemical tests (Routine) ▪ Biological tests (Routine) ▪ Other laboratory testing works
4.	State / Regional Level Water Testing Laboratory	▪ Water testing using precision instruments and equipment ▪ Bacteriological tests (Advanced) ▪ Biological tests (Advanced) ▪ Other laboratory testing works.

Table – 5.2 : Urban Water Supply

Sl. No.	Level	Activities
1.	Water testing laboratory (compulsory) attached to water treatment plant (Plant capacity > 200 MLD)	▪ Water testing using Standard instrument and equipment ▪ Bacteriological tests (Routine) ▪ Physico-chemical tests (Routine) ▪ Biological tests (Routine) ▪ Other laboratory testing works.
2.	Water testing laboratory at Municipal level or for Municipal Club (4/5 municipalities)	▪ Water testing using standard instrument and equipment ▪ Bacteriological tests (Routine) ▪ Physico-Chemical tests (Routine) ▪ Biological tests (Routine) ▪ Other laboratory testing works
3.	State Level Referral Laboratory	▪ Water testing using precision instruments and equipment ▪ Bacteriological tests (Advanced) ▪ Physico-chemical tests (Advanced) ▪ Biological tests (Advanced) ▪ Other laboratory testing works.

5(4)

a) *All water supply agencies shall ensure availability of laboratory network for regular water quality testing of different essential characteristics and certain desirable characteristics as laid down in Indian Standard for Drinking Water (IS10500 : 1991).*

b) *All water supply agencies shall ensure availability of water quality testing results for inspection by the consumers or displayed at convenient places for inspection by the consumers or if feasible, shall be published in web site for wide circulation and inspection. The Water Authority shall take initiation or co-ordinate with all water supply agencies, municipalities, Panchayat Bodies, NGOs etc. for ensuring the water quality test results available to consumers.*

5.3.3. Sampling Frequency

The water sampling frequency for testing for different water supply systems are suggested below :

Table – 5.3 : Suggested Frequency of Sampling and Analysis of Water Supplies

Source and Mode of Supply	Minimum Frequency of Sampling and Analysis		Remarks
	Bacteriological	***Physical / Chemical***	
Ground Water :			
Open wells for community supply	Every 7 days	Once initially then 4 times yearly	Pollution usually expected to occur
Covered dug wells and shallow tube wells with hand pumps	Every fortnight	Once initially then 4 times yearly	Situations requiring testing; change in environmental conditions; outbreak of water borne diseases, or increase in incidence of waterborne diseases.
Deep tubewells with handpumps	Once initially, thereafter as situation demand	Once initially then 4 times yearly	Situations requiring testing; change in environmental conditions; outbreak of water borne diseases, or increase in incidence of waterborne diseases
Wells and Piped supplies	Once initially, thereafter as situation demand	- Once initially then 4 times yearly - Test weekly for residual chlorine if water is chlorinated	Situations requiring testing; change in environmental conditions; outbreak of water borne diseases, or increase in incidence of waterborne diseases
Springs and Piped	Once initially,	- Once	Situations requiring testing;

supplies	thereafter as situation demand	initially then 4 times yearly - Test weekly for residual chlorine if water is chlorinated	change in environmental conditions; outbreak of water borne diseases, or increase in incidence of waterborne diseases

Contd…

(Contd.)

Source and Mode of Supply	Minimum Frequency of Sampling and Analysis		Remarks
	Bacteriological	*Physical / Chemical*	
Surface Water and Rainwater :			
Filtered and / or chlorinated and piped supplies	Once monthly	- Once initially then 4 times yearly - Residual chlorine test daily	Increase frequency of bacteriological test if situation demands.
Community rainwater collection system	Sanitary protection measures; bacteriological testing only if situation demands	- Once initially and then half yearly	—

Table – 5.4 : 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 weeks	
More than 1,00,000	One day	One sample per 10,000 of population per month

Table – 5.5 : Suggested Minimum Sampling Frequency for Water Quality Control Monitoring

Sl. No.	Size and Source	Frequency	Parameters					Heavy Metals & Pesticides	Problem Parameters As, Cr^{+6} , Fe & Mn, Fluoride	Remarks
			Residual Chlorine	*Physical*	*Chemical*	*Bacteriologcal*	*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 summary & rainy season
2.	>50,000 upto 1,00,000 Population	i. Daily	✓							From source and distribution system
	a. Ground water (Tube well, Sanitary Well, Bore well	ii. Monthly				✓				
		iii. Quarterly		✓	✓				✓	
	b. Ground water (Hand pump)	Twice a year		✓	✓	✓			✓	In summary & rainy season
3.	>1,00,000 Population									From source & distribution system
	a. Ground water (Tube well, Sanitary Well, Bore well	i. Daily	✓							
		ii. Monthly				✓				
		iii. Quarterly		✓	✓				✓	
		iv. Annually						✓		
	b. Ground water (Hand pump)	i. Twice a year		✓	✓	✓			✓	In summary & rainy season

Sl. No.	Size and Source	Frequency	Parameters					Heavy Metals & Pesticides	Problem Parameters As, Cr^{+6} , Fe & Mn, Fluoride	Remarks
			Residual Chlorine	*Physical*	*Chemical*	*Bacteriologcal*	*Biological*			
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
		ii. Annually						✓		
4.	Surface water									
	a. Raw water, source and intake point	i. Daily		✓	✓					
		ii. Weekly				✓				
		iii. Annually						✓	✓	
		iv. Occa-sional (as and when required)					✓			
	b. Sedimentation tank after clarifier	i. Daily		Turbidity only						
		ii. Weekly				✓				
		iii. Occa-sional (as and when required)					✓			
	c. Filtered water	i. Daily		Turbidity only						
		ii. Weekly				✓				
	d. Clear Water Storage reservoirs	i. Daily	✓	✓	✓					
		ii. Weekly				✓				

Sl. No.	Size and Source	Frequency	Parameters					Heavy Metals & Pesticides	Problem Parameters As, Cr^{+6} , Fe & Mn, Fluoride	Remarks
			Residual Chlorine	*Physical*	*Chemical*	*Bacteriologcal*	*Biological*			
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
	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, Appendis 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.

5(5) *A water supply agency shall carry out water quality testing for the public water supply system (supplying water for human consumption) as per guidelines on water sampling frequency laid down in Table – 5.5. If any public water supply system is operated and maintained by community group, the water quality testing shall be carried out as per the water sampling frequency laid down in Table – 5.3.*

5(6) *A water supply agency shall comply the sampling procedures as laid down in Art 4.6 of Implementation Manual on National Rural Water Quality Monitoring and Surveillance Programme, published by RGNDWM, Department of Drinking Water Supply, Ministry of Rural Development, Government of India.*

5.4. SANITARY SURVEY

An effective drinking water quality control programme involves two equally important activities; the carrying out of sanitary survey and the sampling and analysis of water changes in the quality of water at various stages of supplies can help in detecting contamination and in determining whether these have arisen at the source or during the course of water treatment or in the distribution system.

Sanitary Inspections, are complementary to such analysis and functions as a part of water quality control programmes. They allow for an overall appraisal of the many factors associated with a supply system, including the water works and the distribution system. Moreover, such an appraisal may later be verified and confirmed by micro-biological analysis, which will indicate the severity of the defects.

Sanitary inspects thus provide a direct method of pinpointing possible problems and source of contamination. They are also important in the prevention and control of potentially hazardous conditions, including epidemics of waterborne diseases.

Sanitary Inspection are intended to provide a range of information and to locate potential problems. The data obtained may identify failures, anomalies, operator errors and any deviations from normal that may effect the production and distribution of safe drinking water.

5(7)

a) *A water supply agency shall ensure for public water supply system. Sanitary survey which requires a thorough examination of the water supply system or at least its key points, in order to check whether the installations are satisfactory and whether the various operations are being carried out properly. Sanitary survey shall be carried for the assessment of risks of contaminations of all types of water supply systems, e.g. dug well, dug well with hand pumps, shallow and deep hand pumps (Tubewells) deep bore wells, gravity feed piped spring water supply, gravity feed piped supply, piped water supply from ground and surface water sources, rain water tank, traditional water source upgradation (purification) system etc.*

b) *Sanitary Inspection shall be carried out as mentioned in 5(7)(a) above by the community, water supply agency as well as by a neutral organization termed as surveillance agency. The minimal annual frequency of sanitary inspection shall be followed as suggested below in Table – 5.6.*

Table – 5.6 : 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

5.5. 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. Local laboratory under WQM&S should maintain detailed field reports regarding inspections and water analysis of all water supplies available in the area.

The consumers have the right to know about the quality of water being supplied to them.

5(8) *Water supply agencies responsible for monitoring shall develops strategies for informing public the health related results obtained by them along with recommendations for action (e.g. boiling during severe faecal contamination, household storage technique, hygiene education etc.) through publicity, Panchayat etc.*

5(9) *Water supply agencies shall prepare Gram Panchayat (Mouza) level GIS map showing all types of public water supply systems, their relevant component and salient features including water quality supplied for human consumption.*

5.6. REMEDIAL AND PREVENTIVE MEASURES FOR PROTECTION OF WATER SUPPLIES

Remedial action entails a series of exercises to be carried out to rectify sanitary deficiency upon detection. Preventive measures are always useful to protect any water supply system from risk of contamination of water. The evaluator should be extremely cautious in interpreting the relative effect of the identified deficiency on the safety of the supply and kind of corrective and preventive measures needed.

5(10) *Water supply agencies shall take remedial and preventive measures for protection of water supplies and accordingly suggestive guidelines as furnished in Table – 5.7 may be followed.*

Table – 5.7 : Remedial and Preventive Measures for Protection of Water Supplies

Source and Mode of Supply	Evidence or Information Available	Immediate Remedial Measures Available	Preventive Action
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 round and cover. It is preferable to provide hand pumps and promote community education and participation.
Unpiped 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 or 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
	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	

Source and Mode of Supply	Evidence or Information Available	Immediate Remedial Measures Available	Preventive Action
		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.
	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.

5.7. ORGANISATIONAL FRAMEWORK

Water quality surveillance requires strong and effective organizational framework for carrying out duties and responsibilities for assessing the safety and accessibility of water supplied to the people. The surveillance agency may be separate from the water supply agency; alternatively there may be two wings in the water supply agency. Water supply agency or wing is responsible for safe water supply to the consumers, which the surveillance agency or wing ensures water supply free from health hazard. However, their activities are essentially complimentary.

Some important aspects of surveillance programme are as follows :

- To ensure services to protect the consumers from waterborne diseases and water supply related other hazards.
- It may be integrated with environmental sanitation programme.
- Personnel involved in surveillance programme should be trained so as o impart knowledge on various issues of environmental sanitation and community health.
- Adequate infrastructure must be available for cross-checking of water quality and extending support to quality monitoring at grass-root level.
- Sustainability of the programme through community participation.
- Establishing cascading communicative system and information management and recording.

5(11) *Water supply agencies shall set up organizational framework with manpower development and support for protection of consumers from waterborne diseases and water supply related other hazards. Water supply agency shall ensure sustainability of WQM&S Programme through community participation with Panchayati Raj Institution in rural areas of the country. In urban water supply system the sustainability of WQM&S shall be ensured by water supply agency in collaboration with the Municipality / Corporation and participation of Municipal Ward Committees.*

6. SPECIFICATIONS FOR THE ANALYSIS OF PARAMETERS

6.1. INTRODUCTION

The water quality testing to be carried out in the laboratories must follow the standard of practices which are approved by the scientific community. The performance of a water testing laboratory depends on the quality of instruments, equipments, glassware and chemicals, expertise of the chemists, technicians and analysts, sampling procedure and techniques etc. The laboratories working under water quality monitoring and surveillance programme must have accreditation from the approved authority. The personnel engaged in the laboratory required to be trained from the recognized institutions and they must also undergo orientation / refresher training courses from time to time. All the laboratories associated with the water quality monitoring and surveillance programme as well as other water quality testing programme must have appropriate quality management system.

6.2. ANALYTICAL QUALITY CONTROL

6(1) *Each water testing laboratory at which samples are analysed must have a system of analytical quality control i.e. subject from time to time to checking by a person / firm who is not under the control of the laboratory and who is approved by the water supply agency for that purpose.*

6(2) *A laboratory carrying out analysis of drinking water shall attain accreditation of recognized institutions / NABL for a period of maximum 3 years. The accreditation to the laboratory must be revalidated before expiry of the above period from the recognized institutions / NABL. The Water Authority of each state shall identifying the recognized institutions for the purpose of extending accreditation to the laboratories.*

6(3) *All water testing laboratories have to meet to demonstrate that they are operating a quality management system and are able to produce valid analytical results. The key requirement of the quality management system for the water quality testing laboratories shall include document control of all*

procedure and analytical methods used in the laboratory, procedure for dealing complaints about the service, a self-assessment process including internal audit and management review, integrity and impartiality, valid test procedures, competence of personnel and maximum traceability of measurements.

6.3. COMPETENCY AND TRAINING OF ANALYSTS

Water supply agencies and their laboratories or their contract / associated laboratories should ensure that water samples are analysed by, or under the supervision of a person / firm who is competent to perform that task. As many laboratories will have some staff with only basic technical qualifications and limited experience in water analysis, the organizational and management structure of the laboratory is important.

6(4)

c) *In order to carry out drinking water quality correctly it is essential that all the laboratory personnel are fully trained and competent before they are allowed to work unsupervised*

d) *Water supply agencies and their laboratories or their contract / associated laboratories should produce a comprehensive analysts training manual and programme to cover all aspects of analysis that as a minimum should include :*

- ☑ *The criteria for selection of persons to be engaged in the laboratory for analysis.*
- ☑ *The relevant principle and practice of analysis, including calibrations and analytical quality control.*
- ☑ *Supervised training and experience of the relevant analytical systems.*
- ☑ *The criteria and method of assessment of competence to work supervised and unsupervised.*
- ☑ *The criteria and method of assessment of competence to train, audit and supervised others.*
- ☑ *The monitoring / audit of trained analysts to check that they continue to perform satisfactorily and the criteria for satisfactory performance*

- ☑ *Retraining when performance is not satisfactory*
- ☑ *An annual review of each laboratory personnel training to assess whether further training is necessary.*

All analysts should have :

i. a copy of the analytical method that they are trained to use and access to a copy of the laboratory analysis manual;
ii. have trained in all the analytical methods that they are, or could be, required to carry out;
iii. been trained in the principles and practices of calibrations of equipment and methods and in analytical quality control.

Analysts should not carry out analytical procedure unless they have been successfully trained to an acceptable standard or they are being supervised by competent and experienced analysts as part of their training.

6.4. SAMPLE STORAGE AND PRESERVATION

Sample must be transported to the laboratory with the minimum delay as per guideline of the standard laboratory manual which would contain written instructions for the storage and preservation of the samples or sample portion.

6.5. PERFORMANCE OF ANALYTICAL METHODS

In order to ensure the accuracy of results of monitoring of drinking water quality is an essential requirement of the Regulations that laboratory must use specified methods of analysis approved by the competent authority of the country. Each laboratory should have tested the performance of the analytical methods used for each parameter or each determine constituent of a parameter and to have demonstrated that the method is capable of meeting the performance requirement before that method is used for routine analysis for compliance sample. The performance testing should cover the entire analytical method, including any sample preparation and concentration steps. Performance testing should be carried out in a manner emulating that used routinely without taking special precautions

that would not generally apply to achieve optimum performance. An analytical method is the specific combination of laboratory, analysts, instrumentations and analytical procedure used to analyse the sample, including any sample preparation or pretreatment steps.

6(5)

c) The water testing laboratories shall follow the method of testing as prescribed by Indian Standard on Drinking Water Specifications (IS10500 : 1991).

d) The water testing laboratories may follow the method of testing as prescribed by the Standard Method of APHA —Current Edition.

e) The water testing laboratories may follow the method of testing as prescribed by WHO.

f) Each laboratory shall test the performance of the analytical methods used for each parameter and compare with the State Referral Laboratory.

g) The State Referral Laboratory shall undertake performance evaluation on quality control and quality assurance of each laboratory in the state at least once in a year. The State Referral Laboratory shall verify the analytical method followed by each of the laboratory in the state. An analytical method is the specific combination of laboratory, analysts and instrumentation and analytical procedure used to analyse the sample, including any sample preparation or pre-treatment steps.

6.6. RECORDS OF LABORATORY ANALYSIS

Water supply agencies and their laboratories or associated laboratories should keep adequate records of key aspects of analytical procedures and the results. As a minimum, these records should include :

- ☑ All key instruments installation, commissioning, maintenance and repair records, including any instruments log or diary;
- ☑ All basic calibration records, methods suitability checks and any other records necessary to demonstrate the suitability of any equipments used at the time of analysis.
- ☑ The analytical procedure used.

- ☑ Routine internal and external analytical quality control data including charts, investigations of out of control conditions and corrective actions
- ☑ Raw data for the whole analytical run and all calculations to obtain the final results of the analysis.

6.7. CALIBRATION OF ANALYTICAL SYSTEMS

It is essential that the calibration procedure for each analytical system or method is fully documented and is sufficient to establish fully or check fully the calibration each time the system or method is used. The procedure will vary with the system or method used and the parameter being analysed, but in all cases the calibration should be established or checked over the entire range of the method and all results of analysis falling outside the applicable calibration range of the method should be rejected. Instrumental systems of the analysis (such as chromatography, absorption and emission spectroscopy and automated colorimetric analysis) often require full calibration each time they are used. At least three calibration points are required to demonstrate straight line. Generally the more complicated the calibration the greater the number of calibration points required.

6.8. INTEGRITY OF COMPLIANCE MONITORING RESULTS

It is vitally importance for public confidence in the results of compliance monitoring that water supply agencies and their laboratories or associated laboratories have arrangements and procedures in place to prevent unauthorized alteration of results at all stages of the production of the results in the laboratory and during the transfer of those results to the water supply agency and water authorities' database.

6(6)

a) *In no case water testing results can be modified or altered at any stage from data generation to recording.*
b) *A designated person in the laboratory should be responsible for validating the results and authorizing its transfer to the water supply agency and water*

authorities' database. Once a result is on the database it must not be deleted or altered. If it is subsequently discovered that a result on the database is incorrect the result may be disqualified by a suitable explanation that gives the correct results.

7. SUSTAINABILITY TO DRINKING WATER SYSTEMS IN RURAL INDIA

7.1. INTRODUCTION

History stands witness to man's use of varied forms of technology and science, ranging from the simplest to the most complicated, for storing and extracting water. India has particularly strong tradition of rainwater harvesting — communities have met their minimum water requirements effectively by collecting rainwater locally, diverting and storing water from local streams and springs and tapping sub-surface water. However, these traditional technologies and methods have fallen prey to inattention and ignorance over time, and need to be revived and rejuvenated.

Traditional structures such as the tankas and khadims of Rajasthan, baoris (step wells) of Western India, the orranis, cheruvus and temple tanks of South India, and the bamboo-split pipe harvesting method practiced in the north each still serve as lifelines for local people. Communities can combine and converge this knowledge with modern technologies and scientific tools such satellite imaging. Emphasizing on the urgent need for rainwater harvesting, replenishing and restoring existing surface water bodies and creating new ones, and recharging ground water, this segment urges water supply agencies, water managers, practitioners to think beyond the conventional and look for innovative solutions.

7.2. MOBILISING TECHNOLOGY FOR SUSTAINABILITY

Based on the requirements of agricultural development, the country has been demarcated into different sixteen agro-climatic regions. Broad features of these sixteen regions and recommended water harvesting measures for each region are presented below.

Agro-Climatic Region	Areas	Recommended Water Harvesting Measures
Humid Northwestern Himalayas	Hilly areas of Jammu & Kashmir, Himachal Pradesh and Uttarakhand	i. Roof water harvesting ii. Diversion of perennial springs and streams in storage structures iii. Village ponds iv. Collection from hill slopes.
Himalyan Foot Hills	Foothill areas of Jammu & Kashmir,	i. Collection from hill slopes

Agro-Climatic Region	Areas	Recommended Water Harvesting Measures
	Himachal Pradesh, Punjab and Uttarakhand in the west and parts of West Bengal, Assam and Arunachal Pradesh in the east	ii. Village ponds iii. Contour trenching
Humid High Rainfall North Eastern Zone	Sikkim, Darjeeling hills, Arunachal Pradesh, Meghalaya, Nagaland, Manipur, Tripura, Mizoram, Assam, and Jalpaiguri and Cooch Behar district of West Bengal	i. Roof top harvesting ii. Diversion of perennial springs and streams in storage structures (tanks)
Humid Assam Bengal Plains	Assam and West Bengal	i. Tanks ii. Check dams / Anicuts iii. Gully plugging iv. Contour building
Sub-Humid and Humid Satluj-Ganga Alluvial Zone	Punjab, Haryana, Uttar Pradesh and Bihar and is served by middle reaches of the Satluj basin and the lower and middle reaches of the Ganga basin	i. Ponds ii. Check dams iii. Gully plugging iv. Contour buding
North-Western Semi-Arid and Arid Zone	Western Rajasthan	i. Nadi / Talab ii. Tanka iii. Khadin iv. Percolation tanks v. Anicuts vi. Gully plugging vii. Contour bunding
Central Semi-Arid Vindhyan Zone	South-Eastern districts of Rajasthan, Southern districts of Uttar Pradesh and Central parts of Madhya Pradesh	i. Ponds ii. Check dams iii. Contour buding iv. Gully plugging v. Sub-surface dykes
High Rainfall High Runoff Chhototanagpur Plateau	Jharkhand, adjoining hilly areas of Bihar, West Bengal and Orissa	i. Tanks / Ponds ii. Check dams / Anicuts iii. Gully plugging iv. Contour bunding
Malwa Plateau and Namada Basin	Gujarat, western parts of MP and northern parts of Maharashtra	i. Ponds ii. Check dams iii. Sub-surface dams
South-Central Deccan Plateau Zone	Parts of Andhra Pradesh, Tamil Nadu, Karnataka and Maharashtra	i. Ponds ii. Check dams iii. Percolation tanks iv. Bandhara v. Gully plugging

Agro-Climatic Region	Areas	Recommended Water Harvesting Measures
		vi. Sub-surface dams vii. Contour bunding
Chhattisgarh Plateau Zone	Chattisgarh and South-Western Orissa	i. Ponds ii. Check dams iii. Percolation tanks iv. Bandhara v. Gully plugging vi. Sub-surface dams vii. Contour bunding
South-Eastern Brown / Red Soil Zone	Pachamalal and Kadavur hills and pediplain areas of Tamil Nadu and Veligond hills and part of the plains (excluding the 4-5 km wide coastal belt) of Andhra Pradesh	i. Traditional Ponds/ tanks ii. Percolation tanks and Sub-surface dams suggested in the vicinity of drinking water sources like dug wells, hand pumps and tube wells
Southern Variable Rainfall, Mixed Soil Zone	Southern parts of Maharashtra and West Central Parts of Tamil Nadu	i. Ponds / Tanks / Kunta ii. Nadi iii. Check dams iv. Percolation tanks v. Sub-surface dams vi. Gully plugging
Southern Bi-Modal Rainfall Zone	Southern most parts of Kerala, Karnataka and Tamil Nadu	i. Ponds / Tanks ii. Percolation tanks iii. Check dams iv. Gully plugging v. Contour bunding
Eastern Coromandal	Entire coastal belt of Orissa, Andhara Pradesh and West Bengal	i. Ponds / Tanks / Kunta ii. Nadi iii. Check dams iv. Percolation tanks v. Sub-surface dams vi. Gully Plugging
Western Malabar	Western Malabar area of Kerala and coastal areas of southern Karnataka	i. Ponds / Tanks / Kunta ii. Check dams iii. Weirs iv. Bandhara v. Percolation tanks vi. Sub-surface dams vii. Contour bunding.

7.3. SUSTAINABILITY THROUGH GROUND WATER RECHARGING

In order to counter ground water depletion due to over-abstraction of water, it would be appropriate to take up ground water recharging schemes / systems to replenish the aquifers with fresh water. Many traditional methods of recharging could be popularized in the villages through peoples' participation. Rainwater harvesting structures could be installed with aim to recharge not only sub-surface aquifers but also semi-confined and confined aquifers. Following specific data must be considered for developing ground water recharging :

7.3.1. Specific Data Considered for Ground Water Recharge Studies

- Land use pattern
- Irrigated and Non-irrigated Area
- Water bodies status
- Soil cover condition
- Forest Status
- Toposheets
- Drainage System
- Physiography
- Stop conditions
- Soil map
- Geology
- Ground water status
- Ground water prospects
- Climatic data
- Hydro-geomorphology
- Water Quality Maps
- Watershed consisting of moderate drainage texture with drainage density of approx. 1.95.

The main characteristics of the said watershed are erratic and uneven distribution of rain fall spatially and temporarily which results into frequent water shortage, flesh floods and soil loss. On the other hand area receives average

rainfall of 1027 mm annually. It has been observed that approx. 90% of the water goes as surface runoff of the watershed as unused.

7.4. ROOF TOP RAINWATER HARVESTING

Roof top rainwater harvesting structures could be constructed in any part of the country. It is a simple mechanism of collecting rainfall, allow it to pass through filter and store it a tank. The excess water could be drained into the recharge pit. There should be a provision to drain out portion of the first rainfall, as it would flush out the dirt. This water can also be connected to the recharge pit.

Roof top rainwater harvesting is suitable in water scarcity areas, coastal areas, arsenic and fluoride affected areas etc.

7(1) *Water supply agencies shall work for bringing sustainability to drinking water system in rural areas of the country. The water supply agencies shall seek solutions to make water supply systems sustainable and reliable in terms of quality as well as quantity by emphasizing a combination of traditional wisdom and best practices in water management with modern technologies and scientific understanding.*

7(2) *Water supply agencies shall popularize water harvesting and watershed management works based on agro-climatic zone. Traditional water harvesting structures shall be popularized among villagers with their active participation.*

7(3) *Rainwater recharging shall be popularized amongst villagers for sustainability of the ground water resources. Such approaches shall be sub-surface or semi-confined aquifer or confined aquifer recharging, as per local hydro-geological conditions as well as feasibility. Relevant information and data shall be collected and consulted to arrive at rain water recharging strategy.*

7(4) *Panchayati Raj Institutions (PRI), NGO shall also take initiative to popularize rainwater harvesting, recharging, traditional water source protection and conservation.*

7.5. MOBILIZING HUMAN RESOURCE FOR SUSTAINABILITY

It is most important to mobilize human resources for sustainability. Local community is the key human resources involved in rural water supply programme. They are the primary user of the water supply facility and again they will manage the facility. Community participation, thus, refers to the involvement of village households — both men and women in water resource management by working for rejuvenation of traditional water bodies and building new structures. Community participation shall lead to a feeling among the households of owning these structures and water resources, and therefore, motivate them to work for their conservation and protection, and contribute monetarily for the use of water. Community should have control over is resources, and should feel responsible for their upkeep.

7(5) *State Water Authority and water supply agencies as a facilitator shall take up campaign for intensive awareness generation amongst the villagers regarding issues like, over-extraction of ground water, local water security, contamination of drinking water and water quality monitoring, water conservation, rainwater harvesting, artificial recharge etc. PRI (Zilla Parishad, Panchayat Samity and Gram Panchayat) and NGOs shall play active role in the awareness generation campaign.*

7(6) *Water supply agencies, PRI, NGOs and others shall encourage and help women to come forward and participate for sustainability of the water resources and management.*

.7.6. MOBILIZING FINANCIAL RESOURCES FOR SUSTAINABILITY

Numerous government programmes on soil and water conservation and for augmentation of ground water are being undertaken by various Ministries at the Central and State levels. There is a need to converge these efforts at the district, block, village and habitations levels as well as to optimize the benefits of the range of technical options and financial outlays in a synergistic manner. The State also has a central role to play in providing the legislative framework for protection of water bodies, regulating indiscriminate extraction of ground water and in the arbitration of competing interests for water. Additionally, the State has a facilitating

role to create institutional mechanisms for community ownership and management of water supply system, as well as for monitoring strategies and devising new ways to move ahead on the journey of continued sustainability.

The National water policy (2002) enunciates that "water is a scarce and precious national resource to be planned, developed, conserved and managed as such, and on an integrated an environmentally sound basis, keeping in view the socio-economic aspects and needs of the states. It is one of the most crucial elements in developmental planning. As the country has entered the 21st Century, efforts to develop, conserve, utilize, and manage this important resource for sustainability have to be guided by national perspective."

It is estimated that in India, 85% of the drinking water is based on ground water resources. The schemes based on surface water also depend on continued and secure supply from the catchment. Efforts should be made to manage the water right from the catchment, conserving the runoff and using the natural filter systems to ensure safety of water.

7.6.1. National Rural Employment Guarantee Scheme (NREGS)

The NREGS' objective is to strengthen livelihood opportunities and create durable assets in rural areas through legal guarantee of hundred days employment in a financial year to a rural household that demands employment. Among the works undertaken under NREGS, water conservation and water harvesting has a high priority. The kind of works under NREGS on water conservation and water harvesting are :

- Water conservation and water harvesting
- Drought proofing, afforestation and tree plantation
- Irrigation canals including micro and minor irrigation works
- Renovation traditional water bodies including desilting of tanks
- Flood control and protection works including drainage in waterlogged areas

Under NREGS the communities are involved from development of village development plan to implementation, operation and maintenance.

.7.7. NATIONAL AFFORESTATION PROGRAMME (NAP)

Under NAP, all afforestation schemes of the Ministry of Environment and Forests have been brought under a single umbrella scheme being implemented through decentralized Forest Development Agencies (FDA) set up at the district level. The FDAs have a strong linkage to the district panchayat and village forest protection committee. The overall objective the scheme is to develop the forest resources with people's participation, with focus and improvement in livelihoods of the forest-fringe communities, especially the poor.

.7.8. NATIONAL PROJECT FOR REPAIR, RESTORATION AND RENOVATION OF WATER BODIES

It is a Central Government scheme prepared with the aim to repair, renovate and restore all the water bodies directly linked to agriculture managed by the Ministry of Water Resources, the project envisages active community participation. Under the schemes, projects are to be taken up in one or two districts each in the state. The states are to take up restoration of water bodies having original irrigation cultivable command area of 40 ha upto 2000 ha to revive, augment and utilize their storage and irrigation potential.

7.9. RIVER VALLEY PROJECTS AND FLOOD PRONE RIVE PROGRAMME

The centrally sponsored programme on soil conservation for enhancing the productivity of degraded lands in the catchments of River Valley Project and Flood Prone River, in the present form, is being implemented since November 2000 by the Ministry of Agriculture and Cooperation. The main objectives the programme are prevention of the land degradation by adoption of a multi-disciplinary integrated approach for soil conservation and watershed management in catchement areas, improvement of land capacity and moisture regime in the watersheds, prevention of soil loss from the catchment, reduction of siltation in multipurpose reservoirs, enhancement of surface rainwater storages etc.

.7.10. INTEGRATED WASTE LAND DEVELOPMENT PROGRAMME (IWDP)

This scheme is implemented by the Department of Land Resources, Ministry of Rural Development. Apart from the development of non-forest waste lands the scheme also provide for the development of an entire micro-watersheds in a holistic manner. The basic objective of the scheme is an integrated waste land development based on village / micro-watersheds plants. These plants are prepared after taking into considerations the land capability, site conditions and local needs of the people.

7(7) *As there are numerous government programmes on soils and water conservations and for augmentation of ground water are being undertaken by various Ministries at the Central and State levels there is a need to converge these efforts so as to optimize the benefits of the range of technical options and financial outlays in a synergistics manner. State Water Authority, Water Supply Agencies, Panchayati Raj Institutions and other stakeholders shall have coordination so as to take holistic approach in providing sustainable safe water supply to the community.*

8. WATER QUALITY COMPLAINTS

8.1. INTRODUCTION

Water Supply Agencies will be aware that the Drinking Water Quality is very important to consumers. If something has gone wrong with the water supply it could present a risk to consumers' health or affect the appearance, taste or odour of the supply.

8(1)

a) Complaints about drinking water quality receives from consumers shall be investigated promptly by the Water Supply Agencies and the results of the investigation shall be given quickly to the complainants and, if necessary, appropriate action shall be taken by the Water Supply Agencies or shall advise to the consumers to remedy any fault. Complaints may be receives from consumers by telephone, in writing by letter, fax or e-mail or in person.

b) Water supply agencies shall have in place comprehensive written procedures for dealing with the complaints about the quality of drinking water supplies.

c) If complaint regarding water quality is not attended by the Water Supply Agency within 48 hours, the complainant may contact State Water Authority by telephone or writing letter or fax or e-mail or in person for redressal.

8.2. PROCEDURE TO DEAL WITH WATER QUALITY COMPLAINTS

The Water Supply Agency should laid down procedures for dealing with water quality complaints as outline hereunder :

- A system of recording the receipt of complaints
- Assigning immediately the management of the investigation of the complaints to a person / VWSC who will coordinate the activities for investigating the complaints. The person / VWSC should be capable of determining the nature of the problem, determining appropriate investigations to ascertain the cause and assessing whether there could be wider implications.

- Requiring the assigned person / VWSC to contact the complainants and explain what the Water Supply Agency is doing and when the complainant can expect a response. The complainant should be informed, particularly if there is any delay.
- Investigating the causes of deterioration in water quality which may include contamination of water quality at sources, malfunctioning of unit operations in water treatment plants, post contamination in pipelines, inadequate disinfection, pollution travel in hand pump attached tube wells, deep bore wells, dug wells, priming of tube wells with contaminated water etc.
- Taking and analyzing water samples for appropriate parameters from appropriate locations including complainants' premises.
- Receiving and assessing the results of the investigation and if necessary discussing them with laboratory and operational staff.
- Reviewing the results of recent water quality testing.
- Taking any appropriate remedial action when the complaint has been caused by Water Supply Agency's operation.
- Giving advice to the complainant where necessary, the actions he /she should take when the investigation has been established that the cause is associated with the conditions of his / her pipelines, fittings, storage reservoir or any operation of the complainant.
- Reporting the outcome to the complainant as quickly as possible in simple term.
- A system for reviewing periodically all complaints by number, type and locations to determine whether there are particular difficulties with some aspect of the Water Supply Agencies operation.

8(2) *Water Supply Agency shall make a standard procedure for dealing with the water quality problems as mentioned in clause 8(1).*

9. RISKS ASSESSMENT

9.1. INTRODUCTION

Water Supply Agencies should carry out a risk assessment of each of the water sources and supplies to determine whether there is a significance risk of contaminant water being supplied to the consumers from time to time, say every few years, the risk assessment should be reviewed. The urgency and frequency of review depends on whether there have been significant changes in the catchment that could affect the quality of the water source, whether there have been any significant changes in the treatment of water before supply and whether there have been any significant changes in the condition of the distribution system. There are a number of significant factors that should be taken into account in any risk assessment from water source to consumer points. These factors are outline below.

9.2. CATCHMENT FACTORS

The nature of the catchment and activities in the catchment can have a significant effect on the quality of water source in the catchment. Important factors are —

a) *geology and hydrogeology* – determines whether potentially harmful natural *substances* are likely to be present in *significant concentrations* in water sources such Arsenic, Fluoride, Uranium and Radon and whether substances that could affect the aesthetic quality of water supplies are likely to be present such as *peat colour, Iron and Manganese;*

b) *animals* – high numbers of farmed or wild animals including birds *roosting on reservoirs can cause a deterioration of the microbiological* quality of water sources, particularly in relation to *Cryptosporidium;*

c) other agricultural practices —such as :

   i. storage of slurry or dung presents a risk of microbiological contamination, particularly as many stores are not secure from *leakage from rainwater*;

ii. widespread slurry or dun spreading presents a risk of microbiological contamination and

iii. use of fertilizers and pesticides presents a risk of contamination by Nitrate and Pesticides;

d) *discharges* – such as :

i. sewage works effluents, septic tank effluents, and leachate from on-site sanitation pits can present a risk of microbiological contamination, particularly when not operated satisfactorily;

ii. effluents from industrial premises can present a risk of chemical and other types of contamination depending on the nature of the industrial process and the substances used;

iii. from mining, quarrying and similar activities, particularly when abandoned, can present risks of chemical contamination, and

iv. *surface water and storm water overflows in urbanized areas;.*

v. *open defecation and contamination thereof;*

vi. *leachate from garbage (organic solid waste) dump.*

9.3. TYPE OF WATER SOURCE

Some types of water source are of greatest risk of contamination than other types for example :

a) *deep boreholes and wells* – generally they are secure and present little risk unless the hydrogeology is considered vulnerable to activities on the surface; however, in certain areas water may get chemically contaminated due to leachates from sedimentary deposits (geological reasons);

b) *shallow boreholes and wells* – generally these are less secure and present more of a risk unless the hydrogeology is considered not to be vulnerable to activities on the surface;

c) *springs* – risk depends on security of spring, which in turn depends on, whether the hydrogeology is considered vulnerable;

d) *upland surface waters* – risk depends on nature of, and activities in, catchment and whether collected in an impounding reservoir (less risk) or *direct abstraction from stream (more risk); and*

e) *lowland surface waters* – risk depends on nature of, and activities in, catchment and whether long-term storage (lower risk), bankside short-term storage (medium risk) or direct abstraction (higher risk).

9.4. MONITORING QUALITY OF WATER SOURCES

Risk is reduced when there is appropriate continuous or semi-continuous monitoring of the quality of the water source and that information is used for taking appropriate preventive and remedial measures for protection of water sources or making adjustment in the water treatment process.

9.5. WATER TREATMENT

Risk is considerably reduced when there are appropriate water treatment processes to deal with the full range of variations in microbiological, chemical and physical water quality of the water source. For example, a secure good quality ground water may not require any treatment or may require only disinfection. Ground water subject to contamination may require appropriate treatment for removal of the contamination. Most of the surface water sources require conventional treatment. Specific contamination may require specialized treatment such as, adsorption, ion exchange, reverse osmosis, etc. In most of the cases, disinfection is practiced before water supply. An assessment needs to be made about whether the treatment processes provided are likely to inactivate or remove the organisms and substances likely to be present in the water source at the range of concentrations present. If the treatment processes are inadequate there is clearly a risk.

9.6. MONITORING TREATED WATER QUALITY

Risk is considerably reduced when there is appropriate continuous or semi-continuous monitoring of the treated water and that information is used for taking preventive and remedial measures. Risk is also reduced when there is discrete

monitoring of important parameters that indicate whether the treatment processes are operating effectively.

9.7. OPERATION AND MAINTENANCE

The risk of failures of treatment processes and poor treated water quality is considerably reduced when the operators of the treatment works follow good operating and maintenance practice and procedure and the practices and procedures are quality assured. Occasional or regular failure to meet the standards for drinking water quality and operational criteria over a significant period indicates that either the treatment work is not being adequately operated and maintained or the treatment processes are inadequate for the quality of the water source. Such failures indicate a risk and action should be taken to minimize that risk.

The integrity of water distribution system is important in reducing the risk of water quality failures at consumer points. In intermittent water supply, there is always a risk of entry of post contamination in the pipeline through leaky joints during non-supply hours. Risk of contamination in distribution system is less if round the clock water supply is maintained.

9(1)

d) Water Supply Agencies shall carry out risk assessment of each of their water sources and water supply system to determine whether there is a significant risk of contaminated water being supplied to the consumers.

e) Water Supply Agencies shall carry out risk assessment through sanitary survey of water supply systems adopted by the agency for supplying water for human consumption.

f) Water Supply Agency shall take appropriate preventive and remedial measures to minimize the risk of contamination of drinking water.

g) The risk assessment programme can be associated with the National Water Quality Monitoring and Surveillance Programme.

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