UNIT 23 DRINKING WATER

Structure

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23.0 OBJECTIVES

After studying this unit, you will be able to:

- describe the sources of water supply and the requirements of drinking water;
- highlight the water borne diseases;
- explain the methods of purifying water; and
- pinpoint the water supply requirements in emergency situation.

23.1 INTRODUCTION

Water is essential to maintain life. It is the basic necessity of life for human beings, animals and plants. Thus the availability of water, adequate in quantity and of desired quality is essential for survival. It is very important that the water required for the human consumption must be free from unwanted impurities and harmful chemical compounds of bacteria. In order to ensure the availability of sufficient and good quality water to the community, it becomes utmost necessary to plan and design the water supply system carefully to ensure potable water. The water supply systems must be designed to withstand adverse effects of the emergencies created by the various types of disasters.

In the aftermath of any disaster, the immediate need of the situation is to provide sufficient potable water to the affected population. By providing potable water various problems like spread of epidemics can be avoided. In the present unit, we will study the water supply requirements and various water borne diseases in the context of disaster situations.

23.2 WATER SUPPLY SOURCES AND WATER RESOURCES

The basic source of all fresh water is from precipitation, which may be in various forms such as rain, snow, hail, and dew. This from the atmosphere may either remain on surface or go underground. Our requirements of water are met from these origins. The surface and sub-surface sources of water is categorized as follows:

1) Surface Sources
   a) Ponds and lakes
   b) Streams and rivers
   c) Storage reservoirs
2) **Sub-Surface/Underground Sources**

a) Wells and tube wells

b) Springs

In the surface sources of water supply, the water drawn from lakes and reservoirs is considered most safe, due to settlement of suspended materials usually present in the water. However, still water standing for long periods in lakes encourages the growth of algae, weeds and other vegetation in the water. These usually contribute to the development of bad smell, taste and colour to the water. Similarly the quality of water obtained directly from rivers is usually not useful for direct human consumption due to the presence of silt, sand and other suspended solids. Harmful bacteria and unwanted chemicals could also be present in such waters. The practice of discharging untreated sewage into the river increases such impurities in the water. Thus the water from majority of surface sources could be contaminated and cannot be used without treatment or purification.

Rivers and streams are the most important sources for public water supply schemes. The importance of water from quantity viewpoint had been recognised for a long time now. That’s why most of the present urban centres grew up on the banks of major rivers which enacted continuous and regular water supply to the inhabitants. In most of the rivers the quantity of water flow is not constant round the year but is based upon various factors including seasons. Thus to overcome this problem and to ensure a regular supply of water, a barrier in the form of a dam is constructed across the river to store the excess water that flows during the monsoon season. The pool so created upstream of a dam constitutes the storage reservoir. Smaller reservoir may also be termed as artificial lake.

The sub-surface sources of water are based on rainwater that percolates down to be stored inside the earth. The water, which is so stored inside the earth in the form of ground water reservoirs, constitutes the major source of sub-surface water supply. Underground water is generally pure because of natural filtration during the percolation process. This type of water is expected to be free from the presence of harmful bacteria but may have higher quantities of dissolved inorganic/organic compounds depending upon the geological formations of the region. The underground water may be brought unto the surface by some natural phenomenon like springs etc. or through some artificial means such as by constructing wells and tube wells.

**Table 1:** Describes the possible pollution of water sources and the remedial measures.

### Pollution in water sources and the remedial measures

<table>
<thead>
<tr>
<th>Water Source</th>
<th>Possible Pollution</th>
<th>Suggested remedial Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dug wells</td>
<td>Contamination by nearby water discharges; surface water pollution through lining, cover slab, or manhole</td>
<td>Sanitary conservation of nearby area, sealing of leaks, chlorination of supply</td>
</tr>
<tr>
<td>Tube wells</td>
<td>Entry of polluted drainage due to improper sealing at top, liquid water discharges in the vicinity</td>
<td>Sanitary conservation of the area, sealing of the top and at ground level with a concrete apron, emergency chlorination</td>
</tr>
<tr>
<td><strong>Infiltration wells and galleries in river beds</strong></td>
<td>Raw water access through leaky lining and cover slabs, short circuiting through deep underground water channel.</td>
<td>Closing holes and filling up leaks, and chlorination of the water supply.</td>
</tr>
<tr>
<td><strong>Natural streams and springs</strong></td>
<td>Access near point of intake for human and animals; pollutional discharges upstream; irrigation works or cultivation nearby.</td>
<td>Sanitary conservation of the area, emergency chlorination at the intake point.</td>
</tr>
<tr>
<td><strong>Lake or reservoir</strong></td>
<td>Drift of pollution by wind; access to intake point for people and animals; fishing, boating, swimming, and wading activities; picnics on marginal land and shores; habitations, manure pits, and agricultural operations in the nearby catchment areas; inadequate policing.</td>
<td>Restrictions and treatment to be decided by the bacterial purity of the water at the point of intake; sanitary conservation of the nearby watershed area; routine post-chlorination treatment. Regulatory measures for picnic uses.</td>
</tr>
<tr>
<td><strong>River flows</strong></td>
<td>Liquid waste discharge upstream of the intake point and chemicals in the return flow from irrigation, sewage farms, dumping grounds, the growing of crops in the river bed above the intake point during periods of reduced flow; fairs and festivals near the river margin; laundry, washing, and ferry activities just above the intake point.</td>
<td>Corrective steps to avoid, to mitigate, or to minimize the pollutional load at the point of intake depending on discharges into the river and the “extent of contamination” in the nearby watershed; pre-chlorination during emergencies; routine post-chlorination treatment. Enforcement of pollution control regulations strictly.</td>
</tr>
<tr>
<td><strong>Raw water transmission</strong></td>
<td>Route and mode of conveyance should be chosen to avoid additional pollution during transmission.</td>
<td>Open canals should be protected in accessible reaches against contamination; cross drainages, if any, should be diverted.</td>
</tr>
<tr>
<td><strong>Treatment plant</strong></td>
<td>No part of the plant should be affected by contamination from any sewage or sludge near the area.</td>
<td>All quality assurance measures should be followed strictly.</td>
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</table>


**Check Your Progress 1**

**Note:** 
1. Use the space given below for your answers.
2. Check your answers with those given at the end of this Unit.
1) Describe the water supply sources?

Proper selection and protection of water sources are of prime importance for safe drinking water supply. It is always wise and economical to protect water sources from contamination than to treat the water after it gets contaminated. Prior to the selection of water supply sources it is very important to ensure the satisfactory quality and quantity of water. The water sources must be protected from human activities, which may contaminate the water. Activities like mining, quarrying, hazardous waste dumping, agricultural use of fertilizers and pesticides and recreational activities must not be allowed around the water source. In practice, it is very difficult to protect sources like rivers but all efforts should be made to keep away the various sources and activities which may contaminate the river waters.

It is very important to purify/treat the water before distribution to community. The extent of treatment required to be given to the water, however, depends upon the qualities of available raw water and the quality requirements prescribed for the intended use.

The basic purpose of water treatment is to protect the consumer/user from pathogens and impurities in water that may be offensive or injurious to human health. The water treatment systems for urban water supply schemes mainly involve following stages:

1) Pre-Treatment
2) Sedimentation aided with coagulation
3) Filtration and
4) Disinfection

1) Pre Treatment of Water

The pre treatment of water consists of storage or disinfection of river waters. Most of the suspended impurities have to settle down under gravity during the storage process. The microbiological quality of water also improves during the
impoundment of water in lakes or reservoirs, especially when combined with the exposure to ultraviolet radiation of sunlight. Pre-disinfection is usually done when water is abstracted and treated without storage. This process destroys or reduces harmful faecal bacteria and pathogens. Another important objective of pre-treatment or pre-disinfection is to reduce the amount of ammonia in the water.

2) Sedimentation aided with coagulation

The very fine suspended mud particles and colloidal matter present in water cannot settle down during the pre-treatment impoundment of water in the sedimentation tanks. These particles can easily be removed by increasing their size by changing them into flocculated particles. For this purpose certain chemical compounds like aluminum sulphate, ferric or ferrous sulphate and ferric chloride are used. These compounds commonly known as coagulants on thorough mixing, form a gelatinous precipitate called floc, which absorbs and entraps the very fine mud particles, colloidal matter, and mineral particles present in the water. This can bring about a major reduction in turbidity and in the numbers of pathogens. This process of adding and mixing of chemicals is called coagulation. The coagulated water is then made to pass through sedimentation tanks to remove the flocculated particles after proper settlement.

3) Filtration

Even after the pre-treatment and sedimentation aided with coagulation processes, water may contain some very fine suspended particles and pathogens. To remove or to reduce the remaining impurities still further and to enhance quality, the water is filtered through beds of fine granular materials such as sand. This process of passing the water through beds of such material (called filters) is known as filtration. The filtration process helps in removal of colour, odour, turbidity and pathogens from the water.

4) Disinfection

Disinfection is the process in which microbiological organisms are destroyed by physical or chemical action, and is commonly used as the final process in the water treatment. A small amount of the active disinfectant should normally remain in the distributed water, to destroy subsequent contamination during distribution. Chlorine is the most common and most effective disinfectant used world over as it is cheap, reliable and easy to handle. The term chlorination is used very commonly to indicate that the water has been treated with a sterilizing agent. Other acceptable methods of disinfection are:

- Boiling of water
- Treatment with lime
- Treatment with ozone gas
- Treatment with iodine and bromine
- Treatment with ultraviolet rays
- Treatment with potassium permanganate

Disinfection by Chlorination

The application of chlorine during disinfection process require certain precautions due to harmful effects of chlorine compounds and thus the careful dosing of chlorine is essential. The quantity of chlorine required for disinfecting the water depends upon the water quality, quantity and contact period, i.e. the
period for which chlorine remains in contact with water before serving to consumer. However, the excess amount of chlorine gives bitter and bad taste to water.

The dose of chlorine is generally determined by experimenting various combinations in a water sample and to check the residual left after a 20-minute contact period. The dose, which gives a residue of 0.1 – 0.2-mg/l milligram per litre is considered ideal.

Chlorine used for disinfection can be applied in any of the following forms:

i) in the form of liquid chlorine or chlorine gas.
ii) in the form of bleaching powder.
iii) in the form of chloroamines and
iv) in the form of chlorine dioxide.

### 23.4 WATER SUPPLY IN DISASTER SITUATIONS

An adequate supply of clean, safe drinking water is very important for the proper health and well-being of the community. When water and sanitation facilities break down, the public health is at risk. The chances of break down of water supply during the emergency situation can not be ruled out. In the aftermath of an earthquake, flood, or cyclone, there could be a serious water crisis. It, therefore, becomes very necessary to develop contingency action plans for meeting any emergency arising due to any of the natural or man made disasters. These contingency action plans should include:

- Coordinating measures to be taken up to ensure safe water supply
- A communication plan to alert and inform users of the supply
- Detailed plans to provide and distribute emergency supplies of water

Alternative safe water supply means have to be developed in the case of water supply system becoming inoperational due to any disaster. Various practical and social considerations must be taken into account prior to assessing the emergency needs of the affected community, such as:

- number of people to be served;
- quantity of water can be calculated by taking atleast 15-20 litres per person per day for needs like drinking, cooking, personal hygiene etc.;
- quality of available water and level of contamination;
- availability of water in the nearest source.

#### a) Urban Water Supply Scheme:
If the disaster has affected an urban centre and a disruption to water supply scheme has taken place, the first priority should be to put the system back into operation. Damaged portions must be replaced or repaired and the supply must be quickly restored. In the aftermath of the disaster, the water pressure and the chlorine concentration must be increased to avoid any contamination from polluted water. In case any of the portions of treatment plant gets affected by the disaster, it should be repaired and proper disinfection must be done prior to putting it back into operation.
b) **Underground Source:** Underground sources are usually free from disaster related contamination and may not require any treatment. When springs are being used as a source after a disaster certain changes in the water quality may take place after earthquake or floods. Hence proper testing for water quality is required before restoration of supplies. As far as wells as the potential water sources are concerned, the location of these should be at least 30 metres away from the potential source of contamination like latrines and should be at a higher elevation. The wells must be properly covered. For additional precaution, the drinking water from these sources must be boiled or disinfected prior to use.

c) **Surface Water:** The usage of surface water as a water supply source should be the last option. Muddy, coloured, polluted water should not be consumed. The water from the surface sources should be treated to remove turbidity, colour and other impurities and should be disinfected. For this purpose mobile water treatment plants as an adhoc measure could be pressed into service. Mobile plants are available mounted on a truck along with all accessories which include a centrifugal pump run by an engine, a rapid sand filter unit, chemical solution tanks, chlorine solution tank and other necessary accessories.

### 23.4.1 Water Storage in Emergency Situation

Emergency storage of water can be done in canvas, rubber coated nylons and plastic containers. Polyethylene containers erected in pits dug to size can also be used as storage. The total storage capacity for water distribution should be equal to the amount required for 24 hrs. Elevated water tanks must be erected using drums, iron sheeting and wooden poles. For long term emergency camps, all the storage tanks must be covered to protect from dust, and other contaminations. Special attention must be paid to proper sanitation near these tanks.

### 23.4.2 Distribution of Water

In emergency situations water is usually distributed through tankers. The individual families and local groups must be provided with water containers to store water. Special care has to be taken in checking the quality of water prior to transporting the water for distribution.

In long term camps, distribution pipes with community taps must be installed for water supply.

### Check Your Progress 1

**Note:** i) Use the space given below for your answers.
                   ii) Check your answers with those given at the end of this Unit.

1) What are the different methods of water purification?
23.5 LET US SUM UP

In the aftermath of any disaster, there is an immediate need to restore drinking water supply and also to ensure its purity. To ensure its purity, there is need to have pretreatment of water, sedimentation aided with coagulation, filtration and disinfection, especially chlorination. The disrupted water supply has to be restored and till that time alternative safe water supply means have to be arranged.

23.6 KEY WORDS

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Colloidal</td>
<td>Suspended in liquid</td>
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<tr>
<td>Coagulate</td>
<td>Curdle, turn from liquid to somewhat solid like curd.</td>
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<tr>
<td>Pathogen</td>
<td>Any organism that causes disease.</td>
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<tr>
<td>Potable</td>
<td>Fit for drinking</td>
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<tr>
<td>Percolation</td>
<td>Filter down</td>
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<tr>
<td>Faecal</td>
<td>Belonging to human excrement</td>
</tr>
<tr>
<td>Flocculated</td>
<td>Turned into small wooly lumps</td>
</tr>
<tr>
<td>Turbidity</td>
<td>Muddy, translucent</td>
</tr>
</tbody>
</table>

23.7 REFERENCES AND FURTHER READINGS


23.8 ANSWERS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress 1

1) Your answers should include the following points:
   - Surface Sources: ponds, lakes, streams, rivers and reservoirs
   - Sub-Surface or Underground Sources: wells, tube wells, springs

2) Your answers should include the following points:
   - Remedial measures for removing pollution from water sources vary for different water sources
• However, sanitary conservation of the area, covering the water storage if possible, emergency chlorination at intake point and regulatory measures are some of the common methods.

Check Your Progress 2

1) Your answer should include the following points:
   • Pre-treatment or pre-disinfection
   • Sedimentation with coagulation
   • Filtration
   • Disinfection

2) Your answer should include the following points:
   • Chlorination
   • Boiling
   • Treatment with lime
   • Treatment with ozone gas
   • Treatment with ultra violated rays
   • Treatment with potassium permanganate