MODULE 4

WATER POLLUTION

The topics covered in this module are:

- Water pollution & human health
- Water quality issues in India
- Sources / Causes of pollution
- Wastewater: Treatment and Reuse
- Purification - Domestic & community Level
- Demonstration of water quality testing

OBJECTIVE (S) OF THE MODULE

The trainer informs the following module objectives to participants:

- Learning the causes and extent of water pollution.
- Understanding the impact of polluted water on human health and environment.
- Sensitization on the water quality issues existing in the country.
- Learning approaches and techniques for preventing water pollution as well as treatment and reuse of wastewater.
- Explain the procedures of water quality testing at the individual and community level.

WATER POLLUTION & HUMAN HEALTH

Pollution is a word that you hear almost every day in the news, at school and in day-to-day conversations. Much has been done to reduce and control pollution, but there is still more that needs to be done.

Water pollution is the contamination of water bodies (e.g. lakes, rivers, oceans, aquifers and groundwater), very often by human activities.

Water pollution occurs when pollutants (particles, chemicals or substances that make water contaminated) are discharged directly or indirectly into water bodies without enough treatment to eliminate harmful compounds.

Pollutants get into water mainly by human causes or factors. Water pollution is the second most imperative environmental concern along with air pollution.

More to this, water pollution affects not only individual living species, but also populations and entire functioning ecosystems that exists in the waters.

Industrial Wastewater

Humans have now realized the importance of fresh water as a foundation for life. In recent times, more and more organizations and councils are working hard to educate, protect, restore waterways and promote practices that help keep water from contamination, and also to preserve water ecosystems from destruction.

In this lesson, we shall learn all about water pollution, the types of water pollution, causes of water pollution, effects and some preventive practices that we can all use to help deal with water pollution.

Did You KNOW

Half the population of the developing world is exposed to polluted sources of water that increase disease incidence.

Activity

Fill a tray or bowl with water. This represents your local creek or waterway. A funnel represents a storm drain. First, place some of the pollutants into the funnel, holding your finger over the bottom so that they stay inside. Hold the funnel over the 'waterway' and remove your finger. Pour some water on top of the pollutants in the funnel. This is like the rain - washing things into the storm drain. What happened to the water in the bowl? Try the experiment again, this time holding a sieve over the funnel. What happened this time? Did the sieve stop all the pollutants? What kind of pollutants still entered the 'waterway'?

SOME COMMON TERMS OF WATER POLLUTION

Nutrients Pollution

Some wastewater, fertilizers and sewage contain high levels of nutrients. If they end up in water bodies, they encourage algae and weed growth in the water. This will make the water undrinkable, and even clog filters. Too much algae will also use up all the oxygen in the water and other water organisms in the water will die out of oxygen from starvation. Thus, nutrient pollution is a form of water pollution due to contamination of excessive input of nutrients. It is primary cause of 'Eutrophication' in surface water bodies.

Surface water pollution

Surface water includes natural water found on the earth's surface, like rivers, lakes, lagoons and oceans. Hazardous substances coming into contact with this surface water, dissolving or mixing physically with the water can be called surface water pollution.

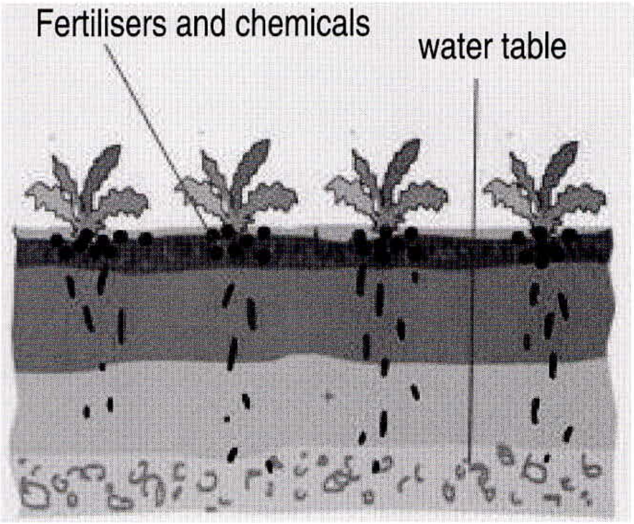
Oxygen Depleting

Water bodies have micro-organisms. These include aerobic and anaerobic organisms. When too much biodegradable matter (things that easily decay) enters in water, it encourages more microorganism growth, and they use up more oxygen in the water. If oxygen is depleted, aerobic organisms die, and anaerobic organism grow more to produce harmful toxins such as ammonia and sulfides.

Ground water pollution

When humans apply pesticides and chemicals to soils, they percolate deep into the ground by rain water. This gets to underground water, causing pollution underground.

This means when we dig wells and bore holes to get water from underground, it needs to be checked for ground water pollution. Shallow wells are more susceptible for ground water pollution than deeper wells.



Microbiological pollution

In many communities in the world, people drink untreated water (straight from a river or stream). Sometimes there is natural pollution caused by microorganisms like viruses, bacteria and protozoa. This natural pollution can cause fishes and other water life to die. They can also cause serious illness to humans who drink from such waters.

Suspended Matter

Some pollutants (substances, particles and chemicals) do not easily dissolve in water. This kind of material is called particulate matter. Some suspended pollutants later settle under the water body. This can harm and even kill aquatic life that live at the floor of water bodies.

Chemical Water Pollution

Many industries and farmers work with chemicals that end up in water. These include chemicals that are used to control weeds, insects and pests. Metals and solvents from industries can pollute water bodies. These are poisonous to many forms of aquatic life and may slow their development, make them infertile and kill them.

Oil Spillage

Oil spills usually have only a localized affect on wildlife but can spread for miles. The oil can cause the death of many fish and stick to the feathers of seabirds causing them to lose the ability to fly.

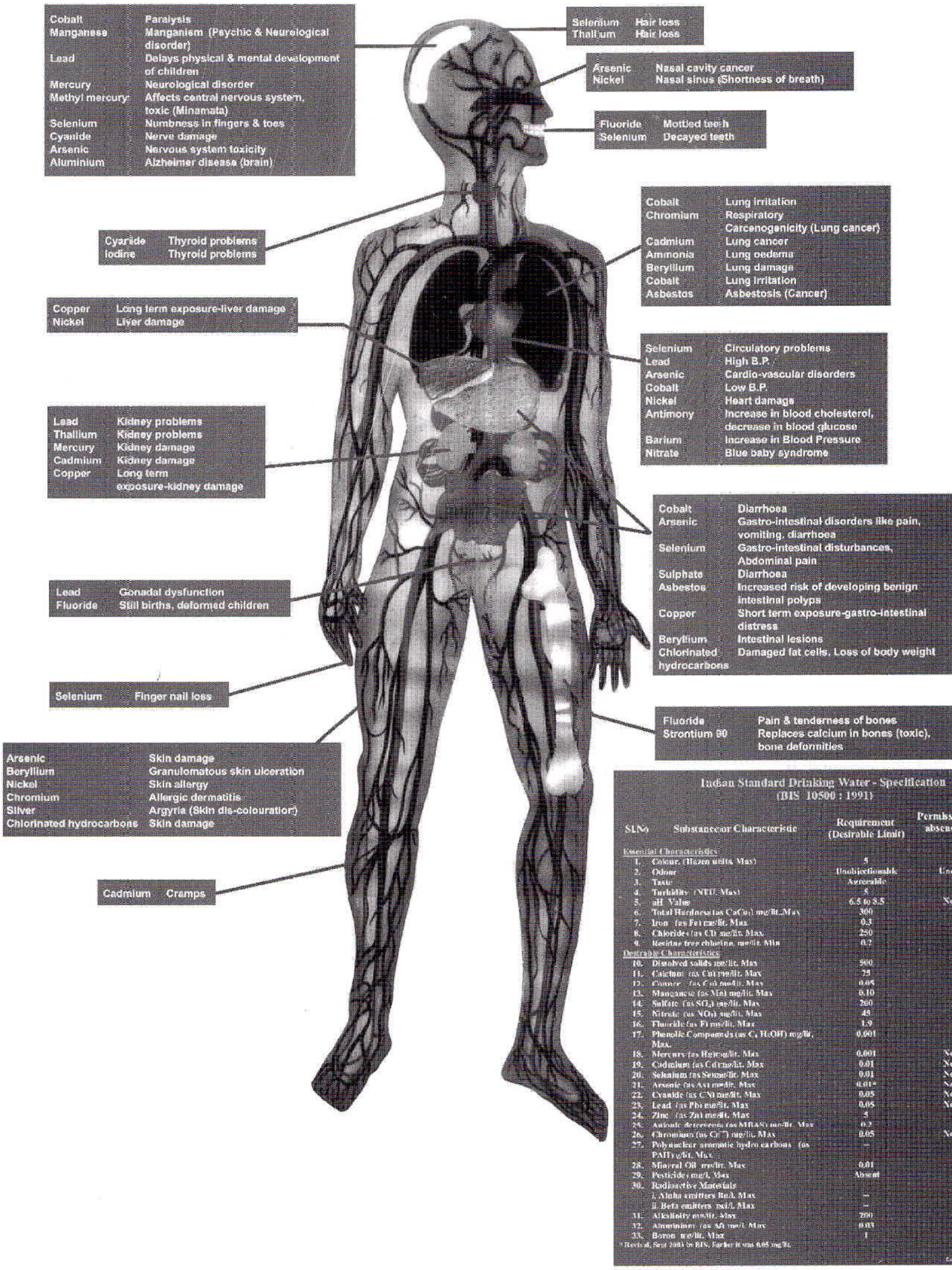
IMPACT ON HUMAN HEALTH

The adverse affects of bad water quality can be seen directly on our health. Intake of contaminated water gives rise to various serious ailments in our body such as cancer, neurological disorders, gastrointestinal disorders, skin related diseases and respiratory diseases sometimes even results in death. The reason of these disorders lies with the presence of pathogens and bacteria, heavy metals or other toxic chemicals in the contaminated water.

Activity

Pollution hurts people, animals and the environment in many different ways. Discuss this statement and then write down five ways in which you can take responsibility to ensure that your environment is not polluted.

Impact of some major pollutants in water on human body



Indian Standard Drinking Water - Specification (BIS 10500 : 1991)

Sl.No	Substance or Characteristic	Requirement (Desirable Limit)	Permissible Limit in the absence of Alternate source
	Essential Characteristics		
1.	Colour, (Hazen units, Max)	5	25
2.	Odour	Unobjectionable	Unobjectionable
3.	Taste	Agreeable	Agreeable
4.	Turbidity (NTU, Max)	5	10
5.	pH Value	6.5 to 8.5	No Relaxation
6.	Total Hardness (as $CaCO_3$) mg/lit., Max	300	600
7.	Iron (as Fe) mg/lit. Max	0.3	1.0
8.	Chlorides (as Cl) mg/lit. Max	250	1000
9.	Residual free chlorine, mg/lit. Min	0.2	–
	Desirable Characteristics		
10.	Dissolved solids mg/lit. Max	500	2000
11.	Calcium (as Ca) mg/lit. Max	75	200
12.	Copper (as Cu) mg/lit. Max	0.05	1.5
13.	Manganese (as Mn) mg/lit. Max	0.10	0.3
14.	Sulfate (as SO_4) mg/lit. Max	200	400
15.	Nitrate (as NO_3) mg/lit. Max	45	100
16.	Fluoride (as F) mg/lit. Max	1.9	1.5
17.	Phenolic Compounds (as C_6H_5OH) mg/lit. Max.	0.001	0.002
18.	Mercury (as Hg) mg/lit. Max	0.001	No Relaxation
19.	Cadmium (as Cd) mg/lit. Max	0.01	No Relaxation
20.	Selenium (as Se) mg/lit. Max	0.01	No Relaxation
21.	Arsenic (as As) mg/lit. Max	0.01*	No Relaxation
22.	Cyanide (as CN) mg/lit. Max	0.05	No Relaxation
23.	Lead (as Pb) mg/lit. Max	0.05	No Relaxation
24.	Zinc (as Zn) mg/lit. Max	5	15
25.	Anionic detergents (as MBAS) mg/lit. Max	0.2	1.0
26.	Chromium (as Cr^{6+}) mg/lit. Max	0.05	No Relaxation
27.	Polynuclear aromatic hydro carbons (as PAH) g/lit. Max	–	–
28.	Mineral Oil mg/lit. Max	0.01	0.03
29.	Pesticides mg/l. Max	Absent	0.001
30.	Radioactive Materials		
	i. Alpha emitters Bq/l. Max	–	0.1
	ii. Beta emitters pci/l. Max	–	1.0
31.	Alkalinity mg/lit. Max	200	600
32.	Aluminium (as Al) mg/l. Max	0.03	0.2
33.	Boron mg/lit. Max	1	5

* Revised, Sept 2003 by BIS. Earlier it was 0.05 mg/lt.

Source: Central Ground Water Board

Water Borne Diseases

Water-borne diseases are infectious diseases spread primarily through contaminated water. Though these diseases are spread either directly or through flies or filth, water is the chief medium for spread of these diseases and hence they are termed as water-borne diseases.

Most intestinal (enteric) diseases are infectious and are transmitted through faecal waste. Pathogens - which include virus, bacteria, protozoa, and parasitic worms - are disease-producing agents found in the faeces of infected persons. These diseases are more prevalent in areas with poor sanitary conditions. These pathogens travel through water sources and interfuses directly through persons handling food and water. Since these diseases are highly infectious, extreme care and hygiene should be maintained by people looking after an infected patient. Hepatitis, cholera, dysentery, and typhoid are the more common water-borne diseases that affect large populations in the tropical regions.

Did You KNOW

Six major elements are found on human body which include oxygen, carbon, hydrogen, nitrogen, calcium and phosphorus.

A large number of chemicals that either exist naturally in the land or are added due to human activity dissolve in the water, thereby contaminating it and leading to various diseases.

Pesticides

The organophosphates and the carbonates present in pesticides affect and damage the nervous system and can cause cancer. Some of the pesticides contain carcinogens that exceed recommended levels. They contain chlorides that cause reproductive and endocrinal damage.

Lead

Lead is hazardous to health as it accumulates in the body and affects the central nervous system. Children and pregnant women are most at risk.

Fluoride

Excess fluorides can cause yellowing of the teeth, dental fluorosis and damage to the spinal cord (skeleton fluorosis) and other crippling diseases.

Nitrates

Drinking water contaminated with nitrates causes blue baby diseases in children. It is also linked to digestive tract cancers.

Petrochemicals

Benzene and other petrochemicals can cause cancer even at low exposure levels.

Chlorinated Solvents

These are linked to reproduction disorders and to some cancers.

Arsenic

Arsenic poisoning through water can cause liver and nervous system damage, vascular diseases and also skin cancer.

Other Heavy Metals

Heavy metals cause damage to the nervous system and the kidney, and other metabolic disruptions.

Salts

It makes the fresh water unusable for drinking and irrigation purposes.

EFFECTS OF WATER POLLUTION

The effects of water pollution are varied and depend on what chemicals are dumped and in what locations.

Many water bodies near urban areas (cities and towns) are highly polluted. This is the result of both garbage dumped by individuals and dangerous chemicals legally or illegally dumped by manufacturing industries, health centers, schools and market places.

Causes	Water Borne Diseases
Bacterial Infections	Typhoid, Cholera, Paratyphoid fever, Bacillary dysentery
Viral Infections	Infectious Hepatitis (Jaundice), Poliomyelitis
Protozoal Infections	Amoebic Dysentery

Death of aquatic (water) animals

The main problem caused by water pollution is that it kills life that depends on these water bodies. Dead fish, crabs, birds and sea gulls, dolphins, and many other animals often wind up on beaches, killed by pollutants in their habitat (living environment).

Disruption of food-chains

Pollution disrupts the natural food chain as well. Pollutants such as lead and cadmium are eaten by tiny animals. Later, these animals are consumed by fish and shellfish, and the food chain continues to be disrupted at all higher levels.

Diseases

Eventually, humans are affected by this process as well. People can get diseases such as hepatitis by eating seafood that has been poisoned. In many poor nations, there is always outbreak of cholera and diseases as a result of poor drinking water treatment from contaminated waters.

Destruction of ecosystems

Ecosystems (the interaction of living things in a place, depending on each other for life) can be severely changed or destroyed by water pollution. Many areas are now being affected by careless human pollution, and this pollution is coming back to hurt humans in many ways.

PREVENTION OF WATER POLLUTION

Never throw rubbish away anyhow. Always look for the correct dust bin. If there is none around, please take it home and put it in your trash can. This includes places like the beach, riverside and water bodies.

Waste dumping at the beach

Do not throw chemicals, oils, paints and medicines down the sink drain, or the toilet. In many cities, your local environment office can help with the disposal of medicines and chemicals. Check with your local authorities if there is a chemical disposal plan for local residents.

Buy more environmentally safe cleaning liquids for the use at home and other public places. They are less dangerous to the environment.

If you use chemicals and pesticides for your gardens and farms, be mindful not to overuse pesticides and fertilizers. This will reduce runoffs of the material into nearby water sources. Start looking at options of composting and using organic manure instead.

Stop untreated release of wastewater. Domestic as well industrial wastewater should be released only after proper treatment through treatment plants. This will stop the further pollution of water.

Avoid usage of chemical fertilizers and pesticides in agricultural fields. This will avoid leaching down of chemical fertilizers and pesticides to the groundwater and other surface water sources. Instead, organic manures, bio-fertilizers and bio-pesticides should be used.

Did You KNOW

Water (Prevention and Control of Pollution Act) in India became effective in 1974.

Activity

Is there a body of water near your home or your school? It could be a small pond, or stream, lake, a river or even the ocean. Take a closer look at it, and answer the following questions.

1. Is there anything unwanted floating on the surface? How dirty are the banks?
2. Do people dump garbage around the water?
3. Do they bathe or wash clothes there?
4. Do they bathe their livestock there?
5. Do they wash trucks or tractors there?
6. Are there factories around the water? Where does waste from the factories go?
7. Where does the sewage from the nearby houses go?
8. Are there any pipes leading into the water? Where do they come from?
9. List 10 unwanted materials/pollutants you find in and around the water body
10. What all is the water from this source of water used for in the village?
11. What else do you observe?

DISCUSSION

Based on your findings discuss the following.

- Is your water source likely to be polluted?
- If so who is responsible for the pollution?
- Are there any problems can you foresee as a result of your observations?
- Who in the village is responsible for the maintenance of this water body?

WATER QUALITY ISSUES IN INDIA

- Summers arrive and the cities in India are found complaining about water shortage; not to mention many villages which lack safe drinking water. In the list of 122 countries rated on quality of potable water, India ranks a lowly 120. Although India has 4% of the world's water, studies show average availability is shrinking steadily. It is estimated that by 2020, India will become a waterstressed nation. Nearly 50% of villages still don't have any source of protected drinking water.

- The ground reality is that of the 1.42 million villages in India, 195813 are affected by chemical contamination of water. The quality of ground water which accounts of more than 85% of domestic supply is a major problem in many areas as none of the rivers have water fit to drink.
- 37.7 million people - over 75% of whom are children are afflicted by waterborne diseases every year. Over-dependence on groundwater has brought in contaminants, fluoride being one of them. Nearly 66 million people in 20 states are at risk because of the excessive fluoride in water. While the permissible limit of fluoride in water is 1 mg per litre in states like Haryana it is as high as 48 mg in some places. Delhi water too has 32 mg. But the worst hits are Rajasthan, Gujarat and Andhra Pradesh. Nearly 6 million children below 14 suffer from dental, skeletal and non-skeletal fluorosis.
- Arsenic is the other big killer lurking in ground water putting at risk nearly 10 million people. The problem is acute in Murshidabad, Nadia, North and South 24 Paraganas, Malda and Vardhaman districts of West Bengal. The deeper aquifers in the entire Gangetic plains contain arsenic.
- High nitrate content in water is another serious concern. Fertilizers, septic tanks, sewage tanks etc are the main sources of nitrate contamination. The groundwater in MP, UP, Punjab, Haryana, Delhi, Kanataka and Tamil Nadu has shown traces of nitrates.
- However it is bacteriological contamination which leads to diarrhoea, cholera and hepatitis which is widespread in India. A bacteriological analysis of the water in Bangalore revealed 75% bore wells were contaminated. Iron; hardness and salinity are also a concern. Nearly 12,500 habitats have been affected by salinity. In Gujarat it is a major problem in coastel districts. Often babies die of dehydration and there are major fights in villages for freshwater. Some villages have seen 80% migration due to high salinity.
- Health is not the only issue; impure water is a major burden on the state as well. Till the 10th plan the government had spent Rs 1,105 billion on drinking water schemes. Yet it is the poor who pay a heavier price spending around Rs 6700 crore annually on treatment of waterborne diseases.
- There is an urgent need to look for alternative sources of portable water in places where water quality has deteriorated sharply. Community based water quality monitoring guidelines should be encouraged. People should be encouraged to look at traditional methods of protecting water sources. Also in places where groundwater has arsenic or fluoride, surface water should be considered as an alternative.

SOURCES OF POLLUTION

Pollution can be divided into two categories based on its source:

Point-source pollution -

Pollution that can be traced to a single source, such as industrial waste.

Nonpoint-source pollution -

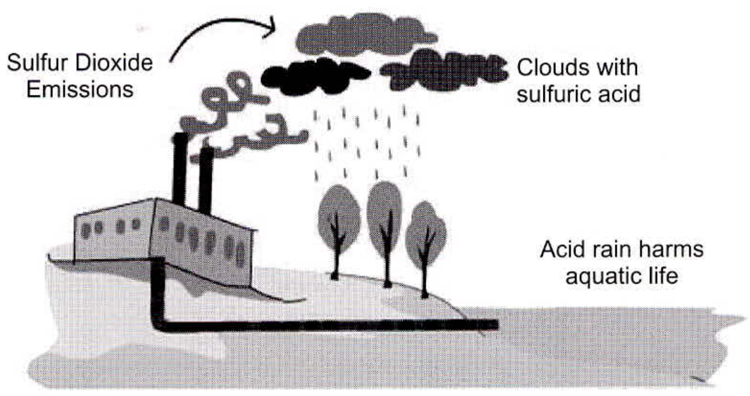
Pollution that comes from many sources and cannot be traced to a single source such as run-off from crop land, failing septic systems, construction sites, and drainage systems. This includes pollution created in residential areas from chemicals used for lawn treatment, soaps used to wash vehicles, and yard waste, pet waste, and garbage that get into the storm sewer system.

INDUSTRIAL WASTE

Industries cause huge water pollution with their activities. These come mainly from:

Sulphur - This is a non-metallic substance that is harmful for marine life.

Asbestos - This pollutant has cancer-causing properties. When inhaled, it can cause illnesses such as asbestosis and many types of cancer.



Pollution of sulphur

Lead and Mercury - These are metallic elements and can cause environmental and health problems for humans and animals. It is even more poisonous. It is usually very hard to clean it up from the environment once it get into it because it in non-biodegradable.

Nitrates & Phosphates - These are found in fertilizers, are often washed from the soils to nearby water bodies. They can cause eutrophication, which can be very problematic to marine environments.

Oils - Oils form a thick layer on the water surface because they do not dissolve in water. This can stop marine plants receiving enough light for photosynthesis. It is also harmful for fish and marine birds. A classic example is the BP oil spill in 2012 with killed thousands of animal species.

DOMESTIC WASTE

Domestic waste discharge

Everyday, we cook, do laundry, flush the toilet, wash our cars, shower and do many things that use water. Think about how we use water in schools, hospitals and public places.

Where do you think all the water, liquid waste, toilet and urine ends up? In many developed communities, all this water and soluble waste (called sewage) is treated, cleaned and dumped into the sea. Even though they are treated, they are never the same as fresh water.

In some not-so-developed countries, the sewage is not treated, but quickly dumped into the sea or water bodies. This is very dangerous because they contaminate the environment and water bodies and bring many deadly diseases to us.

AGRICULTURAL WASTE

Pollutants discharged into water courses due to agricultural activities include:

1. Soil and silt removed by erosion
2. Agricultural run-off
3. Synthetic fertilizers, herbicides and insecticides
4. Plant residue.

Receiving water bodies get fertilized with nutrients, thus resulting in Eutrophication. Some common insecticides in use are chlorinated hydrocarbons such as DDT (Dichloro diphenyl trichloroethane), Aldrin, Heptachlor, PCBs (Polychlorinated biphenyl) etc. Most of the chlorinated hydrocarbons are persistent to degradation and hence remain in the environment for a very long time. Indiscriminate use of insecticides could make them an integral part of the biological, geological and chemical cycles of the earth. Measurable quantities of DDT residues may be found in air, soil and water several thousand kilometres away from the point where it originally entered the ecosystem.

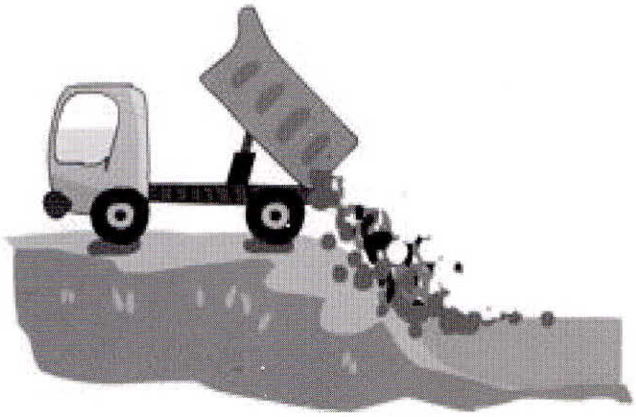
SEPTIC TANKS

Every domestic (home) toilet is connected to septic tank usually located outside the house with each flush the waste goes into this tank, where the solid part is separated from the liquid part. Biological processes are used to break down the solids and the liquid is usually drained out into a land drainage system. From this stage, it can escape into the soil and nearly water bodies.

OCEAN AND MARINE DUMPING

Again, think of the rubbish we all make each day. Paper waste, food waste, plastic, rubber, metallic and aluminum waste. In some countries, these are deposited into the sea. All these waste types take time to decompose. Example, it is know that paper takes about 6 weeks, aluminum takes about 200 years and glass takes even more. When these end up in the sea, they harm sea animals and cause a lot of deaths.

OIL POLLUTION



Routine shipping, run-offs and dumping of oils on the ocean surfaces happen everyday. Oil spills make up about 12% of the oil that enters the ocean. Oil spills cause major problems, and can be extremely harmful to local marine wildlife such as fish, birds and sea otters and other aquatic life. Because oil does not dissolve, it stays on the water surface and suffocates fish. Oil also gets caught in the feathers of sea birds stopping them from flying. Some animals die as a result.

UNDERGROUND STORAGE AND TUBE LEAKAGES

Many liquid products (petroleum products) are stored in metal and steel tubes underground. Other sewage systems run in underground tubes. Overtime, they rust and begin to leak. If that happens, they contaminate the soils and the liquids in them end up in many nearby water bodies.

ATMOSPHERIC

Atmospheric deposition is the pollution of water bodies caused by air pollution. Each time the air is polluted with sulphur dioxide and nitrogen oxide, they mix with water particles in the air and form a toxic substance. This falls as acid rain to the ground, and gets washed into water bodies. The result is that, water bodies also get contaminated and this affects animals and water organisms.

WASTEWATER: TREATMENT & REUSE

WHAT IS WASTEWATER?

Wastewater is water that has been used and must be treated before it is released into another body of water, so that it does not cause further pollution of water sources. Wastewater comes from a variety of sources.

Water that has been used, as for washing, flushing, or in a manufacturing process, and so contains waste products; sewage. Sewage is the subset of wastewater that is contaminated with feces or urine, but is often used to mean any wastewater. Sewage includes domestic, municipal, or industrial liquid waste products disposed of, usually via a pipe or sewer (sanitary or combined).

Sewerage is the physical infrastructure, including pipes, pumps, screens, channels etc. used to convey sewage from its origin to the point of eventual treatment or disposal. It is found in all types of sewage treatment, with the exception of septic systems, which treat sewage on-site.

Did You KNOW

Pure water has no color, smell, or taste.

ORIGIN

- Human waste (fæces, used toilet paper or wipes, urine, or other bodily fluids), also known as blackwater;
- Drain leakage;
- Septic tank discharge;
- Sewage treatment plant discharge;
- Washing water (personal, clothes, floors, dishes, etc.), also known as greywater;
- Rainfall collected on roofs, yards, hard-standings, etc. (generally clean with traces of oils and fuel);
- Groundwater infiltrated into sewage;
- Surplus manufactured liquids from domestic sources (drinks, cooking oil, pesticides, lubricating oil, paint, cleaning liquids, etc.);
- Urban rainfall runoff from roads, carparks, roofs, sidewalks, or pavements (contains oils, animal feces, litter, gasoline, diesel or rubber residues, soapscum, metals from vehicle exhausts, etc.);
- Seawater ingress (high volumes of salt and microbes);
- Direct ingress of river water (high volumes of micro-biota);
- Direct ingress of manmade liquids (illegal disposal of pesticides, used oils, etc.);

- Storm drains (almost anything, including cars, shopping trolleys, trees, cattle, etc.);
- Blackwater (surface water contaminated by sewage);
- Industrial waste
- Industrial site drainage (silt, sand, alkali, oil, chemical residues);
- Industrial cooling waters (biocides, heat, slimes, silt);
- Industrial process waters;
- Organic or biodegradable waste, including waste from creameries, and ice cream manufacture;
- Organic or non bio-degradable/difficult-to-treat waste (pharmaceutical or pesticide manufacturing);
- Extreme pH waste (from acid/alkali manufacturing, metal plating);
- Toxic waste (metal plating, cyanide production, pesticide manufacturing, etc.);
- Solids and emulsions (paper manufacturing, foodstuffs, lubricating and hydraulic oil manufacturing, etc.);
- Agricultural drainage, direct and diffuse; and
- Hydraulic fracturing

Did You KNOW

pH of pure water is 7. It is neither an acid nor a base, but is the reference point for acids and bases.

COMPOSITION

- Water (> 95%) which is often added during flushing to carry waste down a drain;
- Pathogens such as bacteria, viruses and parasitic worms;
- Non-pathogenic bacteria;
- Organic particles such as feces, hairs, food, paper fibers, plant material, humus, etc.;
- Soluble organic material such as urea, fruit sugars, soluble proteins, drugs, pharmaceuticals, etc.;
- Inorganic particles such as sand, grit, metal particles, ceramics, etc.;
- Soluble inorganic material such as ammonia, road-salt, sea-salt, cyanide, hydrogen sulfide, thiocyanates, thiosulfates, etc.;
- Animals such as protozoa, insects, arthropods, small fish, etc.;
- Macro-solids such as sanitary napkins, nappies/diapers, needles, children's toys, dead animals or plants, etc.;
- Gases such as hydrogen sulfide, carbon dioxide, methane, etc.;

- Emulsions such as paints, adhesives, mayonnaise, hair colorants, emulsified oils, etc.;
- Toxins such as pesticides, poisons, herbicides, etc; and
- Pharmaceuticals and hormones.

TREATMENT

Wastewater treatment is gaining popularity as a source of usable water in different countries across the globe. In India, where the disparity in demands and supply is extremely high, wastewater management can be revolutionary with its economic benefits and importance as a coping strategy for the poor.

Wastewater treatment and reuse augments water scarcity giving a dependable and sustainable resource for applications requiring large volumes of water consumption. It has transformed into an indispensable solution to meet the water demand not just in the residential segments but also for agriculture, irrigation and industrial operations.

In India, large volumes of wastewater are discharged unprocessed by industries and the available sources for treatment of domestic and industrial wastewater are underutilized.

Methods

Physical →

- Sedimentation (Clarification)
- Screening
- Aeration
- Filtration
- Flotation and Skimming
- Degassification
- Equalization

Chemical →

- Chlorination
- Ozonation
- Neutralization
- Coagulation
- Adsorption
- Ion Exchange

Biological →

Aerobic
- Activated Sludge Treatment Methods
- Trickling Filtration
- Oxidation Ponds
- Lagoons
- Aerobic Digestion

Anaerobic
- Anaerobic Digestion
- Septic Tanks
- Lagoons

3R's should be adopted for effective wastewater management - REDUCE, REUSE & RECYCLE

REUSE

The term wastewater reuse is often used synonymously with the terms wastewater recycling. Because the general public often does not understand the quality difference between treated and untreated wastewater, many communities have shortened the term lands. High-quality reclaimed water is used to irrigate food crops.

- Recreational impoundments - such as ponds and lakes.
- Environmental reuse - creating artificial wetlands, enhancing natural wetlands, and sustaining stream flows.
- Industrial reuse - process or makeup water and cooling tower water.

Why Reuse Water?

The most common reasons for establishing a wastewater reuse program is to identify new water sources for increased water demand and to find economical ways to meet increasingly more stringent discharge standards.

Classification

Wastewater reuse can be grouped into the following categories:

- Urban reuse - the irrigation of public parks, school yards, highway medians, and residential landscapes, as well as for fire protection and toilet flushing in commercial and industrial buildings.
- Agricultural reuse - irrigation of nonfood crops, such as fodder and fiber, commercial nurseries, and pasture lands. High-quality reclaimed water is used to irrigate food crops.
- Recreational impoundments - such as ponds and lakes.
- Environmental reuse - creating artificial wetlands, enhancing natural wetlands, and sustaining stream flows.
- Industrial reuse - process or makeup water and cooling tower water.

Health Protection - Critical Component of Reuse

In any reuse system, protecting public health is critical. Human exposure to disease-causing organisms or other contaminants in treated effluent could cause serious public health problems.

For this reason, wastewater that could come in contact with the public is treated at the tertiary level, which removes most of the original pollutants.

The most common disinfectants used to remove or inactivate pathogenic organisms are chlorine, ultraviolet light, and ozone.

PURIFICATION - DOMESTIC & COMMUNITY LEVEL

A community should be consulted when choosing a water-treatment system and should be made aware of the costs associated with the technology. In particular, community members should be made aware of the behavioural and/or cultural changes needed to make the system effective over the long-term and thus be acceptable to them. Communities may also need to be educated about protecting water sources from animal or human contamination, and mobilized. It should be emphasized that all the positive effects of a water-treatment system could be jeopardized if the water is not drawn, stored and transported carefully and hygienically.

METHODS

We will learn about five main methods of treating water at household or community level, which are -

- Reverse Osmosis
- Boiling
- Filtration
- Chlorination
- Solar Water Disinfection

Activity

Inform the participants that water can get contaminated at the source, during transport or through inaccurate handling and storage. Start a discussion about the different stories.

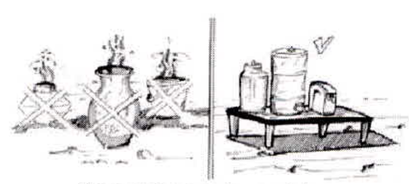
- Are the stories similar?

- At which stage did the people commit mistakes?

- What could they improve?

Reverse Osmosis

RO technology is probably the best known purification technology to the mankind. It effectively removes all harmful micro-organisms such as bacteria, viruses etc. When it is used in combination with other filters (sediment and carbon), it successfully removes all other suspended impurities from water including dissolved gases and organic impurities. The biggest advantage of this technology is that it is able to remove more than 99% of dissolved impuritiessuch as chemicals, rusts, salts of heavy metals, pesticides andinsecticides present in water. Infact, RO is the only affordable technology to be able to remove dissolved impurities from water.



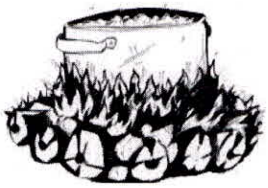
Proper storage in containers

Disadvantage

The process is so efficient that all the dissolved salts (minerals) from the drinking water are filtered out including the essential ones necessary for our body. Water purified through only RO technology is distilled, has a bitter taste (because of no essential minerals) and has pH value lower than 7 which makes it slightly acidic.

Further, RO technology uses a very fine membrane which has a pore size of 0.0001 micron. The process requires raw water to be forced at a very high pressure so that waterpasses through the small pores of the membrane, which blocks the bacteria, germs and other impuritiesfrom passing through. However due to variation in day and night temperatures and high speed pressure, some of the pores of the membraneget enlarged after few months of continuous use, allowing harmful micro-organisms to easily pass through it, thereby making the process ineffective in the long run.

Boiling



Water boiling or heat treatment is the most traditional water treatment method. It is effective against the full range of microbial pathogens and can be employed irrespective of water turbidity or dissolved constituents in the water.

However, the cost and time used in procuring fuel, the potential indoor air pollution with smoke and associated respiratory infections, the increased risk of burning, and questions related to the environmental sustainability of boiling have led to the development and dissemination of other alternatives.

At sea level, boiling point is reached at 100 °C. While WHO and others recommend bringing water to a rolling boil for one minute, it is mainly intended as a visual indication that a high temperature has been achieved; even heating to 60 ºC for a few minutes will kill or deactivate most pathogens. Ideally, the water is cooled, stored in the same vessel and covered with a lid to minimise the risk of recontamination.

ADVANTAGES

Common technology
Complete disinfection if applied with sufficient temperature and time
Can be combined with cooking and tea boiling

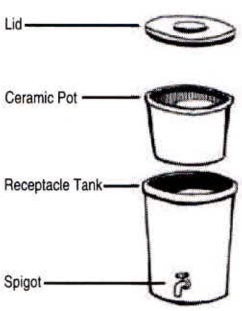
DRAWBACKS

Boiled water tastes flat
Expensive (fuel, fire wood, gas etc.)
Time consuming (physical presence needed during heating process, long cooling time)
Chemical contaminants are not removed

Filtration

A number of processes occur during filtration, including mechanical straining, absorption of suspended matter and chemicals as well as biochemical processes. Depending on the size, type and depth of the filter media, as well as on the flow rate and physical properties of the raw water, filters can remove suspended solids, pathogens, certain chemicals, tastes, and odours.

Ceramic Filter



Elements of a ceramic filter

Water is filtered through a candle or pot made of porous material, usually unglazed ceramic. The ceramic filters' effectiveness depends on the size of the pores in the clay. To use the ceramic filters, people fill the top receptacle or the ceramic filter with water that flows through the ceramic filter into a water storage receptacle. The treated and stored water is accessed via a spigot on the water storage receptacle.

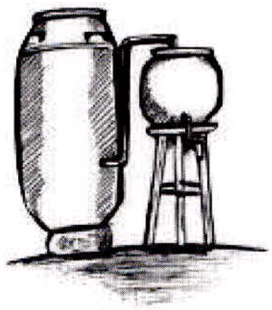
ADVANTAGES

- Proven reduction of bacteria and protozoa
- Proven reduction of diarrhoeal disease incidence in users
- Neither chemicals nor fossil fuels required
- Simple installation and operation
- Turbidity removed
- No change in water taste or odour

DRAWBACKS

- Low rate of virus inactivation
- Lack of residual protection and removal of less than 100% bacteria
- Difficult to transport and high initial costs
- Continuous use of the filter required
- Difficult to use in highly turbid water

BioSand Filter


BioSand Filter

The BioSand filter is a technological adaptation of the century old slow sand filtration process and suited for home use. In slow sand filtration, the water flows slowly (flow velocity of 100 - 200 $l/m^2/h$) downwards through a bed of fine sand.

The most widely used version is a concrete container approximately 90 cm high and 30 cm wide filled with sand. The water level is maintained at 5 - 6 cm above the sand layer by adjusting the height of the outlet pipe. This maintains the water level always above the sand and leads to the formation of a biologically active layer.

A perforated plate on top of the sand prevents disruption of the bioactive layer when water is added to the system. After pouring water into the BioSand filter, it is purified by the following four processes:

- Mechanical trapping (sediments, cysts and worms get trapped between the sand grains)
- Adsorption or attachment (viruses are adsorbed or become attached to the sand grains)
- Predation (microorganisms consume pathogens found in the water)
- Natural death (pathogens die because of food scarcity, short life span)

ADVANTAGES

Easy to operate
No electricity required
No need to backwash or clean the filter
No recurring cost (e.g. chemicals)
Effective against bacteria and viruses
Applicable on highly turbid water

DRAWBACKS

Equipment not always available
Relatively expensive

Membrane Filter

Gravity Driven Membrane (GDM) filtration removes all types of pathogens by ultrafiltration. Most ultrafiltration membranes have pores, which are smaller than the size of bacteria and viruses. Water filtered through these membranes is microbiologically safe. GDM filtration works with flux stabilisation. Pressure necessary to press water through the membranes is generated by gravity created by differences in water levels between two storage tanks.

As a feed, natural water (river, spring, well or rainwater) can be used without pre- or posttreatment. Neither pumps nor chemical cleaning or backflushing are necessary. Thus, no maintenance is required for long-term operation. A 40 - 60 cm water column is sufficient to operate the system using 0.5m^2 of membrane to produce at least 50 litres of safe drinking water per day.

ADVANTAGES

Proven removal of protozoa and about 90% bacteria
One-time installation with few maintenance requirements

Long life, durable and robust

Easy to use

Removes turbidity, some iron, manganese and arsenic

Water quality improves with time

Opportunity for local business

DRAWBACKS

Candles and pots are fragile

Low effectiveness against viruses

Small fissures and cracks may lead to reduced removal of pathogens

No residual disinfection effect (risk of recontamination)

Regular cleaning of the filter and receptacle is necessary

Not applicable with extremely turbid water

Chlorination

Chlorine is the most commonly used disinfectant worldwide. It is an effective method capable of killing 99% of germs such as viruses, bacteria and parasites. Chlorine can be found in different forms such as tablets, powder granules and liquid concentrated solutions. It can also be produced locally.

Chlorination is a method of water purification to make it safe for human consumption. It is left for 30 minutes in water to allow reaction with the germs. Before treating with chlorine, the water must be clear. After treatment with chlorine, the presence of residual chlorine in drinking water indicates that the water is protected from recontamination during storage.

Chlorine production is safe if you stick to the following rules:

- Do not inhale the concentrate over a long period
- Work in a well ventilated area
- Never use a metallic container during the procedure
- Do not drink the concentrated solution (it is not toxic but it will taste very bad)
- Do not spill it on your clothes as it is a bleach

ADVANTAGES

Proven reduction of viruses, bacteria, and protozoa in water

Proven reduction of diarrheal disease incidence in users

Acceptability to users because of the simplicity of use

No cost to the user after obtaining the plastic bottles

Minimal change in taste of the water

DRAWBACKS

- Requires relatively clear water
- Relatively expensive
- Alters taste and odour of water
- Not effective against chemical contamination
- Lower protection from some organisms (cryptosporidium)
- Concentrated chlorine solutions require careful handling
- Dosage is considered as a main challenge
- Not always available locally

Solar Water Disinfection

Solar water disinfection is a type of portable water purification that uses solar energy, in one or more ways, to make contaminated water safe to drink by ridding it of infectious disease-causing biological agents such as bacteria, viruses, protozoa and worms. However, disinfection may not make all kinds of water safe to drink due to non-biological agents such as toxic chemicals or heavy metals. Consequently, additional steps beyond disinfection may be necessary to make water clean to drink.

Solar disinfection using the effects of electricity generated by photovoltaics typically uses an electrical current to deliver electrolytic processes which disinfect water, for example by generating oxidative free radicals which kill pathogens by damaging their chemical structure. A second approach uses stored solar electricity from a battery, and operates at night or at low light levels to power an ultraviolet lamp to perform secondary solar ultraviolet water disinfection.

In this technique, colourless, transparent water or soda bottles (2 litre or smaller size) with few surface scratches are chosen for use. The labels are removed and the bottles are washed before the first use.

Water from contaminated sources is filled into the bottles. To improve oxygen saturation, bottles can be filled three-quarters, shaken for 20 seconds (with the cap on), then filled completely and recapped. Very cloudy water with turbidity higher than 30 NTU must be filtered prior to exposure to the sunlight.

Filled bottles are then exposed to the sun. Bottles will heat faster and to higher temperatures if they are placed on a sloped sun-facing corrugated metal roof as compared to thatched roofs.

ADVANTAGES

- Most widely used disinfection method worldwide
- Powerful and effective
- Reliable, kills 99% of all pathogens
- Proven health impact

Easy to use

Residual chlorine prevents recontamination

Low cost

Rapid method: only 30 minutes are needed

Treats large water volumes

DRAWBACKS

The need for pretreatment (filtration or flocculation) of waters of higher turbidity

User acceptability concerns because of the limited volume of water that can be treated at once and the length of time required to treat water

The large supply of intact, clean, suitable plastic bottles required

DEMONSTRATION OF WATER QUALITY TESTING

WHAT IS WATER QUALITY?

Water quality can be defined as the chemical, physical and biological characteristics of water alongwith its general composition qualities such as pH, value suspended particle matter, oxygen levels, and the level of nutrients present; usually in respect to its suitability for a designed use.

These attributes affect water's ability to sustain life and its suitability for human consumption. Water quality is vital not only for healthy bio-diverse aquatic environments and human health but also in terms of its usage in agriculture, industry and fishing. If the quality of water is degraded then its potential for use will diminish.

Did You KNOW

The unstable hardness of water is due to bicarbonate salts of magnesium and calcium.

Thus, water of a high quality means -

- Water is safe for people to drink (potable).
- Water can be used to irrigate crops.
- It allows for large number of fish so fishermen can catch them and we can eat them.
- It provides a home for many different aquatic animals.
- It is available for industries, such as sugar mills.
- Safe and clean water bodies for swimming and leisure are available.

WHAT IS WATER QUALITY TESTING?

Water quality testing is to measure the required parameters of water, following standard methods, to check whether they are in accordance with the standards.

WHY TEST WATER?

Water testing is required mainly for monitoring purpose. Some importance of such assessment includes:

1. To check whether the water quality is in compliance with the standards, and hence, suitable or not for the designated use.
2. To monitor the efficiency of a system, working for water quality maintenance.
3. To check whether upgradation / change of an existing system is required and to decide what changes should take place.
4. To monitor whether water quality is in compliance with rules and regulations.

PROCEDURAL STEPS FOR WATER QUALITY MONITORING

Step 1 Setting Water Quality Monitoring Objectives

Step 2 Assessment of Resources Availability

- Laboratory facilities and competence
- Transport
- Manpower -adequate number and competence

Step 3 Reconnaissance Survey

- Map of the area
- Background information
- Human activities
- Potential polluting sources
- Water abstractions and uses
- Hydrological information
- Water regulation

Step 4 Network Design

- Selection of sampling locations
- Optimum number of locations
- Parameters to be measured
- Frequency of sampling
- Component to be samples - water, sediment or biota

Step 5 Sampling

- Representative sampling
- Field testing
- Sample preservation and transport

Step 6 Laboratory Work

- Laboratory procedures
- Physical, chemical analysis
- Microbiological and biological analysis

Step 7 Data Management

- Storage
- Statistical analysis
- Presentation
- Interpretation
- Reporting

Step 8 Quality Assurance

- Production of reliable data
- Quality control
- Internal AQC
- External AQC

(Source: CPCB, 2007-08. Guidelines for Water Quality Monitoring, Central Pollution Control Board, New Delhi, MINARS/27/2007-08)

Setting Water Quality Monitoring Objectives

Before formulation of any water quality monitoring programme it is very important to have clear understanding on the monitoring objectives. Everybody of the programme team should be fully aware of the objectives, methodology, quality assurance, data validation and other aspects. Clearly environmental monitoring must have a purpose and a function in the process of risk assessment and pollution control. In risk management, monitoring is essential in the stage of problem recognition (indication of water quality deviations), the stage of analysis (with respect to the expected changes) and the stage of management (verification or control of strategy results).

Assessment Resources Availability

Once the monitoring objectives are known, it is important to look into the availability of resources for monitoring. Generally a compromise is made between quality and quantity of data required to fulfil certain objective(s) and resources available. Before planning water quality monitoring programme it is important to ensure that following resources are available:

a. Sampling equipment (as per checklist)
b. Transport for sampling
c. Laboratory facilities
d. Trained Manpower adequate number and competence

e. Equipment/instruments for desired parameters analysis

f. Chemicals/glassware and other gadgets for analysis of desired parameters

g. Funds for operation and maintenance of laboratory

Reconnaissance Survey

This survey is to understand the overview of the geographical location of the water body to be monitored, its accessibility all kind of human influences to decide appropriate sampling location and also appropriate number of sampling locations. The survey may include acquisition of following information:

a. Location map

b. Background information on water body

c. Human activities around the water body like mass bathing, melon farming, cattle wading etc

d. Identification of potential polluting sources

e. Water abstraction - quantity and uses

f. Water flow regulation - schedule, quantity etc

The above information will help in proper designing the network and also planning the schedule for sampling.

Network Design

In designing the sampling network, it is important to consider optimum number of sampling location, sampling frequency and parameters required to fulfil the desired objectives.

Criteria for Site Selection

The sampling site selection is generally linked with water quality monitoring objectives. For example if the monitoring is carried out for judging suitability of water for drinking water source then the monitoring site should be closer to the intake point whereas for outdoor bathing it should be near bathing ghats. After understanding the factors affecting water quality thoroughly, it is necessary to select specific reaches or areas of the stream or river to sample.

Sampling frequency

The sampling frequency is governed by the level of variation in water quality of a water body. If variations are large in a short duration of time, a larger frequency is required to cover such variations. On the other hand, if there is no significant variation in water quality, frequent collection of sample is not required.

Sampling

Planning for Sampling

When planning a sampling programme the number of sampling stations or wells that can be sampled in one day is required. For this is necessary to know the required time needed for sampling, and other actions required, at the site.

Selection of Parameters

The parameters of water quality are selected entirely according to the need for a specific use of that water. Some examples are -

(a) Drinking - As per BIS (2012) Standards

(b) Irrigation - As per BIS Standards

(c) Domestic Consumption - As per BIS standards

(d) Water Bodies - As per CPCB guidelines

Selection of Methods

The methods of water quality testing are selected according to the requirement. The factors playing key role for the selection of methods are:

(a) Volume and number of sample to be analyzed

(b) Cost of analysis

(c) Precision required

(d) Promptness of the analysis as required

The water can be tested at laboratories or at the field itself. In this module, we are going the discuss the field testing method of a few parameters.

Accuracy of Methods

What precision and accuracy to be maintained against a particular method is selected according to the need. The factors influencing the design include:

(a) Cost

(b) Parameter

(c) Use

Checklist for Field Visit

Following items should be checked before starting on a sampling mission:

- Itinerary for the trip (route, stations to be covered, start and return time)
- Personnel and sample transport arrangement
- Area map
- Sampling site location map
- Icebox filled with ice or icepacks or ice
- Weighted bottle sampler
- BOD bottles

- Rope
- Special sample containers: bacteriological, heavy metals, etc.
- Sample containers
- Sample preservatives (e.g. acid solutions)
- Thermometer
- Tissue paper
- Itinerary for the trip (route, stations to be covered, start and return time)
- Personnel and sample transport arrangement
- Area map
- Sampling site location map
- Icebox filled with ice or icepacks or ice
- Sample preservatives (e.g. acid solutions)
- Thermometer
- Tissue paper
- Other field measurement kit, as required
- Sample identification forms
- Labels for sample containers
- Field notebook
- Pen / pencil / marker
- Soap and towel
- Match box
- Spirit lamp
- Torch
- Drinking water
- Knife
- First-aid box
- Gloves and eye protection
- Dump sampler to check well conditions
- Submersible pump and accessories
- Weighted bottle sampler
- BOD bottles
- Rope
- Special sample containers: bacteriological, heavy metals, etc.
- Sample containers

General guidelines for sampling

- Rinse the sample container three times with the sample before it is filled.
- Leave a small air space in the bottle to allow mixing of sample at the time of analysis.
- Label the sample container properly, preferably by attaching an appropriately inscribed tag or label. The sample code and the sampling date should be clearly marked on the sample container or the tag.

Surface water Sampling

- Samples will be collected from well-mixed section of the river (main stream) 30 cm below the water surface using a weighted bottle or DO sampler.
- Samples from reservoir sites will be collected from the outgoing canal, power channel or water intake structure, in case water is pumped. When there is no discharge in the canal, sample will be collected from the upstream side of the regulator structure, directly from the reservoir.

Groundwater Sampling

Samples for groundwater quality monitoring would be collected from one of the following three types of wells:

- Open dug wells in use for domestic or irrigation water supply,
- Tube wells fitted with a hand pump or a power-driven pump for domestic water supply or irrigation
- Piezometers, purpose-built for recording of water level and water quality monitoring.
- Open dug wells, which are not in use or have been abandoned, will not be considered as water quality monitoring station. However, such wells could be considered for water level monitoring.
- Use a weighted sample bottle to collect sample from an open well about 30 cm below the surface of the water. Do not use a plastic bucket, which is likely to skim the surface layer only.
- Samples from the production tube wells will be collected after running the well for about 5 minutes.

Sample Labeling

Label the sample container properly, preferably by attaching an appropriately inscribed tag or label. Alternatively, the bottle can be labelled directly with a water-proof marker. Information on the sample container or the tag should include:

- sample code number (identifying location)
- date and time of sampling

- source and type of sample
- pre-treatment or preservation carried out on the sample
- any special notes for the analyst
- sampler's name

Sample Preservation and Transport

Samples for BOD and bacteriological analyses should be stored at a temperature below 4°C and in the dark as soon as possible after sampling. In the field this usually means placing them in an insulated cool box together with ice or cold packs. Once in the laboratory, samples should be transferred as soon as possible to a refrigerator. If samples collected for chemical oxygen demand (COD) analysis cannot be analysed on the day of collection they should be preserved below pH 2 by addition of concentrated sulphuric acid. This procedure should also be followed for samples for ammoniacal nitrogen, total oxidised nitrogen and phenol analysis. Samples which are to be analysed for the presence of metals, should be acidified to below pH 2 with concentrated nitric acid. Such samples can then be kept up to six months before they need to be analysed; mercury determinations should be carried out within five weeks, however. After labeling and preservation, the samples should be placed in an insulated ice box for transportation. Samples should be transported to concerned laboratory as soon as possible, preferably within 48 hours. Analysis of bacteriological samples should be started and analysed within 24 hours of collection. If samples are being brought to the laboratory they should be transported in less than 24 hours.

Mostly Adopted Sampling Methods: Apart from a separation into compartments (water, sediment and biota) different types of samples can be collected:

• Grab sample (also called spot - or catch samples): One sample is taken at a given location and time. When a source is known to vary with time, spot samples collected at suitable time intervals and analyzed separately, can document the extent, frequency and duration of these variations. Sampling intervals are to be chosen on the basis of the expected frequency with which changes occur. This may vary from continuous recording, or sampling every 5 minutes, to several hours or more.

• Composite samples: In most cases, these samples refer to a mixture of spot samples collected at the same sampling site at different times.

Laboratory Work

- Work Assignment and Personnel Register
- The laboratory incharge should maintain a bound register for assignment of work. This register
- Would link the laboratory sample number to the analyst who makes specific analyses, such as pH, EC, BOD, etc.
- An estimate of time needed for performing the analyses may also be entered

in the register.

- Each laboratory analyst should have his/her own bound register, where all laboratory readings and calculations are to be entered.
- When analysis and calculations are completed, the results must be recorded in a register containing data record sheets described in the next section.

Laboratory Analysis

The laboratory analysis is to be performed by the laboratory staff within stipulated time and precision using standard methods/laboratory manuals.

Data Management

General checks:

Total solids	≥ Total dissolved solids
Total solids	≥ Total settleable solids
COD	> BOD
Total Coli	≥ Faecal Coli
Total Iron	≥ Fe+2, Fe+3
Total P	≥ PO4-3
EC (?S/cm)	≥ TDS (mg/l)
Total oxidized nitrogen	≥ Nitrate, nitrite
Total oxidized nitrogen	= Nitrate + nitrite
Total hardness	= Ca hardness + Mg hardness

Data Analysis and Presentation

It is often useful to subject data to some simple statistical analysis. The data can also be summarized in form of index. Statistical analysis like parametric correlation, seasonal fluctuations, seasonal trends over a period of time are also common. The data after analysis can be presented in different format.

Graphical Presentation

1. Time Series Graphs
2. Histograms
3. Pie Charts
4. Profile Plots (river profiles)
5. Geographical Plots (contours)

Data Interpretation

The data interpretation involves understanding on the water chemistry, biology and hydrology. Normally data analysed and interpreted in terms of chemical quality,

quality fluctuations, and their possible effect on different uses and ecosystem. A comparison is made with predefined criteria or standards set for protection of different uses. The quality fluctuations are explained in view of possible sources of pollution and their fates in aquatic environment and their effects.

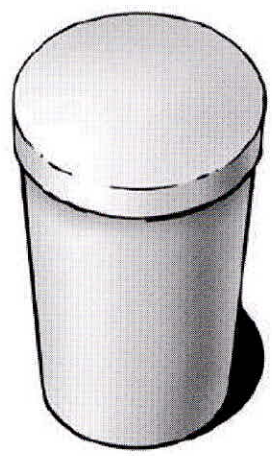
Quality Assurance

The Quality Assurance programme for a laboratory or a group of laboratories should contain a set of operating principles, written down and agreed upon by the organisation, delineating specific functions and responsibilities of each person involved and the chain of command. The following point are important to consider for Quality Assurance programmes for laboratories:

- Sample control and documentation
- Standard analytical procedures:
- Analyst qualifications
- Equipment maintenance
- Calibration procedures
- Data reduction, validation and reporting
- Analytical quality control

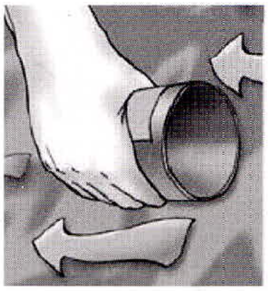
SIMPLE WAYS OF TESTING WATER PARAMETERS

TEST KIT



A basic test kit normally includes:

- Instruction booklet
- Sample collection jar
- pH test tube
- Dissolved oxygen vial
- Secchi disk decal
- 2 Temperature strips (14-40°C and 0-12°C)
- 50 pH reagent tablets (enough for 50 tests)
- 100 Dissolved oxygen reagent tablets (enough for 50 tests)
- Color chart for determining DO, pH and turbidity test results
- Mini pencil



COLLECTING A WATER SAMPLE

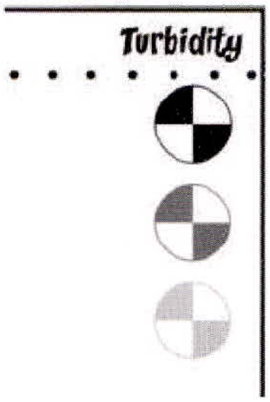
Collect the water sample in a sterile, wide mouthed jar or container (approximately 1 liter) that has a cap. If possible, boil the sample container and cap for several minutes to sterilize and avoid touching the inside of the container or the cap with your hands. The container should be filled completely with your water sample and capped to prevent the loss of dissolved gases.

Test each sample as soon as possible or within one hour of collection. When possible, perform dissolved oxygen procedure at the monitoring site immediately after collecting the water sample.

Collection Procedure:

1. Remove the cap of the sampling jar.
2. Wear protective gloves. Rinse the jar 2-3 times with the stream water.
3. Hold the jar near the bottom and plunge it (opening downward) below the water surface.
4. Turn the submerged jar into the current and away from you.
5. Allow the water to flow into the jar for 30 seconds.
6. Cap the full jar while it is still submerged. Remove it from the water body immediately.

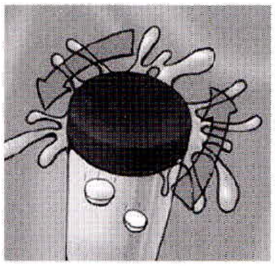
TURBIDITY



The white jar is used to perform the turbidity test. If possible, adhere the Secchi disk icon sticker to the jar 8-24 hours before use to allow the adhesive to cure.

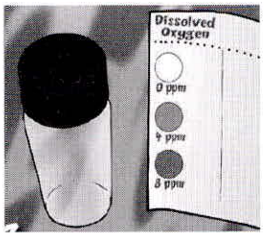
Procedure

1. Remove the backing from the Secchi disk icon sticker.
2. Adhere sticker on the inside bottom of the white jar. Position the sticker slightly off center.
3. Fill the jar completely.
4. Hold the turbidity chart on the top edge of the jar.
5. Looking down into the jar, compare the appearance of the Secchi disk icon in the jar to the chart. Record the result as turbidity in JTU.



TEMPERATURE

1. Wear protective gloves.
2. Place the thermometer four inches below the water surface for one minute.
3. Remove the thermometer from the water and read the temperature (the number with the green background on the high-range thermometer). Record the number in degrees Celsius.

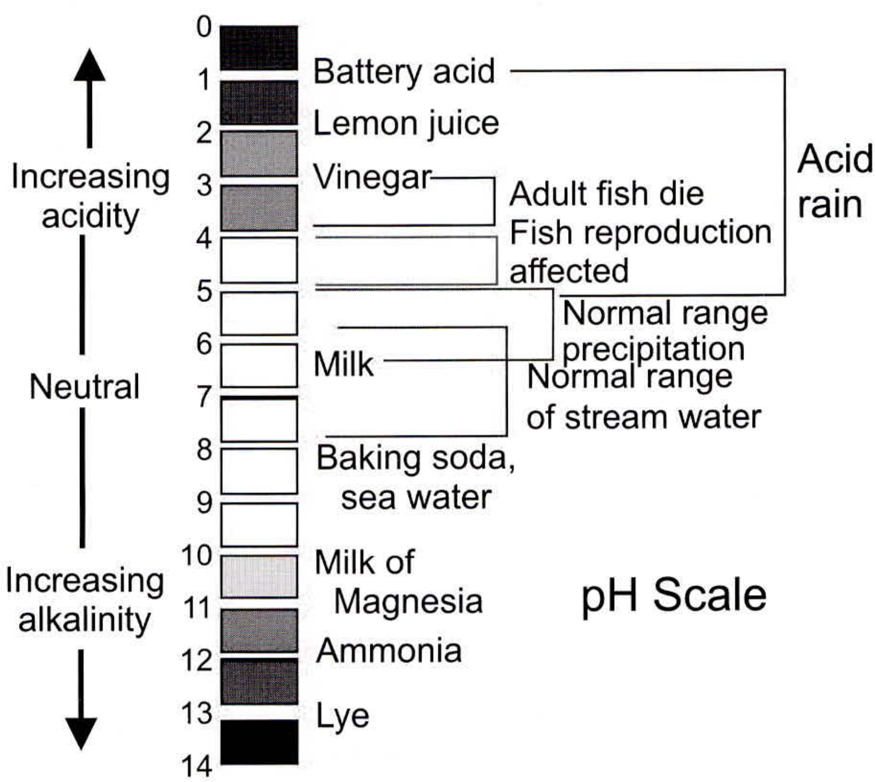


DISSOLVED OXYGEN (DO)

1. Record the temperature of the water sample.
2. Submerge the small vial into the water sample. Carefully remove the vial from the water sample, keeping the vial full to the top.
3. Drop two dissolved oxygen tablets into the vial. Water will overflow when the tablets are added.
4. Screw the cap on the vial. More water will overflow as the cap is tightened. Make sure no bubbles are present in the sample.
5. Mix by inverting the vial over and over until the tablets have disintegrated. This will take about 4 minutes.
6. Wait 5 more minutes for the color to develop.
7. Compare the color of the sample to the dissolved oxygen color chart. Record the result as ppm dissolved oxygen.

pH

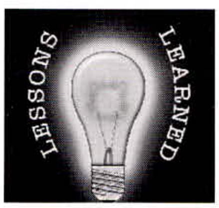
1. Fill the test tube to the 10 ml line with the water sample.
2. Add one pH Wide Range Tablet.
3. Cap and mix by inverting until the tablet has disintegrated. Bits of material may remain in the sample.
4. Compare the color of the sample to the pH color chart. Record the result as pH.



Sample Data Sheet

Parameter	Site 1	Site 2	Site 3
Date			
Location			
Air Temperature			
Water Temperature			
Dissolved Oxygen			
pH			
Turbidity			

LESSONS LEARNED



- Water pollution is the contamination of water bodies (e.g. lakes, rivers, oceans, aquifers and groundwater), very often by human activities.
- Intake of contaminated water gives rise to various serious ailments in our body such as cancer, neurological disorders, gastrointestinal disorders, skin related diseases and respiratory diseases sometimes even results in death.
- Water-borne diseases are infectious diseases spread primarily through contaminated water.
- The effects of water pollution are varied and depend on what chemicals are dumped and in what locations.
- Wastewater is water that has been used and must be treated before it is released into another body of water, so that it does not cause further pollution of water sources.
- Wastewater treatment and reuse augments water scarcity giving a dependable and sustainable resource for applications requiring large volumes of water consumption.
- The most common reasons for establishing a wastewater reuse program is to identify new water sources for increased water demand and to find economical ways to meet increasingly more stringent discharge standards.
- Safe storage is an integral component of water treatment.
- Chlorine is the most commonly used disinfectant worldwide to make it safe for human consumption.
- Water quality can be defined as the chemical, physical and biological characteristics of water alongwith its general composition qualities such as pH, value suspended particle matter, oxygen levels, and the level of nutrients present; usually in respect to its suitability for a designed use.

- Water testing is required mainly for monitoring purpose.
- A basic test kit required for testing water quality includes a instruction booklet, sample collection jar, pH test tube, dissolved oxygen vial, secchi disk decal, 2 temperature strips (14-40°C and 0-12°C), 50 pH reagent tablets, 100 Dissolved oxygen reagent tablets, color chart for determining DO, pH and turbidity test results and mini pencil.

NOTES

The trainer can note down important notes below and discuss them towards the end of the training programme.