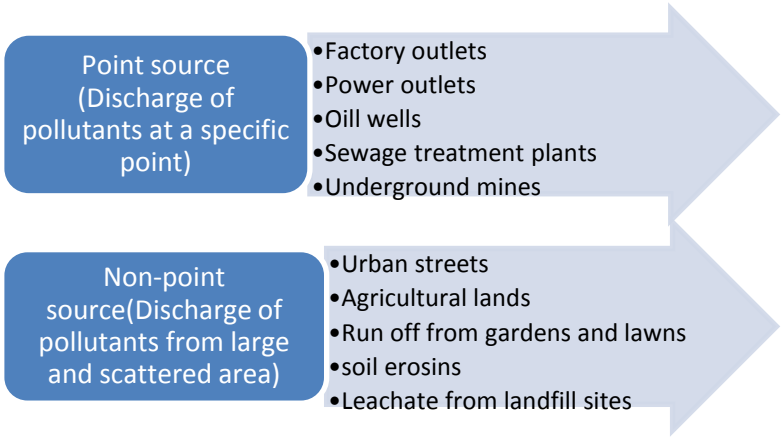
WATER POLLUTION PROBLEM

Definition: Water pollution is defined as any physical, chemical or biological change in quality of water that has a harmful effect on living organism or makes the water unsuitable for needs.

Sources of water pollution: There are two common sources of water pollution-



Water pollution can be categorised into two different types on the basis of contaminated water body:

i. Surface pollution Water: Contamination of Lake, Ponds, Rivers, Streams etc.
ii. Ground pollution Water: Contamination of underground water aquifers like, wells, tube-wells, Hand pumps etc.
iii. Marine pollution: Contamination of oceanic ecosystem.

Different Types of Water Pollutants: There are several types of water pollutants responsible for causing water pollution, these are as follows:

i. **Chemical Water Pollutants**: Many industries and farmers use chemicals for their various purposes. It causes water pollution. Pollutants used to control weeds, insects and pests leech into the water and spreading the pollution. Also, metals and solvents from industries also lead to water pollution.

ii. **Sewage**: Disposing of sewage in water is one of the major reasons for water pollution. Sewage disposed into the sea from households as well as factories can cause water pollution. Sewage disposal leads to a number of water-related illnesses such as diarrhoea which is a leading cause of death among children.

iii. **Industrial Waste**: Many factories pour industrial waste like toxic chemicals into the water bodies before treatment. It leads to polluting the water. Due to dumping toxic chemicals, the oxygen levels in water decreases leading to pollution.

iv. **Dumping of Solid Waste**: Another major reason for water pollution is littering by humans. Dumping solid waste such as plastics, cardboards, Styrofoam contaminates water and make water unsuitable for consumption. Mass dumping of solid waste clogs the water bodies and leads to water pollution.

v. **Radioactive Wastes**: Discharging of radioactive wastes into the sea is also one of the main water pollution cause in today's world. Radioactive substances can enter the humans with food and water and get accumulated in blood, thyroid gland, liver, bones and muscular tissues. In man-made sources like in nuclear power plant, mostly uranium, plutonium and thorium types of radioactive substances releases, that reduces the effectiveness of certain enzymes, skin cancer or leukaemia etc.

vi. **Suspended Matter Pollution**: In this pollution, the pollutants enter into water and don't mix with the water molecules. Therefore, the suspended particles in water form silt on the waterbed. Due to this nutrient from water were removed and making it polluted.

vii. **Microbiological water pollution** is usually a natural form of water pollution caused by microorganisms. Many types of microorganisms live in water and cause fish, land animals and humans to become ill. Microorganisms such as: **Bacteria, Viruses, Protozoa etc.** Serious diseases such as cholera come from microorganisms that live in water. These diseases usually affect the health of people in poorer countries, as they do not have the facilities to treat polluted water.

viii. **Inorganic Nutrients** are essential for plant growth and development. Many nutrients are found in wastewater and fertilizers, and these can cause excess weed and algae growth if large concentrations end up in water.

- This can contaminate drinking water and clog filters.
- This can be damaging to other aquatic organisms as the algae use up the oxygen in the water, leaving none for the surrounding marine life.

EFFECT OF WATER POLLUTION: Addition of harmful substances in the environment leads to various problems. These are as follows:

On the Environment

Water pollution truly harms biodiversity and aquatic ecosystems. The toxic chemicals can change the color of water and increase the amount of minerals - also known as eutrophication - which has a bad impact on life in water. Thermal pollution, defined by a rise in the temperature of water bodies, contributes to **global warming** and causes serious hazard to water organisms. Change in colour of water affects the usage of water and growth of plants and other organisms in water. The oxygen demanding waste such as

On Human Health

Water pollution has very negative effects on public health. A lot of diseases result from drinking or being in contact with contaminated water, such as diarrhea, cholera, typhoid, dysentery or skin infections. In zones where there is no available drinking water, the main risk is dehydration obviously.

> More amount of nitrates in water due to the application of artificial fertilizer in agricultural lands can causes *Methemoglobinemia* also known as '**Blue Baby Syndrome**' (decreases oxygen carrying capacity of the blood).

Water pollution prevention and control

How to solve water pollution? How can water pollution be prevented?

Water pollution can be controlled by diluting the water pollutants in a reservoir. ***The various methods for the control of water pollution can be summarized as follows:***

1. The sewage pollutants are required to be treated in sewage treatment plants before their discharge in natural water bodies.

2. Water pollution due to organic insecticides and pesticides can be reduced by the use of very specific and less stable chemicals in the manufacture of insecticides/pesticides. Moreover, use of bio-fertilizers needs to be promoted.

3. Oxidation ponds can be useful in removing low level of radioactive wastes.

4. Hot water should not be disposed directly into the river, as it adversely affects the life of aquatic organisms. Thermal pollution can be reduced by employing techniques such as cooling, cooling ponds, evaporative or wet cooling towers and dry cooling towers.

5. Domestic and industrial waste waters should be treated properly in waste water treatment plants, before discharge in the natural aquatic systems.

6. Strict implementation of legislations for water treatment should be done.

7. No solid waste should be dumped into water bodies.

8. Dead bodies of animals/human should not be floated in water sources.

9. Bathing, washing of clothes, and idol immersion should be strictly restricted in natural water bodies.

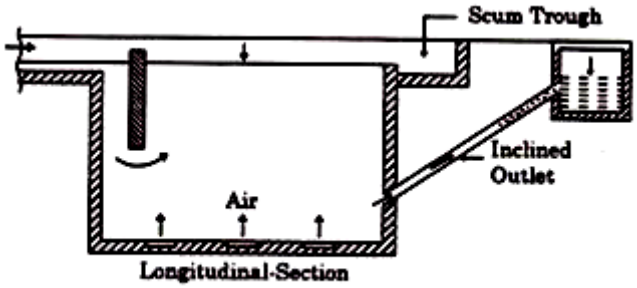
Waste water treatment technology

Sewage, before being discharged of either in river streams or on land, has to be treated so as to make it safe. The degree of treatment required, however, depends upon the characteristics

of the source of disposal. Sewage can be treated in different ways.
Treatment processes are often classified as –
1.Preliminary treatment
2.Primary treatment
3. Secondary (or Biological) treatment

1. Preliminary treatment
Preliminary treatment consists solely in separating the floating materials (like dead animals, tree branches, papers, pieces of rags, wood etc.) and also heavy settable inorganic solids. It also helps in removing the oils and greases etc. from sewage.

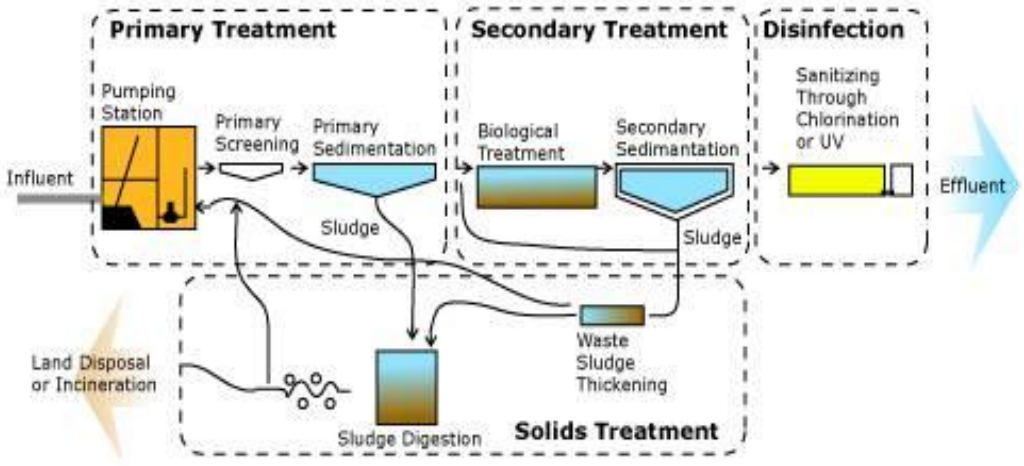
The processes used in preliminary treatment are:
a. **Screening** – for removing floating papers, rags, clothes etc.
b. **Grit chambers or Detritus tanks** – for removing grit and sand
c. **Skimming tanks** – for removing oils and greases.



Skimming Tank

2. Primary treatment

Primary treatment consists in removing large suspended organic solids. This is usually accomplished by sedimentation in settling basins. The organic solids, which are separated out in the sedimentation tanks (in primary treatment), are often stabilized by anaerobic decomposition in a digestion tank or are incinerated. The residue is used for landfills or soil conditioners. The liquid effluent from primary treatment often contains a large amount of suspended organic material. It also has a high biochemical oxygen demand (BOD).
The processes used in primary treatment are
a. **Sedimentation** – for removing part of the organic matter from the sewage effluent as in drinking water purification
b. **Sedimentation aided with coagulation** – similar to drinking water purification



Water Treatment Technologies

3.Secondary (or Biological) treatment

Secondary treatment involves further treatment of the effluent coming from the primary sedimentation tanks. This is generally accomplished through biological decomposition of organic matter, which can be performed either under aerobic (in presence of oxygen) or anaerobic (in absence of oxygen) conditions. In these biological units, bacteria are used to decompose the fine organic matter to produce clearer effluent.

In treatment reactors, in which the organic matter is decomposed (oxidized) by aerobic bacteria are known as ***Aerobic Biological Units,*** *and may consists of*
a. **Filters (intermittent sand filters and trickling filters)** – Sewage is kept in contact with filtering medium, so that fine colloidal organic matter gets trapped in the voids (spaces) of filter medium.

b. **Aeration tanks** – Sewage received from primary sedimentation tanks is mixed with micro-organisms (e.g. bacteria) and large quantity of air, thus causing precipitation of organic and colloidal matter.

c. **Oxidation ponds and aerated lagoons** – Oxidation ponds are used for the oxidation of original organic matter and the production of algae which are discharged with the effluent in the natural water bodies. It results in the net reduction in BOD, approximately upto 90%, and coliform removal of upto 99% or so.

The treatment reactors in which the organic matter is destroyed and stabilized by anaerobic bacteria, are known as ***Anaerobic Biological Units,*** *and may consists of-*

a. **Anaerobic lagoons** – These are deep stabilization ponds, usually operating under the action of anaerobic bacteria (bacteria which survive only in absence of oxygen). In these

ponds, complex organic materials are broken down into short chain acids and alcohols, which are further degraded into gases such as methane and carbon dioxide.

b. **Septic tanks** – A septic tank is a kind of sedimentation tank which directly receives raw sewage and removes about 60 - 70% of the dissolved matter from it. Septic tanks are generally provided in areas where sewers have not been laid and for serving to the sanitary disposal of sewage produced from isolated communities, schools, hospitals, other public institutions etc.

c. **Imhoff tanks** – An Imhoff tank is an improvement over septic tank, in which the incoming sewage is not allowed to get mixed up with the sludge produced, and the outgoing effluent is not allowed to carry with it large amount of organic load, as in the case of septic tank. These are very economical and do not require skilled supervision during operations. There is 60 – 65% removal of solids and 30 – 40% removal of BOD.

(Source: Miscellaneous Books, Web)

Write short notes on:

1. **BOD (Biological oxygen demand)-** It is the amount of oxygen required by microorganisms to carry out the oxidation process of organic materials. BOD is the standard method for indirect measurement of the amount of organic pollution in a sample of water. The BOD and DO (Dissolved oxygen) are indirectly related to each other. When the BOD is too high, the DO becomes too low to support the living organisms. The result of a BOD test indicates the amount of DO in water consumed by microbes incubated in darkness for 5 days at 20˚C temperature. It shows higher the BOD, higher the amount of pollution in the test sample.

$$CH_2O + O_2 \xrightarrow{\text{microorganism}} CO_2 + H_2O.$$

2. **COD (Chemical oxygen demand**)- It is the amount of oxygen required to carry out the oxidation process of organic matter chemically. A COD test can be used to easily quantify the amount of organics in water. The most common application of COD is in quantifying theamount of oxidizable pollutants found in surface water (e.g. lakes and rivers) or wastewater. The COD test is often used in conjunction with the BOD test to estimate the amount of non-biodegradable organic material in a wastewater. Apart from the organic

matter, COD is required for oxidation process in certain inorganic compounds like sulfites, thiosulfates, ferrous ions and other metals.

3. **Eutrophication:** Eutrophication is an enrichment of water due to the accumulation of nutrients mainly phosphate, nitrate, animal waste, agricultural and domestic waste in the water body, that causes structural changes to the ecosystem such as: increased production of algae and aquatic plants, depletion of fish species, general deterioration of water quality like unpleasant odour, turbidity and other effects that reduce and prohibit use*". This is one of the first definitions given by the OECD (Organization for Economic Cooperation and Development).* Excessive levels of nutrients in aquatic system leads to maximum growth of bloom of microorganisms called **algal bloom**, which shows the high BOD in water. Eutrophication is a serious environmental problem of any surface water bodies like stream, ponds and lakes etc.

4. **Aquifers:** An aquifer is an underground layer of rock that holds groundwater. Groundwater is rain or melted snow that has seeped into the ground and is held there. Aquifers are filled slowly. For this reason, aquifers can dry up when people drain them faster than they can be refilled—a process called aquifer depletion. Aquifers can be drained by man-made wells or they can flow out naturally in springs. There are two general types of aquifers: confined and unconfined. **Confined aquifers** have a layer of impenetrable rock or clay above them, while **unconfined aquifers** lie below a permeable layer of soil. Many different types of sediments and rocks can form aquifers, including gravel, sandstone, conglomerates, and fractured limestone.

##Case studies related to water pollution##

1. <u>Arsenic pollution in West Bengal</u>

Arsenic contamination of groundwater is a form of groundwater pollution which is due to naturally occurring high concentrations of arsenic in deeper levels of groundwater. Arsenic found all over the world in groundwater and the Ganga-Bramhaputra region is one of the major arsenic-contaminated zones in the world. It is a problem due to use of tube wells for water supply in the Ganges Delta causing serious arsenic poisoning. Arsenic contaminated water contains arsenous acid (H3 AsO3) and arsenic acid (H3 AsO4) or their derivatives.

Arsenic contaminating ground water causes serious health problems in West Bengal from 1980's. Arsenic poisoning can cause major health complications if not properly treated. Arsenic in the water is extremely dangerous and hard to detect as arsenic has no flavour or odour. Chronic intake of drinking water with above 50µg/L arsenic concentrations can cause the development of **arsenicosis**, it is designated as human health effect of chronic arsenic toxicity was first coined by our group and later used by the World Health Organization to imply a chronic disease caused by prolonged exposure of arsenic in humans. Cancers of skin, lung, and urinary bladder are the important cancers associated with this toxicity. hypertension; nonpitting edema of feet/hands; conjunctival congestion; weakness; and anemia.

2. Minamata Disaster or Mercury poisoning in Japan

Minamata disease, sometimes referred to as Chisso-Minamata disease, is a neurological syndrome caused by severe mercury poisoning. Minamata disease was first discovered in Minamata City in Kumamoto prefecture, Japan in 1956. In the late 1950s Minamata Bay, Japan became contaminated with mercury from a nearby factory manufacturing the chemical acetaldehyde (Chisso Corporation's chemical waste pipe). The mercury was biotransformed by bacteria in the water into methylmercury, or organic mercury, that bioaccumulated and biomagnified in the muscle of fish. First, local cats that ate the fish began to stagger about and die. Then, the local population of people that depended on fish were affected, particularly developing fetuses and children. Over two thousand people died, and thousands more experienced crippling injuries. While cat, dog, pig and human deaths continued over more than 30 years, the government and company did little to prevent the pollution. **Symptoms** include ataxia, numbness in the hands and feet, general muscle weakness, narrowing of the field of vision and damage to hearing and speech. In extreme cases, insanity, paralysis, coma and death follow within weeks of the onset of symptoms. A congenital form of the disease can also affect foetuses. The foetus was poisoned by MeHg when their mothers ingested contaminated marine life.
Some other case studies with the link below:
https://www.fastcompany.com/90425011/coca-cola-nestle-and-pepsico-are-the-worlds-biggest-plastic-polluters-again
https://www.ecowatch.com/coke-pepsi-plastic-polluters-2641090767.html?rebelltitem=2#rebelltitem2

GAP (Ganga Action Plan) Namami Gange....

The Ganga action plan was, launched by Shri Rajeev Gandhi, the then Prime Minister of India on 14 Jan. 1986 with the main objective of pollution abatement, to improve the water quality by Interception, Diversion and treatment of domestic sewage and present toxic and industrial chemical wastes from identified grossly polluting units entering in to the river. The other objectives of the Ganga Action Plan are as under.

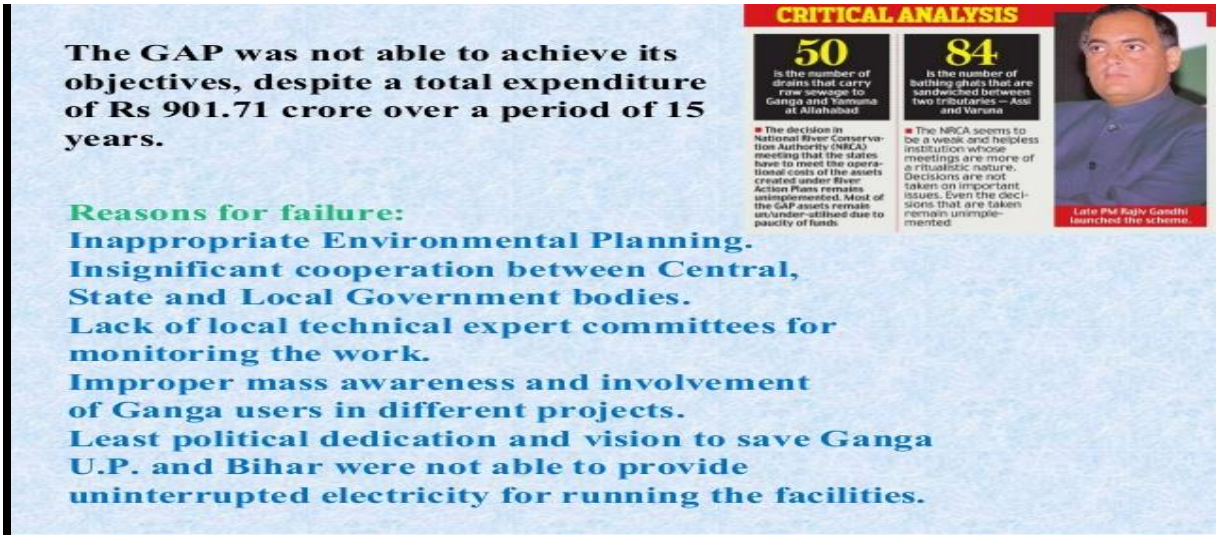
- Control of non-point pollution from agricultural run off, human defecation, cattle wallowing and throwing of unburnt and half burnt bodies into the river.
- Research and Development to conserve the biotic, diversity of the river to augment its productivity.
- New technology of sewage treatment like Up-flow Anaerobic Sludge Blanket (UASB) and sewage treatment through afforestation has been successfully developed.
- Rehabilitation of soft-shelled turtles for pollution abatement of river have been demonstrated and found useful.
- Resource recovery options like production of methane for energy generation and use of aquaculture for revenue generation have been demonstrated.
- To act as trend setter for taking up similar action plans in other grossly polluted stretches in other rivers.

Ganga Action Plan Phase-I

At the time of launching, the main objective of GAP was to improve the water quality of Ganga to acceptable standards by preventing the pollution load reaching the river. However, as decided in a meeting of the Monitoring Committee in June, 1987 under the Chairmanship of Prof. M. G. K. Menon, then Member, Planning Commission, the objective of GAP was recast as restoring the river water quality to the 'Bathing Class' standard.

Ganga Action Plan Phase-II

The important tributaries of river Ganga like, Yamuna, Gomati and Damodar which directly discharge into the river Ganga are heavily polluted and are taken up for pollution abatement Programmes. For this purpose, the second phase of Ganga Action Plan was started in stages between 1993 & 1996. Both Central & State Government Provided help and had equal Share that is 50:50 in the working of Ganga Action Plan (Phase II). After April 1997 Central Government took the full responsibility of this project & sanctioned the total cost Under Ganga Action Plan. Other river conservation plans for Yamuna, Gomati and Damodar have also been accepted and the government has sanctioned Rs.2285.48 crore for the same. This money will help in starting 441 projects in 95 cities under the plan.



'Namami Gange Programme', is an Integrated Conservation Mission, approved as 'Flagship Programme' by the Union Government in June 2014 with budget outlay of Rs.20,000 Crore to accomplish the twin objectives of effective abatement of pollution, conservation and rejuvenation of National River Ganga.

National Mission for Clean Ganga,- https://nmcg.nic.in/NamamiGanga.aspx