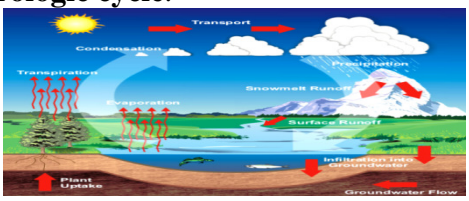
28A. GROUND WATER RESOURCES

- Water and water vapour are in constant circulation, powered by the energy from sunlight and gravity as a natural process called **hydrologic cycle**.

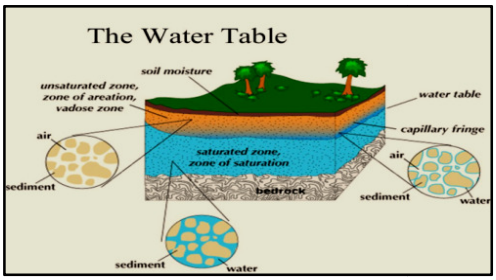


- Water evaporates from the ocean and land surfaces, is held temporarily as water vapour in the atmosphere, and falls back to the earth's surface as precipitation.
- Source of all freshwater on earth is rainfall. When rainfall occurs, part of it flows on the surface of the land as run-off which ultimately gets into a water body like stream, river, pond or lake is called **surface water.**
- Part of rain water that infiltrates the earth's surface slowly seeps downward into extensive layers of porous soil and rock is called **ground water.**

Difference between surface water and groundwater

Surface water	Ground water
is the water which remains on the surface of land in form of streams, rivers, ponds or lakes.	is the water which is normally found underground and is obtained by digging wells, tube wells and hand pumps.
It is exposed and can be easily contaminated.	It is underground (hidden) and thus cannot be easily contaminated.
It often needs to be transported to the place of use and is thus expensive.	It is often available at the place of their use and need not be transported. It is thus cheaper.
It cannot be directly consumed as it is contaminated.	It is mostly un-contaminated and can be directly consumed.
It is exposed and subject to evaporation losses and thus less dependable in times of drought.	It is underground and does not get lost due to evaporation. It is thus more dependable in times of drought.

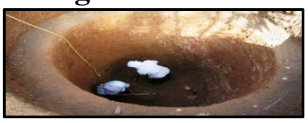
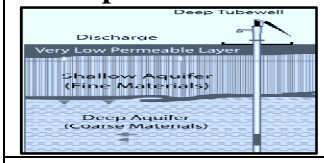
- Both surface water and groundwater eventually return to the ocean, where evaporation replenishes the supply of atmospheric water vapour. Wind carries the moist air over land, precipitation occurs, and the hydrologic cycle continues.
- The process of precipitation replenishing the groundwater supply is known as **recharge.** Recharge occurs only during the rainy season in tropical climates or during spring in temperate climates.
- About 10 to 20% of the precipitation that falls to the earth percolates through soil and contributes to the water-bearing strata, i.e. aquifer.
- Groundwater is constantly in motion. It moves very slowly, the actual rate depends on the transmissibility and storage capacity of the aquifer. Sometimes outflows of groundwater take place through springs and riverbed
- Underground water body is created called **aquifer,** when the soil zone becomes saturated, water percolates downward. A zone of saturation occurs where all the soil pores are filled with water. Part of the renewal time of groundwater near the water table may be a year or less, while in deep aquifers it may be as long as thousands of years.
- The rain water slowly infiltrates into the soil under the pull of gravity
- Sometimes outflows of groundwater take place through springs and riverbeds
- Water table is the upper level of an underground surface in which the soil or rocks are permanently saturated with water. It is also called groundwater table.
- At the water table level the pore space in the soil is completely filled with water.



- The water table fluctuates both with the seasons and from year to year because it is affected by rainfall, uptake by roots of forest tress and climatic variation.
- Water table also affected by the quantum withdrawal from wells or by artificial recharging.
- It is exploited for domestic use, livestock and irrigation since time immemorial. In India a very large percentage of population depends on groundwater for domestic needs.
- The value of an aquifer depends on the porosity of the geologic layer, of which it is formed. Water is withdrawn from an aquifer by pumping it out of a well or infiltration gallery.
- An infiltration gallery typically includes several horizontal perforated pipes radiating outward from the bottom of a large-diameter vertical shaft. Wells are constructed in several ways, depending on the depth and nature of the aquifer.
- Wells used for public water supplies, usually more than 100 feet (30 meters) deep and from 4 to 12 inches (10 to 30 cm) in diameter, must penetrate large aquifers that can provide dependable yields of good-quality water. A submersible pump driven by an electric motor can be used to raise the water to the surface.

GROUND WATER SOURCES

Methods of Groundwater Abstraction to obtain ground water

1. Springs 	The water table generally follows the topography of the ground surface. The flow depends on slope and permeability. When the water table is above the surface water level in some hilly areas, groundwater flows out as a spring. This spring water can be easily used as source of drinking.
2. Dug-well 	It covers ordinary open wells of varying dimension dug or sunk from the ground surface into water bearing stratum to extract water for irrigation purposes. These are broadly masonary wells, kuchcha wells and dug-cum-bore wells. All such schemes are of private nature belonging to individual cultivator. The oldest water supplies to towns as in Rome, Lyon were from such sources.
3. Shallow tube-well 	It consists of a bore hole built into ground with the purpose of tapping ground water from porous zones. The depth of a shallow tube well does not exceed 60-70 m. The tube wells are generally operated for 6 to 8 hours during irrigation season.
4. Deep tube well 	It usually extends to the depth of 100 m and more and is designed to give a discharge of 100 to 200cubic m/h. These tube wells operate round the clock during the irrigation season, depending upon the availability of power. Their annual output is roughly 15 times that of an average shallow tube well.
5. Handpump 	Are commonly used to draw groundwater in villages and slum areas in urban centres. These are manually operated. Thus no electricity or other power is required to operate them.

Economic Use of Water

a. At Home

In Bathroom	In Kitchen and Laundry	Garden and landscaping	Equipment
-Do not let the water run while shaving or brushing teeth, use mug while shaving or brushing teeth. -Take short showers instead of tub baths. - -Turn off the water while soaping or shampooing. -If you must use a tub, close the drain before turning on the water and fill the tub only half full. - Bathe small children together. - Never use your toilet as a waste basket.	-Store drinking water in the refrigerator. - Wash fruits and vegetables in a basin. Use a vegetable brush. - Do not use water to defrost frozen foods; then ahead of use. - Scrape, rather than rinse, dishes before loading into the dishwasher. -Add food wastes to your compost pile instead of using the garbage disposal. - Wash only full loads of laundry in washing machine.	-Use 75% of a home's total water use during the growing season is for outdoor purposes. -Detect and repair all leaks in irrigation system. -Water the lawn or garden in early morning is best. -Water trees and shrubs for a longer time and -Set sprinklers to water the lawn or garden only – not the street or sidewalk -Use soaker hoses or trickle irrigation systems for trees and shrubs. -Install moisture sensors on sprinkler systems. -Use mulch around shrubs and garden plants to reduce evaporation. -Minimize or eliminate fertilizing, which promotes new growth needing additional watering. -Do not use water that contains bleach, automatic-dishwashing detergent or fabric softener for irrigation	- Install low-flow faucet aerators and showerheads. - Consider purchasing a high efficiency washing machine. - Repair all leaks. - To detect leaks in the toilet, add food coloring to the tank water. If the colored water appears in the bowl, the toilet is leaking.

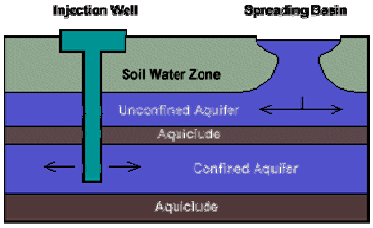
b. Outdoor Uses

- Sweep driveways, sidewalks and steps rather than using hose pipes to wash them.
- Wash the car with water from a bucket, or consider using a commercial car wash that recycles water.
- When using a hose, control the flow with an automatic shut-off nozzle.
- Avoid purchasing recreational water toys which require a constant stream of water.
- **Artificial recharge** (sometimes called planned recharge) **is a process** by which excess surface water is directed into the ground – either by spreading on the surface, by using recharge wells, or by altering natural conditions to increase infiltration.

Direct Artificial Recharge

a. Spreading basins

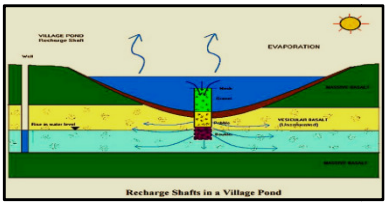
This method involves surface spreading of water in basins which are excavated in the existing terrain. For effective artificial recharge highly permeable soils are suitable and maintenance of a layer of water over the **highly permeable soils** is necessary.



b. Recharge pits and shafts

- Often areas of low permeability lie between the land surface and water table. In such

situations artificial recharge systems such as pits and shafts could be effective.



- Unfiltered runoff waters leave a thin film of sediment on the sides and bottom of the pits which require maintenance in order to sustain the high recharge rates.
- Excavation for making pits and shafts may terminate above the water table level or may by hydraulic connectors extend below the water table.
- Recharge rates in both shafts and pits may decrease with time due to accumulation of fine grained materials and the plugging effect brought about by microbial activity.

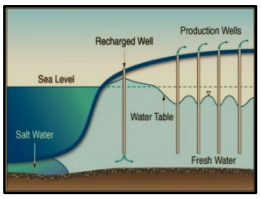
c. Ditches

- A ditch is a long narrow trench, with its bottom width less than its depth and its system can be designed to suit the topographic and geologic conditions that exist at a given site.
- The ditches could terminate in a collection ditch designed to carry away the water that does not infiltrate. This would reduce the accumulation of fine material.

d. Recharge wells

Recharge or injection wells are used to directly recharge water into deep water-bearing zones. Recharge wells are suitable only in areas where a thick impervious layer exists between the surface of the soil and the aquifer to be replenished. They are also advantageous where land is scarce.

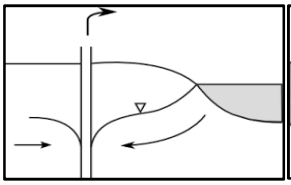
A relatively high rate of recharge can be attained by this method.

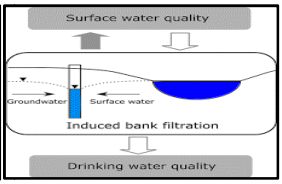


Indirect methods of recharging

a. Enhanced streambed infiltration (induced infiltration)

- This method consists of setting a gallery or a line of wells parallel to the bank of a river and at a short distance from it. Without the wells there would be unimpeded outflow of groundwater to the river.
- When small amounts of groundwater are withdrawn from the gallery parallel to the river, the amount of groundwater discharged into the river decreases.

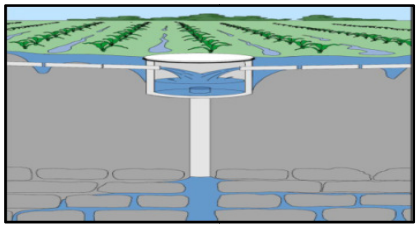




- The water recovered by the gallery consists natural groundwater. Each groundwater withdrawal is accompanied by a drawdown in the water table.

b. Conjunctive wells

- is one that is screened in both a shallow confined and deeper artesian aquifer.
- Water is pumped from the deeper aquifer and when its surface is lowered below the shallow water table, water from the shallow aquifer drains directly into the deeper aquifer.
- Water augmentation by conjunctive wells has the advantage of utilizing sediment-free groundwater without damaging clogging well screens.



- Advantages of Artificial Recharge
- Recharge methods are attractive, particularly in arid regions.
- Most aquifer recharge systems are easy to operate.
- Recharge with less-saline surface waters or treated effluents improve the quality of saline aquifers, facilitating the use of the water for agriculture and livestock.
- Very few special tools are needed to dig drainage wells.
- Groundwater recharge stores water during the wet season for use in the dry season, when demand is highest.
- Aquifer water can be improved by recharging with high quality injected water.
- Recharge can significantly increase the sustainable yield of an aquifer.

Disadvantages of Artificial Recharge

- In the absence of financial incentives, laws, or other regulations to encourage land owners to maintain drainage wells adequately, the wells may fall into disrepair and ultimately become sources of groundwater contamination.
- There is a potential for contamination of the groundwater from injected surface water runoff, especially from agricultural fields and road surfaces unless the surface water runoff is not pre-treated before injection.

Groundwater Quality

Ground water plays an important role in India, particularly as a drinking water source and has a number of unique features as:

1. Generally uncontaminated and thus can be consumed directly without any treatment;
2. It can be available in close proximity to place for its widely distributed and less expensive;
3. It is dependable and relatively less affected by drought;

- Nearly 85% of India's population today is dependent on groundwater for their domestic demands.
- It is an important source of drinking water in rural areas. Groundwater also plays an important role in agriculture,
- Industrial demands for groundwater are also high.
- **Groundwater quality** is being increasing threatened by agricultural, urban and industrial wastes, which leach or are injected into underlying aquifers.
- **Reasons for Declining Ground Water Quality**
- A vast majority of groundwater quality problems are caused by contamination, overexploitation, or combination of the two.
- Most groundwater quality problems are difficult to detect as they may be concealed below surface. They are also hard to resolve.
- Industrial discharges, landfills and subsurface injection of chemicals and hazardous wastes, are an obvious source of groundwater pollution.
- These concentrated sources can be easily detected and regulated but the more difficult problem is associated with diffuse sources of pollution like leaching of agrochemicals and animal wastes, subsurface discharges from latrines and septic tanks and infiltration of polluted urban run-off and sewage where sewerage does not exist or defunct.
- Diffuse sources can affect entire aquifers, which is difficult to control and treat. The only solution to diffuse sources of pollution is to integrate land use with water management.

Table shows land-use activities and their potential threat to groundwater

Land Use	Activities potential to groundwater pollution
Residential activities	• Unsewered sanitation. • Land and stream discharge of sewage. • Sewage oxidation ponds. • Sewer leakage, solid waste disposal, landfill. • Road and urban run-off, aerial fall out.
Industrial and Commercial activities	• Process water, effluent lagoon. • Land and stream discharge of effluent. • Tank and pipeline leakage and accidental spills. • Well disposal of effluent. • Aerial fall out. • Landfill disposal & solid wastes and hazardous wastes. • Poor housekeeping. • Spillage and leakages during handling of material.
Land Use	Activities potential to groundwater pollution
Mining	• Mine drainage discharge. • Process water, sludge lagoons. • Solid mine tailings. • Oilfield spillage at group gathering stations.
In Rural areas	• Cultivation with agrochemicals. • Irrigation with wastewater. • Soil salinization. • Livestock rearing.
Coastal areas	Salt water intrusion.

Common Groundwater Contaminants

1) **Nitrates:** Dissolved nitrates commonly contaminate groundwater. High level of nitrates can cause blue baby disease (Methaemoglobinemia) in children, may form carcinogens and can accelerate eutrophication in surface waters. Sources of nitrates include sewage, fertilizers, air pollution, landfills and industries.

2) **Pathogens:** Poor hygiene of well and inadequate segregation of drainage charcoal from wells may cause pathogenic contamination (Bacteria and viruses) cause water borne diseases such as Typhoid, Cholera, Dysentery, Polio, and Hepatitis

3) **Trace metals:** lead, mercury, cadmium, copper, chromium and nickel can be toxic and carcinogenic. Seepage of industrial and mine discharges, fly ash ponds of thermal power plants can lead to metals in groundwater.

4) **Organic compounds**: Seepage of agricultural runoff loaded with organic compounds like pesticides and may cause pesticide pollution of ground water.

- **RISK OF DEPLETION OF GROUNDWATER**

Groundwater problems are becoming increasingly serious in many areas of the world.

Rapid increase in the rates of pumping of groundwater in many aquifers has caused a steady lowering of water table levels where extraction of water has exceeded rates of recharge.

Check Yourself

1. The process of precipitation and replenishing ground water is termed as:
   a. Seepage
   b. Recharge
   c. Percolation
   d. Infiltration
2. A long, narrow trench, with its bottom width less than its depth is known as:
   a. Pit
   b. Shaft
   c. Ditch
   d. Tube well
3. Blue baby disease in an infant can be cause by high level of:
   a. Arsenic
   b. Nickel
   c. Nitrates
   d. Cadmium
4. An underground water body created by slow infiltration of rain water into the soil under the pull of gravity is called:
   a. Inspect well
   b. Aquifer
   c. Tube well
   d. Spreading basin
5. A well which extend the depth of 100 metres and more, designed to give a discharge of 100-200 cubic meter per hour of water is called:
   a. Deep tube well
   b. Recharge well
   c. Drainage
   d. Shallow tube well

Ans: 1.b 2. c 3. c 4.b 5.a

Stretch Yourself

1. Define the terms: soil zone, aquifer.
2. What is infiltration gallery?
3. List any two outdoor uses of ground water.
4. Name any two waterborne diseases.
5. Define artificial recharge.

Test Yourself

1. Differentiate between ground water and surface water
2. How can we use water in economic way in the kitchen and laundry
3. Mention the disadvantages of artificial recharge
4. Give reasons about the declining the ground water quality.
5. Mention the risk of reducing ground water table.