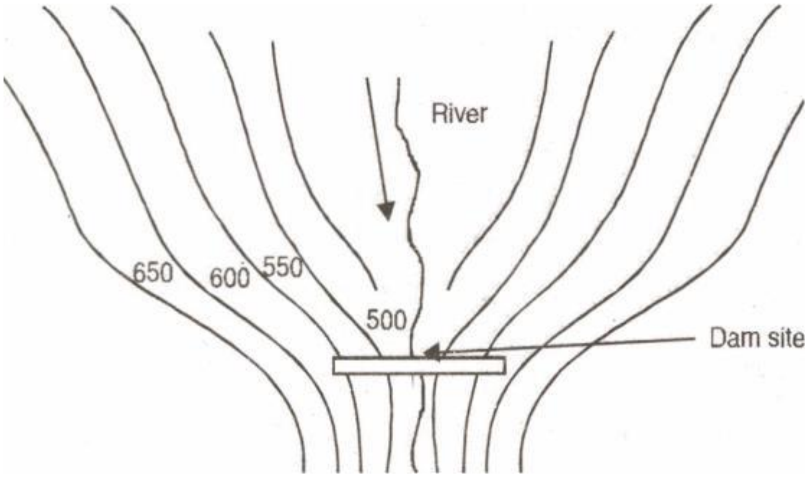
Department of Civil Engineering
Engineering Geology-17CV35
Solution IAT-II

1 (a) Give a general account on geological characters that has been known for location of a Dam.

The main object of placing a dam across a river is to impound its water behind the dam. Naturally, this would require that

(a) Topographically, a place which is most suitable for the purpose is selected. Ideally, it would be a narrow gorge or a small valley with enough catchment area available behind so that when a dam is placed there it would easily store a calculated volume of water in the reservoir created upstream.

A Typical Dam Site; numbers indicate contours.



(b) Technically, the site should be as sound as possible strong, impermeable and stable.

Strong rocks at the site make the job of the designer much easy: he can evolve best deigns. Impermeable sites ensure better storage inventories. Stability with reference to seismic shocks and slope failures around the dam, especially upstream, are a great relief to the public in general and the engineer in particular. The slips, slides, and slope failures around and under the dam and susceptibility to shocks during an earthquake could prove highly hazardous.

(c) Constructionally, the site should not be far off from deposits of materials which would be required for its construction. All types of major dams require millions of cubic meters of natural materials----earth, sand, gravel and rock - for their construction. Their non-availability in the adjoining areas would make the project cost too high, may be even unfeasible.

(d) Economically, the benefits arising out of a dam placed at a particular site should be realistic and justified in terms of land irrigated or power generated or floods averted or water stored. Dams are invariably costly structures and cannot be placed anywhere and everywhere without proper analysis of cost-benefit aspects.

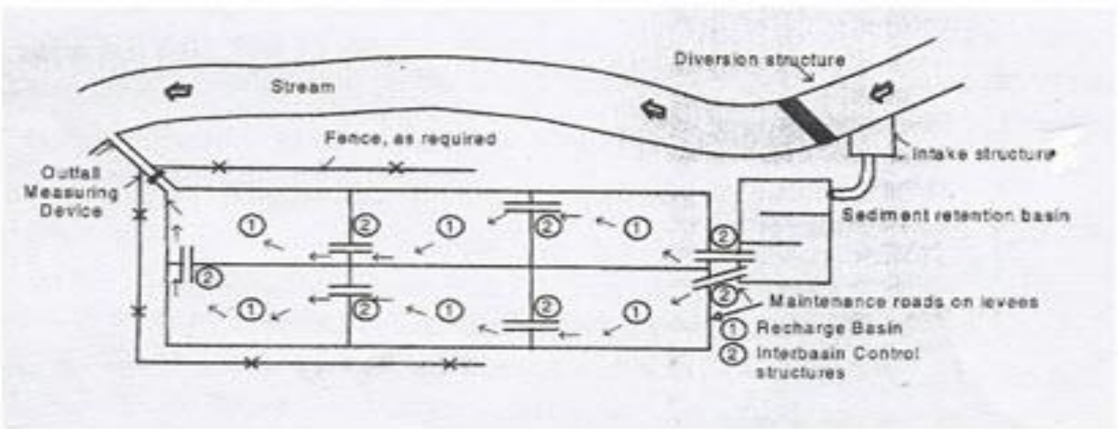
(e) Environmentally, the site where a dam is proposed to be placed and a reservoir created, should not involve ecological disorder, especially in the life cycles of animals and vegetation and man. The fish culture in the stream is the first sector to suffer a major shock due to construction of a dam. Its destruction may cause indirect effects on the population. These effects require as thorough analysis as for other objects. The dam and the associated reservoir should become an acceptable element of the ecological set up of the area.

2 (a) Explain different methods of artificial recharging of groundwater

Artificial Recharge is the Process by which the Groundwater is augmented at a rate much higher than those under natural condition of replenishment.
Types of Artificial recharging methods:

- Basin Channel method
- Stream channel flow
- Ditches and furrow system
- Flooding
- Recharge well
- Recharge pit

Basin channel method:



This is the most common method of artificial recharge. In this method, water is impounded in series of basins or percolation tank, The size of basin may depend upon the topography of area, in flatter area will have large basin . This method is applicable in alluvial area as well as hard formation. The efficiency and feasibility of this method is more in hard rock formation where the rocks are highly fractured and weathered.

Stream channel flow:

Seepage from natural stream or rivers is one of the most important sources of recharge of the ground water reservoir. When total water supply available in the stream /river exceeds the rate of infiltration, the excess is lost as runoff. This runoff can be arrested through check bunds or widening the steam beds thus larger area is available to spread the river water increasing the infiltration. The site selected for check dam should have sufficient thickness of permeable bed or weathered formation to facilitate recharge of stored water with in short span of time. The water stored in these structures is mostly confined to stream course and height is normally less than 2m. To harness maximum runoff, a series of such check dam may be constructed.

Ditches and furrow system:

In areas with irregular topography ditches or furrow provide maximum water contact area for recharge. This technique consists of a system of shallow flat bottomed and closely spaced ditches/ furrow which are used to carry water from source like stream/canals and provide more percolation opportunity. This technique required less soil preparation less is less sensitive to silting.

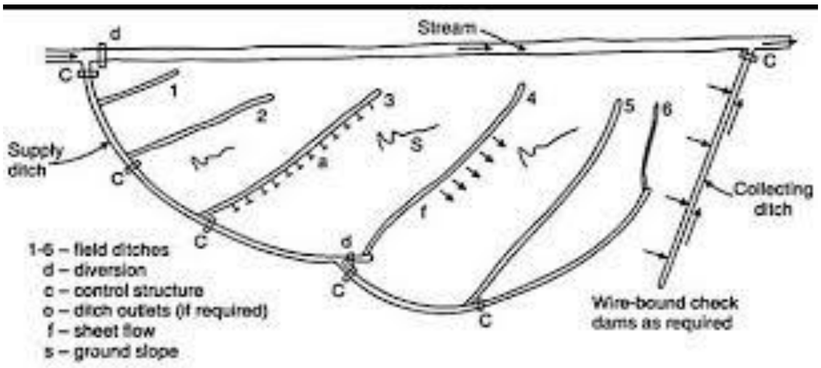


Fig. 15.1 Ditch and flooding-type recharge project

Flooding:

This method is suitable for relatively flat topography. The water is spread as a thin sheet. It requires a system of distribution channel for the supply of water for flooding. Higher rate of vertical infiltration is obtained on areas with undisturbed vegetation and sandy soil covering.

Recharge well:

Recharge wells can be of two types-

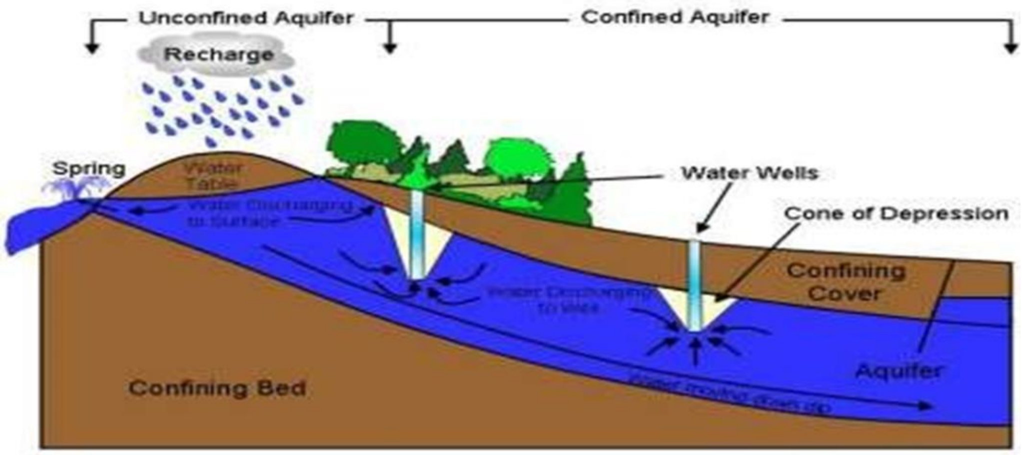
(a) Injection well, where water is "pumped in" for recharge and

(b) Recharge well, where water flows under gravity.

The recharge well for shallow water table aquifers up to 50 m is cost effective because recharge can take place under gravity flow only. These wells could be of two types, one is dry and another is wet. The dry types of wells have bottom of screen above the water table. In such well excessive clogging is reported due to release of dissolved gasses as water leaves the well and on other hand redevelopment methods have not been found effective in dry type of well. The wet types of wells are in which screen is kept below water table. These wet type wells have been found more successful.

3 (a) What is an Aquifer? Explain different types of aquifers with neat diagram.

- An aquifer is a layer of porous substrate that contains and transmits groundwater.
- An aquifer is an underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand, or silt) from which groundwater can be extracted using water well.



Types of Aquifers:

1. Unconfined Aquifer:
An aquifer which is not overlain by any confining layer but has a confining layer at its bottom is called unconfined aquifer. It is normally exposed to the atmosphere and its upper portion is partly saturated with water. The upper surface of saturation is called water table which is under atmospheric pressure therefore this aquifer is also called phreatic aquifer.

2. Perched Aquifer:
It is a special case of an unconfined aquifer. This type of aquifer occurs when an impervious or relatively impervious layer of limited area in the form of a lens is located in the water bearing unconfined aquifer. As shown in Fig. 16.3 the water storage created above the lens is perched aquifer and its top layer is called perched water table.

3. Confined Aquifer:
It is also called artesian aquifer. It is a type of aquifer overlain as well as underlain by confining layers. The water within the aquifer is therefore held under pressure. It is sometimes called pressure aquifer also. If the aquifer has high outcrop laterally than the ground surface there will be positive hydrostatic pressure to create conditions for a flowing well. Water from such well comes to the surface without pumping. The imaginary level upto which the water will raise is called piezometric surface.

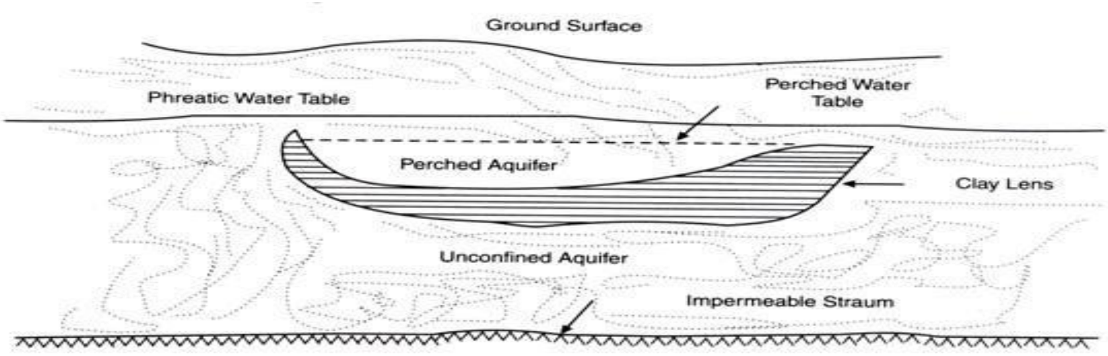


Fig. 16.3. Unconfined and perched aquifers

4 (a) Write a note Saline water intrusion and remedies.

Saline water Intrusion and their remedies:

Saltwater intrusion is a major concern commonly found in coastal aquifers around the world. Saltwater intrusion is the movement of saline water¬ into freshwater aquifers.

Most often, it is caused by ground-water pumping¬ from coastal wells, or from construction of navigation channels or oil field canals. . Saltwater intrusion occurs in virtually¬ all coastal aquifers, where they are in hydraulic continuity with seawater. The channels and canals provide conduits for salt water to be brought into fresh water marshes. Salt water intrusion can also occur as the result of a natural process like a storm surge from a hurricane.

Causes:

• Saltwater intrusion happens when saltwater is drawn in (from the sea) into fresh water aquifers.

• Sea water has a higher density (which is because it carries more solutes) than freshwater.

• This density causes the pressure under a column of salt water to be greater than the pressure under a column of the same height of freshwater.

• If these two columns are connected at the bottom, then the pressure difference would cause a flow of saltwater column to the freshwater until the pressure equalizes.

Saltwater intrusion into freshwater aquifers is also influenced by factors such as:

- tidal fluctuations,
- long-term climate and sea level changes,
- fractures in coastal rock formations
- seasonal changes in evaporation and recharge rates.

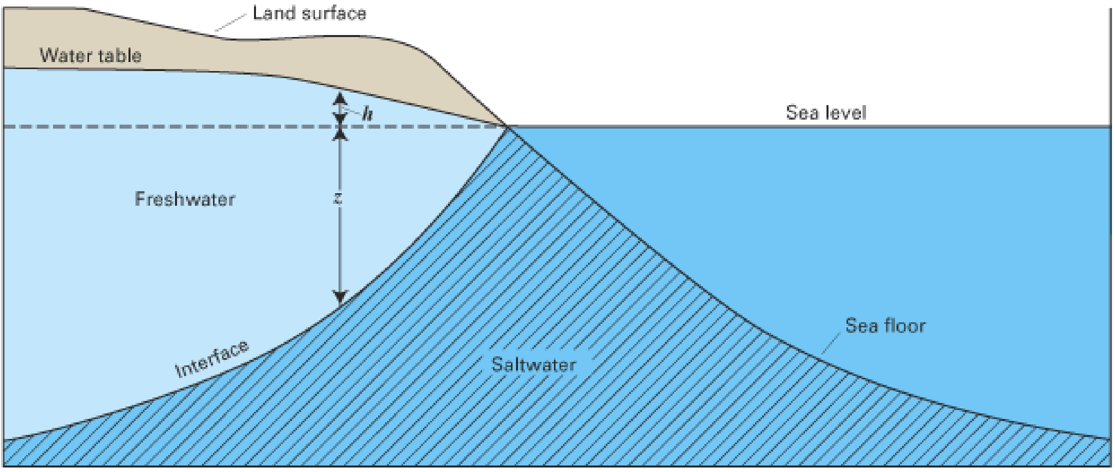
IMPACTS

• Salt-water intrusion from rising sea levels will reduce the quality and quantity of freshwater supplies.

• This is a major concern, since billions of people already lack access to freshwater.

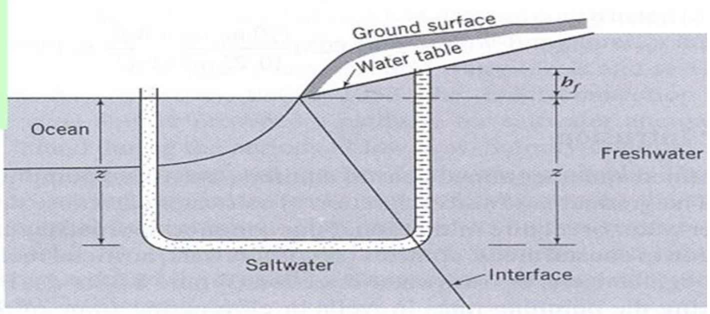
• Salt water intrusion leads to the loss of fresh water vegetation

• Spread of mudflats into previously vegetative areas.



Ghyben-Herzberg Relation:

$$\rho_s g z = \rho_f g (h_f + z)$$



- ρ_f = freshwater density = 1.0g/cm
- ρ_s = saltwater density = 1.025g/c
- z = height of saltwater column
- h_f = hydraulic head above sea level
- $h_f + z$ = height of freshwater column

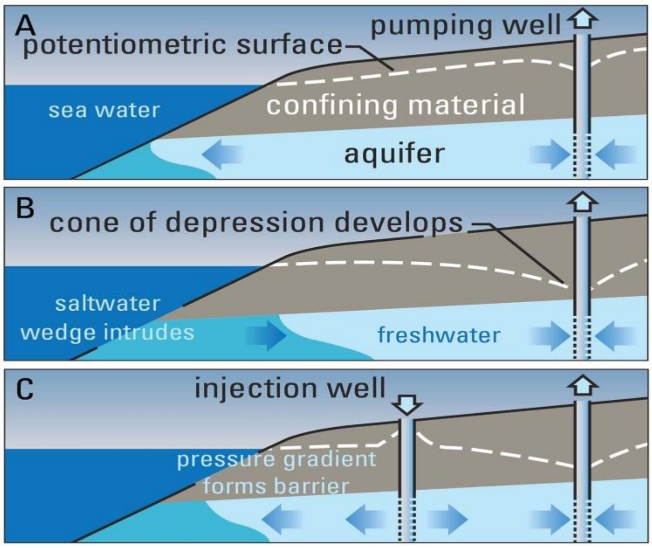
$$z = \frac{\rho_f}{\rho_s - \rho_f} h_f$$

$$z = 40 h_f$$

The Ghysen-Herzberg ratio states that, for every foot of fresh water in an unconfined aquifer above sea level, there will be forty feet of fresh water in the aquifer below sea level. This analysis assumes hydrostatic conditions in a homogeneous, unconfined coastal aquifer. According to this relation, if the water table in an unconfined coastal aquifer is lowered by 1m, the salt-water interface will rise 40 m.

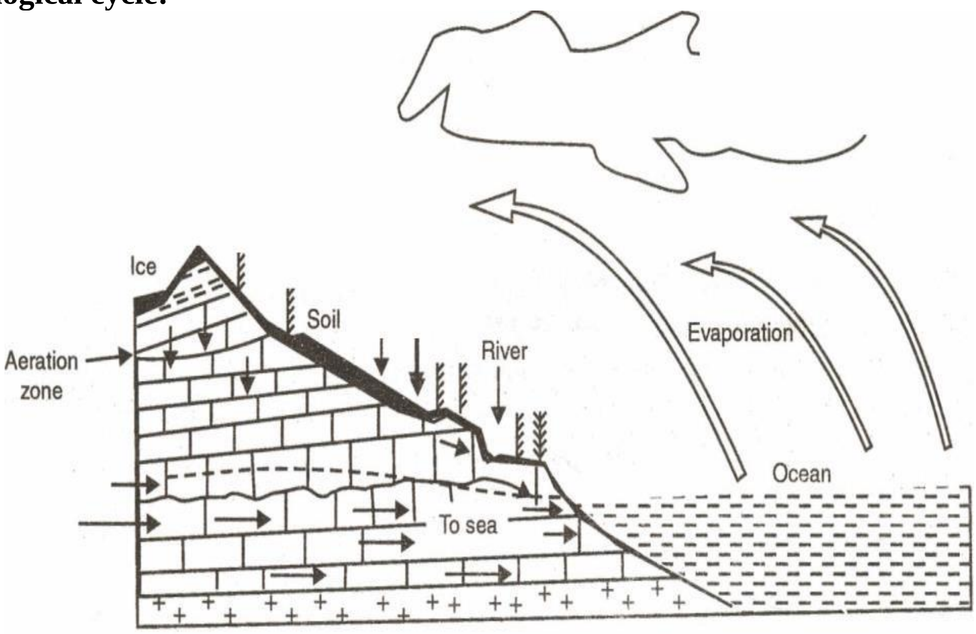
CONTROL AND MANAGEMENT OF SEAWATER INTRUSION:

- Injection Barriers
- Extraction Barriers
- Sub-surface barriers
- Artificial recharging



5 (a)	Explain hydrological cycle with a neat diagram.

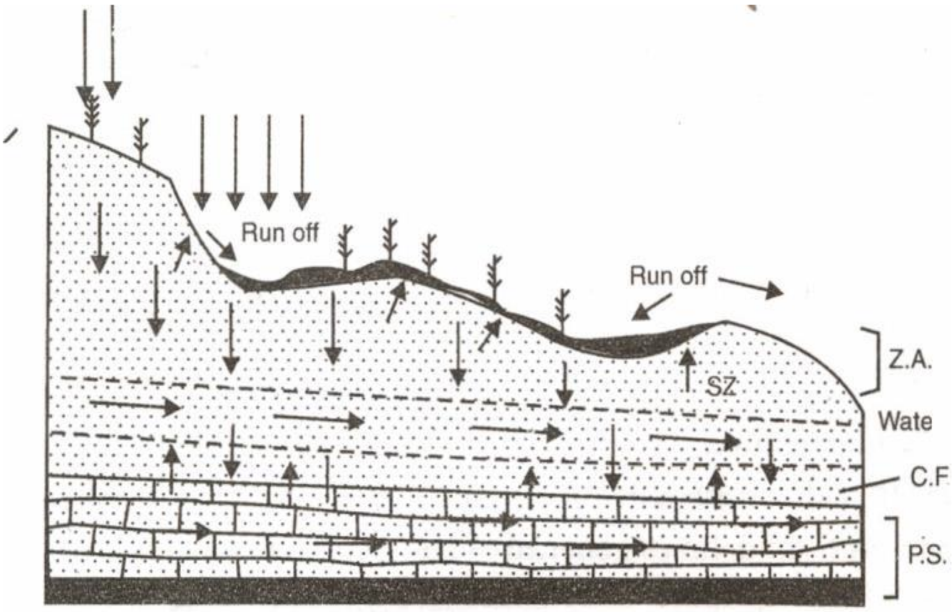
Hydrological cycle:



As we know, water exists on the Earth in three forms: gaseous, liquid and solid. The gaseous is a part of the atmosphere that surrounds the earth and is present in it upto a height of 10-15 km. The liquid water is spread over 70 percent surface of the globe forming huge oceans, seas, rivers, lakes, streams and springs. Included in this category is also the water occurring as an easily-transferable part in plants and other types of vegetation. Similarly, liquid water present in the pores, crevices and variety of openings of soil and rocks below the, surface also makes an important part of this group. The groundwater also moves in many cases to sea through subterranean movement and eventually becomes a part of the water cycle. Thus, essential feature of water cycle are: evaporation (from land and Oceans), condensation and precipitation, return to land and oceans (through interception, run off, infiltration, percolation etc.). Just as a large quantity of water returns from the atmosphere directly to the oceans through precipitation over their vast surface, some water may join atmosphere directly from the land due to evaporation and transpiration. These direct conversions are novelties of the hydrological cycle rather than exceptions to the rule.

5(b) Write a note on zonal distribution of groundwater with a diagram.

Zonal distribution of groundwater:



Zones of Groundwater Z.A = Zone of Aeration; S.Z = Zone of Soil Water; P.S = Zone of (permanent) Saturation; c.p = Capillary fringe.

The soil water forms a thin layer confined to the near surface depth of the land. It may occur at tween 1.0 to 9 meters, and is held up by root zone of vegetable cover and soil chemicals. This 'ery important for the life and growth of the vegetable cover of the globe. It is lost to the 're by transpiration and evaporation.

The intermediate vadose zone occurs immediately below the zone of soil water. It is, in fact a zone of non-saturation: water in this zone is moving downwards under the influence of gravity. It is generally of small thickness and may be even absent in many cases. The above two zones are sometimes collectively referred as zone of aeration.

The zone of capillary water, called capillary fringe is present only in soils and rocks of fine particle size underlying the vadose zone. It is absent in the coarse sediments. In the fine particle size zone, groundwater is drawn upwards by capillary action, sometimes to heights of 2-3 meters above the saturated zone lying underneath. Growth of vegetation observed in some deserts is very often dependent on the presence of the capillary fringe. The cause of rise of water (rather than its downward movement) in the capillaries of fine sediments is the well-known force of surface tension.