**1.Hydrologic cycle**

 water cycle, also known as the hydrologic cycle or the hydrological cycle, describes the continuous movement of water on, above and below the surface of the Earth. The mass of water on Earth remains fairly constant over time but the partitioning of the water into the major reservoirs of ice, fresh water, saline water and atmospheric water is variable depending on a wide range of climatic variables.

* Evaporation

Evaporation is a type of vaporization that occurs on the surface of a liquid as it changes into the gas phase. The surrounding gas must not be saturated with the evaporating substance.

* Condensation

Condensation is the change of water from its gaseous form (water vapor) into liquid water. Condensation generally occurs in the atmosphere when warm air rises, cools and looses its capacity to hold water vapor. As a result, excess water vapor condenses to form cloud droplets.

* Precipitation

Precipitation is any liquid or frozen water that forms in the atmosphere and falls back to the Earth.

* Interception

Interception refers to precipitation that does not reach the soil, but is instead intercepted by the leaves, branches of plants and the forest floor.

* Infiltration

Infiltration is the process by which water on the ground surface enters the soil. It is commonly used in both hydrology and soil sciences.

* Transpiration

Transpiration is the process of water movement through a plant and its evaporation from aerial parts.

* Runoff & Storage

Runoff can be described as the part of the water cycle that flows over land as surface water instead of being absorbed into groundwater or evaporating. Runoff is that part of the precipitation, snow melt, or irrigation water that appears in uncontrolled surface streams, rivers, drains, or sewers.

There are three basic water storage places;

**1.**in atmosphere

**2.**on earth surface

**3.**in the ground

 **Hydrological cycle has been disturbed**

The science community now generally agrees that the Earth's climate is undergoing changes in response to natural variability, including solar variability, and increasing concentrations of greenhous gases and aerosols. Furthermore, agreement is widespread that these changes may profoundly affect atmospheric water vapor concentrations, clouds, precipitation patterns, and runoff and stream flow patterns.

For example, as the lower atmosphere becomes warmer, evaporation rates will increase, resulting in an increase in the amount of moisture circulating throughout the troposphere (lower atmosphere). An observed consequence of higher water vapor concentrations is the increased frequency of intense precipitation events, mainly over land areas. Furthermore, because of warmer temperatures, more precipitation is falling as rain rather than snow.

In parts of the Northern Hemisphere, an earlier arrival of spring-like conditions is leading to earlier peaks in snowmelt and resulting river flows. As a consequence, seasons with the highest water demand, typically summer and fall, are being impacted by a reduced availability of fresh water.

Warmer temperatures have led to increased drying of the land surface in some areas, with the effect of an increased incidence and severity of drought.

 **2.Rainwater Harvesting and Ground water**

 **Sustainability**

* Groundwater Sustainability

Groundwater extraction has facilitated significant social development and economic growth, enhanced food security and alleviated drought in many farming regions. But groundwater development has also depressed water tables, degraded ecosystems and led to the deterioration of groundwater quality, as well as to conflict among water users. The effects are not evenly spread. In some areas of India, for example, groundwater depletion has preferentially affected the poor. Importantly, groundwater in some aquifers is renewed slowly, over decades to millennia, and coupled climate–aquifer models predict that the flux and/or timing of recharge to many aquifers will change under future climate scenarios. Here we argue that communities need to set multigenerational goals if groundwater is to be managed sustainably.

Five Goals for Sustainable Groundwater Management.

1. Protection of groundwater supplies from depletion (Groundwater Quantity)

2. Protection of groundwater quality from contamination (Groundwater Quality)

3. Protection of ecosystem viability (Ecosystems)

4. Achievement of economic and social wellbeing (Socioeconomic)

5. Application of good governance (Governance).

* Rainwater Harvesting

Rainwater harvesting is a type of harvest in which the rain drops are collected and stored for the future use, rather than allowing them to run off. Rainwater can be collected from rivers or roofs and redirected to a deep pit (well, shaft, or borehole), aquifer, a reservoir with percolation, or collected from dew or fog with nets or other tools

Methods of Rainwater Harvesting:

Broadly there are two ways of harvesting rainwater

1)Surface runoff harvesting

2)Roof top rainwater harvesting.

1. Surface runoff harvesting:

In urban area rainwater flows away as surface runoff. This runoff could be caught and used for recharging aquifers by adopting appropriate methods.

Methods of Surface Runoff Harvesting

* Surface spreading Method.
* Recharge Well Method
* Induced Recharge Method

2. Rooftop rainwater harvesting:

It is a system of catching rainwater where it falls. In rooftop harvesting, the roof becomes the catchments, and the rainwater is collected from the roof of the house/building. It can either be stored in a tank or diverted to artificial recharge system. This method is less expensive and very effective and if implemented properly helps in augmenting the groundwater level of the area.

Methods of Rooftop Rainwater Harvesting

Various methods of using roof top rainwater harvesting are illustrated in this section.

Storage of Direct Use.

* Recharging groundwater aquifers
* Recharging of bore wells
* Recharge pits
* Soak way or Recharge shafts
* Recharging of dug wells
* Recharge trenches
* Percolation tank

 **3.Quality Parameters for Water supply Design System**

A water supply network or water supply system is a system of engineered hydrologic and hydraulic components which provide water supply. A water supply system typically includes:

A drainage basin (see water purification - sources of drinking water).

A raw water collection point (above or below ground) where the water accumulates, such as a lake, a river, or groundwater from an underground aquifer. Raw water may be transferred using uncovered ground-level aqueducts, covered tunnels or underground water pipes to water purification facilities.

Water purification facilities. Treated water is transferred using water pipes (usually underground).

Water storage facilities such as reservoirs, water tanks, or water towers. Smaller water systems may store the water in cisterns or pressure vessels. Tall buildings may also need to store water locally in pressure vessels in order for the water to reach the upper floors.

Additional water pressurizing components such as pumping stations may need to be situated at the outlet of underground or above ground reservoirs or cisterns (if gravity flow is impractical).

QUALITY PARAMETER FOR DESIGN WATER SUPPLY SYSTEM.

1. Water consumption rate (Per Capita Demand in liters per day)

2. Population to be served

Water Demand = Per capita demand x Population

PER CAPITA DEMAND (RATE OF DEMAND) (Q).

It is the annual average amount of daily water required by one person and includes the domestic use, industrial and commercial use, public use, wastes, thefts, etc.

Per capita Demand in liters/day/head =Total yearly water requirement of the city in Liters / 365xDesign population.

 Q=V/365P

For an Average As per I.S recommendations the per capita demand may be taken as given in table below.

of the design period shall give the total annual average water requirement of the city/day. When multiplied by 365 will give the volume of the yearly water requirement in liters.

FACTORS AFFECTING PER CAPITAL DEMAND

1. Size and type of city

2. Climatic conditions

3. Class of consumers

4. Quality of water

5. Pressure in the distribution system

6. Sewerage Facilities

7. System of supply

8. Policy of metering system

9. Cost of water.

Population Forecasting

The design population is estimated with due to all factors governing the future growth and development of the project area in the industrial, commercial, educational, social and administrative spheres. Design of water supply and sanitation scheme is based on the projected population of a city or town and estimate the design period of the components of all structures of water supply and sanitation are depends on projection of population. Changes in the population of the city over the years occur, and the system should be designed considering of the population at the end of the design period.

Factors affecting changes in population

* Increase due to births
* decrease due to deaths
* Increase/ decrease due to migration
* Increase due to annexation
* change (in education, politics, recreation and economic).
* increase in facilities of transport system.

Methods of Population Forecasting.

* Arithmetic progressive method,
* Incremental increase method,
* Geometric progression method and
* Exponential growth rate methods.
* Comparative Graphical Method
* Simple Graphical Method