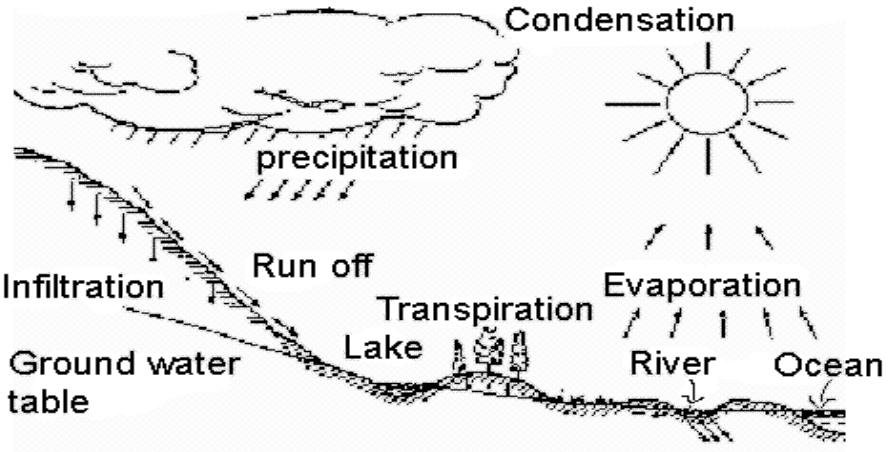
APES Review - Water

Water Cycle:

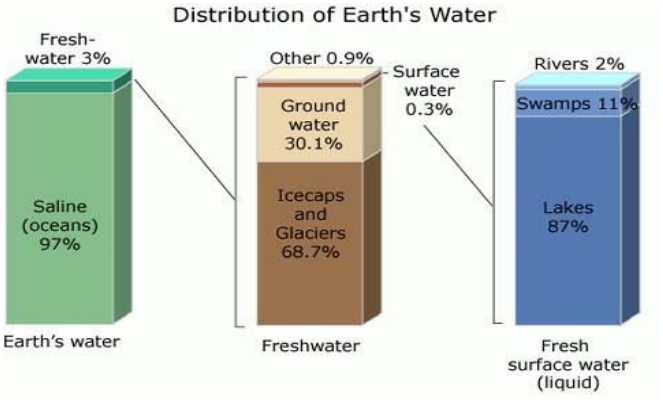
The Oceans hold 97% of all water on the planet and they are the source of 78% of all global precipitation. Oceans are the source of 86% of all global evaporation. The water cycle is actually powered by energy from the sun. The water cycle is in a state of dynamic equilibrium, the rate of evaporation is equal to the rate of precipitation. Warm air holds more water than cold. Some of the processes of the water cycle includes evaporation, evapotranspiration, condensation, infiltration, runoff, and precipitation.



(↑This is a diagram of the water cycle↑)

Global Water:

Over 70% of the Earth's surface is covered by water. The ocean holds about 97% of all water, which leaves the 3% to be freshwater. Most of the freshwater lives inside of glaciers and ice caps. The rest is found in descending order: groundwater, lakes, soil moisture, atmospheric moisture, rivers, and streams.

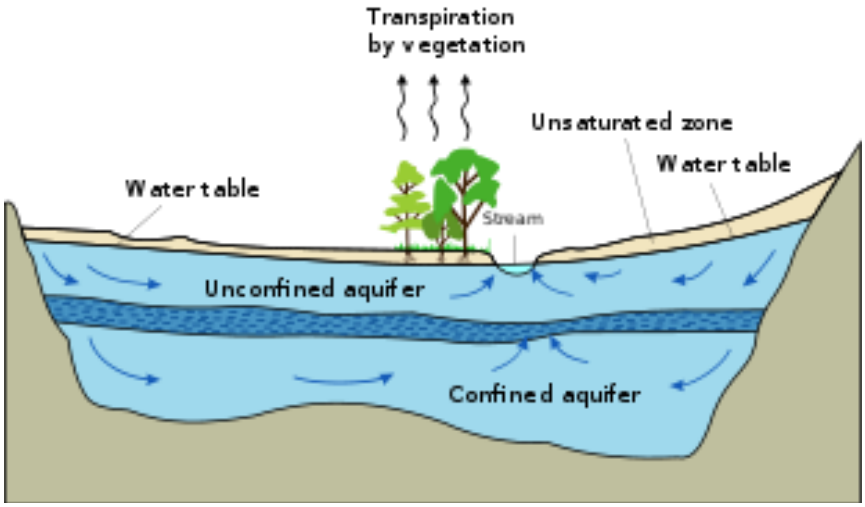


<u>Water has many special properties, some of which are:</u>

- Strong hydrogen bonds hold water molecules to each other
- Water has a high boiling point
- A lot of energy is needed to evaporate water
- The temperature of water changes slowly due to its specific heat capacity
- Water dissolves many compounds
- Water expands when it freezes
- Water adheres to many solid surfaces
- Water filters out harmful UV radiation in aquatic ecosystems

Freshwater:
The highest per capita supplies of freshwater are in countries with high precipitation and small populations (like Norway and Iceland). Some of the lowest Per capita (Egypt and Israel) have little rainfall and large populations. The use of freshwater, which is limited, is growing at twice the rate of population growth and the average amount of freshwater use in the US per person is approximately 500,000 gallons per year.

Aquifers:
Aquifer - a geologic formation that contains water in quantities sufficient to support a well or spring. In the United States, aquifers hold 30 times more water than all US lakes and rivers combined with groundwater supplying almost 40% of all freshwater. **Some important terms to know regarding aquifers are:** Confined aquifer, recharge zone, unconfined aquifer, unsaturated zone, water permeability, and water table.

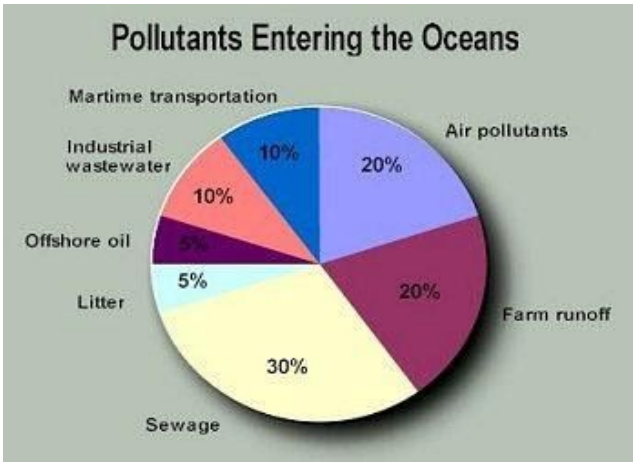


The World's largest aquifer is the Ogallala Aquifer which is located in the central United States. It underlies portions of eight states and contains water from the time of the last glaciation (12,000-1.2 million years ago). The biggest users of water from the aquifers include agricultural irrigation and oil, natural gas, and coal extractions and that is estimated to take about 10% of annual withdrawals from the aquifers. Water that enters an aquifer remains there for approximately 1,400 years compared with 16 days from water entering a river system. Once an aquifer is contaminated it is

practically impossible to remove the pollutants (this leads to groundwater pollution).

Water pollution:

Water pollution is the contamination of water bodies. This is a form of environmental degradation that occurs when pollutants are directly or indirectly discharged into water bodies without adequate treatment to remove any harmful compounds.



Groundwater pollution is a huge issue. More than 50% of the people in the US depend on groundwater for their water supply, some countries even reaching 95%. The EPA estimates that each day, over a trillion gallons of contaminated water seeps into groundwater supplies just in the United States. Over 9 billion gallons, or 60% of the most hazardous liquid waste solvents, heavy metals, and radioactive materials, are injected directly into deep groundwater via thousands of injection wells.

Water Quality-Water Testing:

Water quality refers to the chemical, physical, and biological characteristics of water.It is a measure of the condition of water relative to the requirements of it. Water testing is the description for various procedures that are used to analyze water quality. The Water Quality Index (WQI) a series of tests are used to identify the quality of a sample of water.

Parameters	Water quality standard	Assigned weight (AW)	Relative weight (RW)
pH (pH unit)	6.5-8.5 (8.0)	2.1	0.095023
DO (mg/L)	5.0	4.0	0.180995
Turbidity (NTU)	5.0	2.4	0.108597
Conductivity (µS/cm)	250.0	2.7	0.122172
Hardness (mg/L)	100.0	1.1	0.049774
Alkalinity (mg/L)	100.0	1.6	0.072398
Na (mg/L)	200.0	1.0	0.045249
BOD (mg/L)	5.0	3.0	0.135747
NO_3 (µg/L)	50.0	2.2	0.099548
NO_2 (µg/L)	3.0	2.0	0.090498
Total		22.1	1.0

The WQI was developed as a tool to measure the parameters most likely to affect the health of aquatic ecosystems. Once the measurements are made, a score is calculated that may be used in management decisions.

Water quality testing may be used to evaluate: - the ability of a surface water body to support aquatic life as an ecosystem - the water treated at a municipal water purification plant - the characteristics of a water source before treatment for drinking water - the sustainability of water for industrial uses (like in labs,

manufacturing facilities, or equipment cooling)- the characteristics of polluted water before treatment or after treatment.

Parameter	Description/ How It Is Tested	Desired Results	Environmental Significance
Dissolved oxygen (DO)	The amount of oxygen dissolved in a sample of water. Tested with a variety of methods, including Winkler titration and digital probes. *Note:* The temperature of the water is important. Cold water has a higher capacity to hold DO than does warmer water.	High DO readings, usually in the range of 7–9 ppm or above, are best. Few fish can survive in water of less than 3 DO ppm. Low DO levels put aquatic organisms at risk of hypoxia (lack of oxygen).	All aerobic organisms require oxygen for cellular respiration. Aquatic organisms rely on oxygen dissolved in the water to satisfy this need. DO is higher in flowing water due to interaction between the surface water and oxygen dissolved in atmospheric air.
Biological oxygen demand (BOD)	Samples of water are taken in clear bottles. One is darkened to prevent sunlight from entering; one is left open to light penetration. After a set period of time, the difference in dissolved oxygen in the two bottles is used to determine the BOD.	Lower BOD. ratings are best. Most healthy aquatic ecosystems have a BOD of less than 10 ppm.	Closely related to DO testing, BOD indicates the levels of aerobic bacterial activity in a water sample. High BOD signals that there is a source of organic material to feed decomposing bacteria and encourage their population growth.
pH	A measure of the acidity or alkalinity of water. Using pH indicator paper, pH solution, or a digital probe.	Most aquatic organisms prefer a pH near neutral (7). The pH scale is logarithmic, meaning that a pH of 6 is 10 times more acidic than a pH of 7. (A pH of 5 is 100 times more acidic than 7!)	Low pH may indicate acid deposition and have harmful effects on aquatic life.
Hardness/ alkalinity	Alkalinity is a measurement of the buffering capacity of water; it is the ability of a body of water to neutralize acids without changing the pH of the water. Hardness is a measurement of the concentration of metal ions like Ca^{+} and Mg^{+}.	Higher alkalinity is good in aquatic ecosystems; it acts as a buffer against pH drops from acid deposition. Zero to 60 ppm is soft water; above 60 ppm is in the hard-water range.	Alkalinity is associated with hard water because the calcium and magnesium ions that make water "hard" are great acid buffers. Hard water is mostly a problem in domestic use. It can leave behind cloudy deposits on glassware and requires more detergents to wash clothes or dishes.

Parameter	Description/ How It Is Tested	Desired Results	Environmental Significance
Turbidity/ total suspended solids (TSS)	In the field, a Secci disc is lowered into the water until it can no longer be clearly seen. In the lab, a spectrometer is used.	Low turbidity is best.	Turbid water has low visibility. As turbidity increases, the euphotic zone decreases because sunlight is blocked from penetrating deeper water by the suspended particles in the water.
Fecal coliform	A sample of the water is placed in a culture dish and incubated to see if any fecal coliform bacteria colonies grow.	Zero colonies Presence of fecal coliform in a water sample is an indication that the water is likely to be contaminated by mammal or bird feces.	Although these bacteria are not harmful by themselves, they are indicators of the presence of feces, which may carry a host of pathogens that *are* harmful to human health, such as viruses, parasites, and harmful bacteria.

Sewage Treatment:

Sewage treatment incorporates physical, chemical, and biological processes to remove contaminants from wastewater. The process that sewage treatment facilities use is to turn water that is unsuitable for its most recent use, into an effluent that can be either returned to the water cycle with minimal environmental issues or reused. If wastewater is predominantly from municipal sources (households and such), it is called sewage, and its treatment is called sewage treatment.

Primary Treatment - PHYSICAL SEPARATION

Primary treatment removes large objects such as cans, leaves, plastic bottles, and rags by filtering, screening, or nets. Smaller materials, like sand and fecal materials, are removed by using a settling tank. During that process, fats, oils, and grease are allowed to float to the top and can be mechanically screened off.

Secondary Treatment - BIOLOGICAL TREATMENT

Secondary treatment is designed to substantially degrade the organic and biological content of the sewage. Dissolved or suspended material is brought into contact with oxygen in the presence of aerobic and anaerobic microorganisms to break down and consume organic matter. It is then moved into another stage that includes floc removal.

Tertiary Treatment - CHEMICAL TREATMENT

Disinfection happens during this stage that destroys any pathogens. Chlorine, ozone, UV, bromine, hydrogen peroxide, and chloramines are used to disinfect. Soluble phosphates are removed by various precipitating chemicals and PAO's (polyphosphate-accumulating organisms) can also be added at this stage. Nitrates and ammonia are removed through denitrifying bacteria in an anaerobic microbial digester.