

Water Supply

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Water and Health

- 80% of sickness in the world is caused by inadequate water supply or sanitation
- 40% of the world population does not have access to safe drinking water
- It is estimated that water-borne diseases kill 25,000 people per day
- In many populated areas of the world, water-borne diseases represent the leading cause of death

Water Types

- **Fresh Water:** may come from either a surface or ground source, and typically contains less than 1% sodium chloride. It may be either "hard" or "soft," i.e., either rich in calcium and magnesium
- **Brackish Water:** contains between 1 and 2.5% sodium chloride, either from natural sources around otherwise fresh water or by dilution of seawater.
- **Seawater:** typically contains about 3.5% sodium chloride, although the salinity may be weakened in some areas by dilution with fresh water or concentrated by solar evaporation in others. Seawater is normally more corrosive than fresh water because of the higher conductivity and the penetrating power of the chloride ion through surface films on a metal.
- **Distilled or Demineralized Water:** The total mineral content of water can be removed by either distillation or mixed-bed ion exchange.
- **Potable Water:** it is fresh water that is sanitized with oxidizing biocides such as chlorine or ozone to kill bacteria and make it safe for drinking purposes.

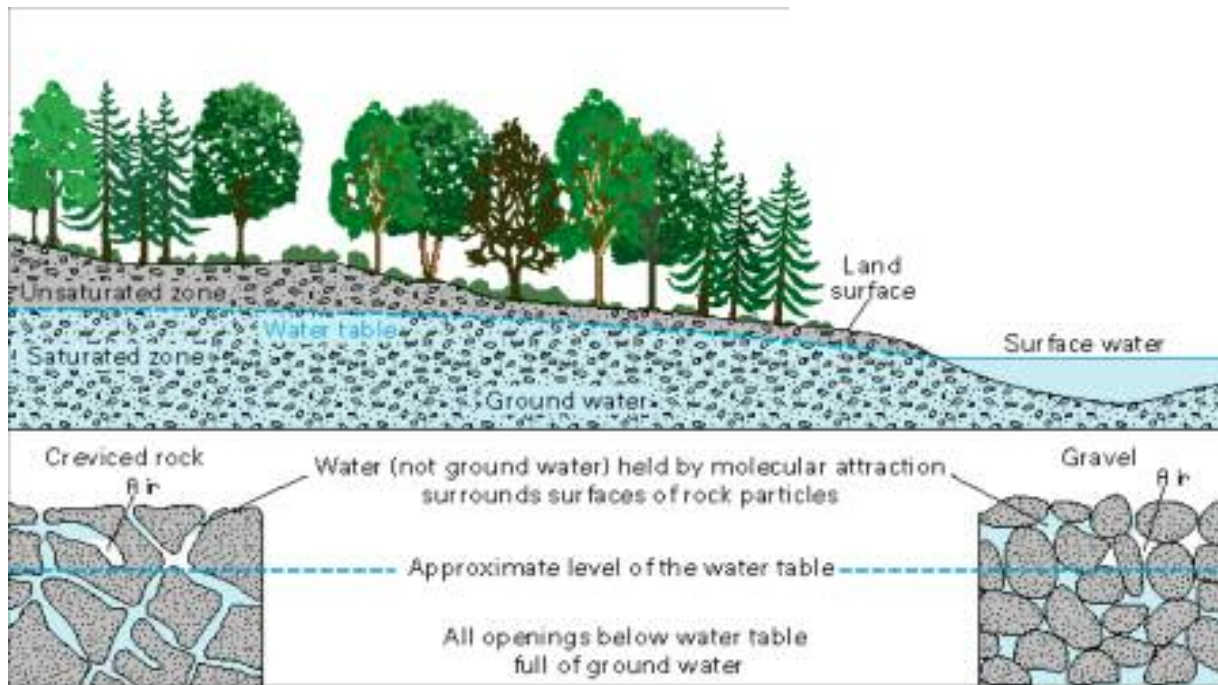
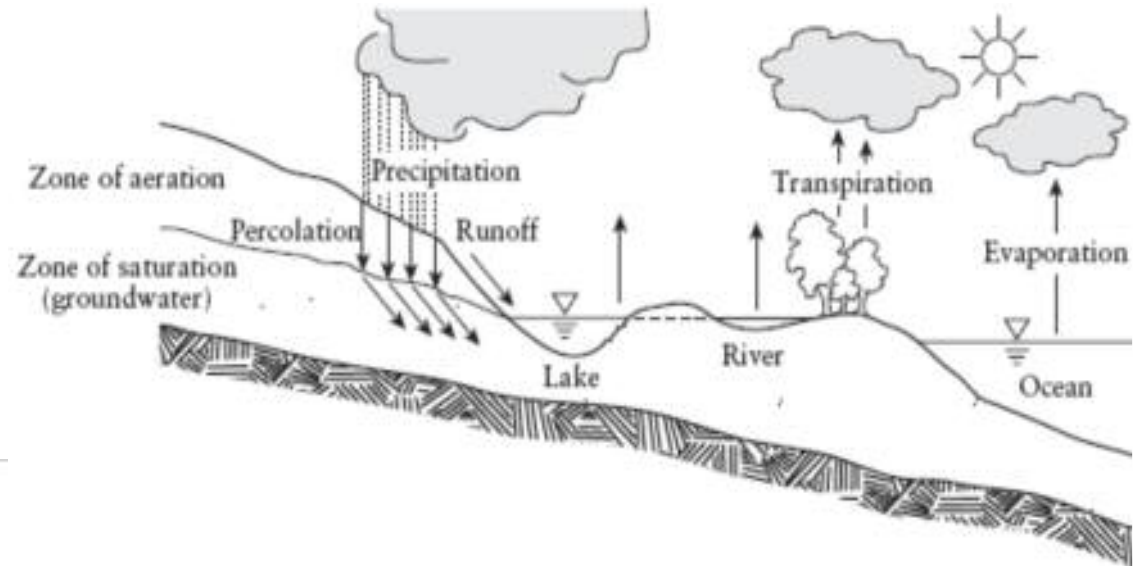
Saline in Water

- drinking water : *100 ppm*
- restriction on drinking water : *500 ppm*
- fresh water - limit drinking water : *1000 ppm*
- limit agriculture irrigation : *2000 ppm*
- brackish water, mildly : *1000 - 5,000 ppm*
- brackish water, moderately : *5000 - 15,000 ppm*
- brackish water, heavily : *15,000 - 35,000 ppm*
- sea water : *30,000 - 50,000 ppm (approx. 35,000)*
- brine > *50.000 ppm*

Sources of Drinking Water

■ Groundwater

- shallow wells
- deep wells



■ Surface water

- rivers
- lakes
- reservoirs

Ground-vs. Surface Water

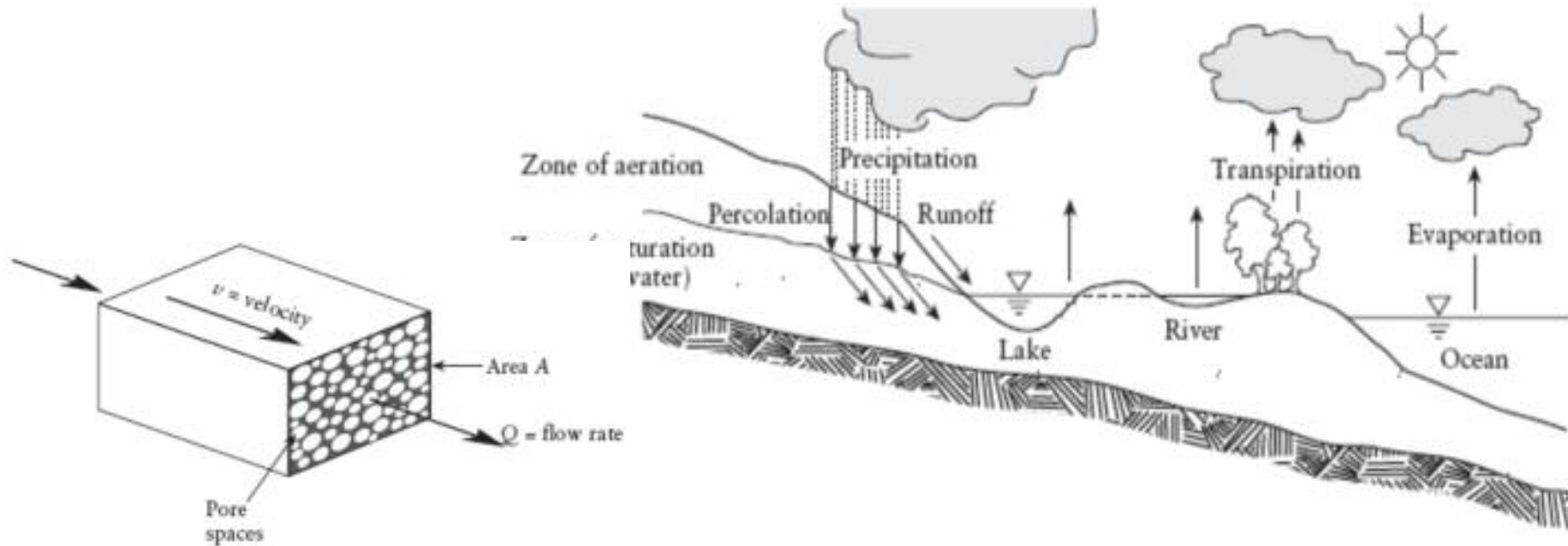
Groundwater

- ✓ constant composition
- ✓ high mineral content
- ✓ low turbidity
- ✓ low color
- ✓ low or no D.O.
- ✓ high hardness
- ✓ high Fe, Mn

Surface water

- ✓ variable composition
- ✓ low mineral content
- ✓ high turbidity
- ✓ colored
- ✓ D.O. present
- ✓ low hardness
- ✓ taste and odor

Groundwater Supplies



$$\text{Porosity} = \frac{\text{Volume of voids}}{\text{Total volume}}$$

$$\text{Specific yield} = \frac{\text{Volume of water that will drain freely from a soil}}{\text{Total volume of water in the soil}}$$

Aquifer Material	Porosity (%)	Specific Yield (%)	Coefficient of Permeability (m/s)
Clay	55	3	1×10^{-6}
Loam	35	5	5×10^{-6}
Fine sand	45	10	3×10^{-5}
Medium sand	37	25	1×10^{-4}
Coarse sand	30	25	8×10^{-4}
Sand and gravel	20	16	6×10^{-4}
Gravel	25	22	6×10^{-3}

Source: Adapted from Davis, M., and D. Cornwell. 1991. *Introduction to Environmental Engineering*. New York: McGraw-Hill. The McGraw-Hill Companies, Inc.

Surface Water Supplies

- The surface water is only 1.5% of the total fresh water and most of the fresh water is the ground water.

Potable Water

- Potable water is water that has been treated and disinfected so that it is free from disease-producing organisms, poisonous substances, chemical or biological agents, and radioactive contaminants which make it unfit for human consumption or other uses (safe to drink).
- Not necessarily aesthetically pleasing.
- Potability affected by microbes (e.g. *Guardia*, *Cryptosporidium*), organic chemicals (e.g., chlordane, disinfection by-products), heavy metals (e.g., cadmium, copper, lead, mercury) and radionuclides.

Palatable Water

- Palatable water is water that is pleasing in appearance and taste.

“Undoubtedly, you have tasted water which have had some unpleasant tastes or odors but were drinkable”

➤ Tastes and odors in water can be traced to a number of factors:

- ✓ decaying organic matter;
- ✓ living organisms;
- ✓ iron, manganese and the metallic products of corrosion;
- ✓ industrial waste pollution from substances such as phenol;
- ✓ chlorination;
- ✓ high mineral concentrations;
- ✓ dissolved gases.

Palatable water need not always be potable!

Palatable and Potable

- The goal of municipal water treatment is to provide water that is both palatable and potable
- Palatability and Potability regulated under Safe Drinking Water Act

Palatability: Secondary Maximum Contaminant Levels (SMCLs)

Potability: Primary Maximum Contaminant Levels (MCLs) -(for systems serving more than 25 persons per day for greater than 60 days per year)

MCLs For Drinking Water

Parameter	Primary MCL	Secondary MCL	Potential Effects
Alkalinity	None	None	Alkalinity is influenced by local rock type and reflects the chemical properties of dissolved constituents.
Arsenic	0.01 mg/l	None	Arsenic is a carcinogen.
Barium	2 mg/l	None	Can cause increase in blood pressure.
Cadmium	0.005 mg/l	None	Can cause liver damage.
Calcium	None	None	
Chromium	0.1 mg/l	None	Can cause allergic dermatitis.
Chloride	250 mg/l	None	Chloride can affect taste, and can indicate salt water intrusion.
Copper	1.3 mg/l	1.0 mg/l	In large doses, copper is dangerous to infants and people with certain metabolic disorders. However, lack of copper intake causes anemia, growth inhibition, and problems with blood circulation.
Fluoride	4.0 mg/l	2.0 mg/l	Fluoride in concentrations above 4 mg/l can cause skeletal damage. Fluoride in concentrations above 2 mg/l can cause staining.
Hardness	None	None	Indicates the presence of dissolved ions in water.
Iron	None	0.30 mg/l	Iron may contribute to bad taste, pipe clogging, and clothes, tub, sink, and teeth staining.
Lead	0.015 mg/l (action level)	None	Lead can cause neurological and physical problems, especially in young children.
Magnesium	None	None	
Manganese	None	0.05 mg/l	In large doses, manganese can cause headaches, apathy, irritability, insomnia, and weakness of the legs. Long-term heavy exposure may result in nervous-system disorders.
Mercury	0.002 mg/l	None	Can cause kidney damage.
Nitrate	10.0 mg/l	None	Nitrates and Nitrites can cause shortness of breath and "blue baby syndrome" in children under the age of 6 months.
Nitrite	1.0 mg/l	None	Nitrites and Nitrates can cause shortness of breath and "blue baby syndrome" in children under the age of 6 months.
pH	None	6.5-8.5	Low pH (less than 6.5) can contribute to the corrosiveness of water and can allow leaching of impurities from pipes into drinking water.
Selenium	0.05 mg/l	None	Too much selenium can cause hair or fingernail loss, numbness in fingers or toes, and circulatory problems.
Silver	None	0.10 mg/l	Silver can cause skin discoloration (Argyria) if ingested. Additionally, silver is used as an antibacterial agent in home water treatment systems.
Sodium	None	None	Water softeners can contribute to the level of sodium in water.
Zinc	None	5.0 mg/l	More than 5.0 mg/l causes a metallic bitter taste and 25 – 40 mg/l may cause nausea and vomiting.