

Prentice Hall

EARTH SCIENCE



Tarbuck ♦ Lutgens

Running Water and Groundwater

Running Water

The Water Cycle

- ◆ Water constantly moves among the oceans, the atmosphere, the solid Earth, and the biosphere. This unending circulation of Earth's water supply is the **water cycle**.

Running Water

The Water Cycle

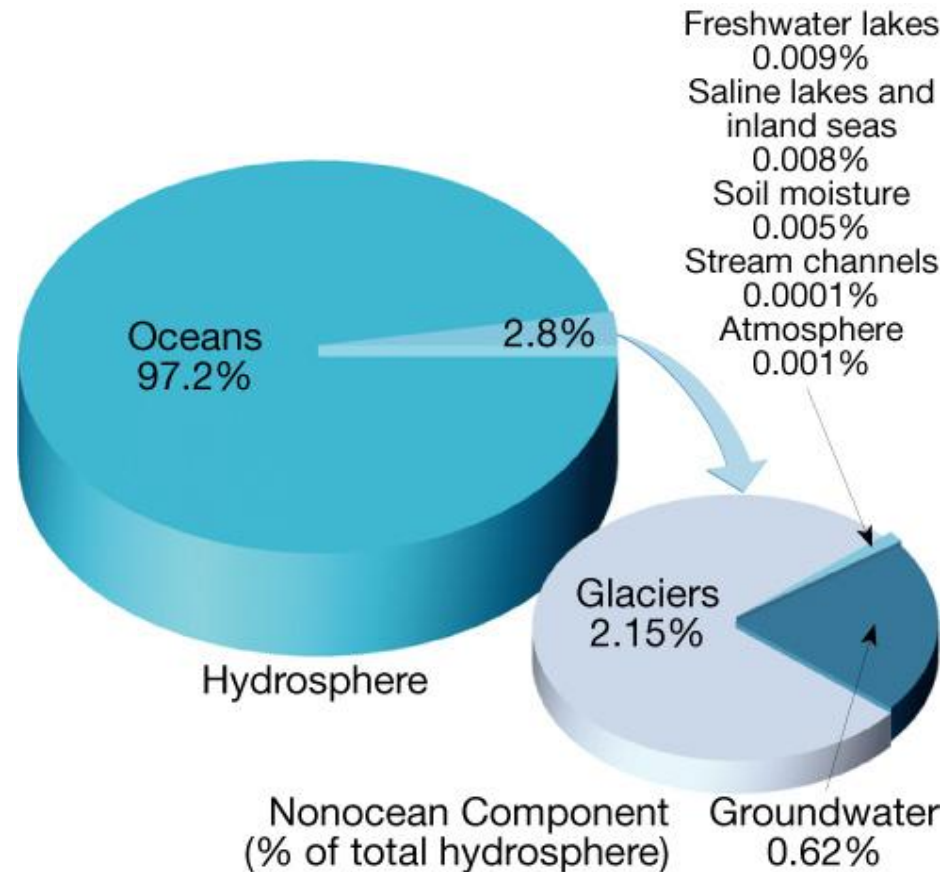
- ◆ Processes involved in the cycle are
 - precipitation
 - evaporation
 - **infiltration**—the movement of surface water into rock or soil through cracks and pore spaces
 - runoff
 - **transpiration**—the release of water into the atmosphere from plants through the ground

Running Water

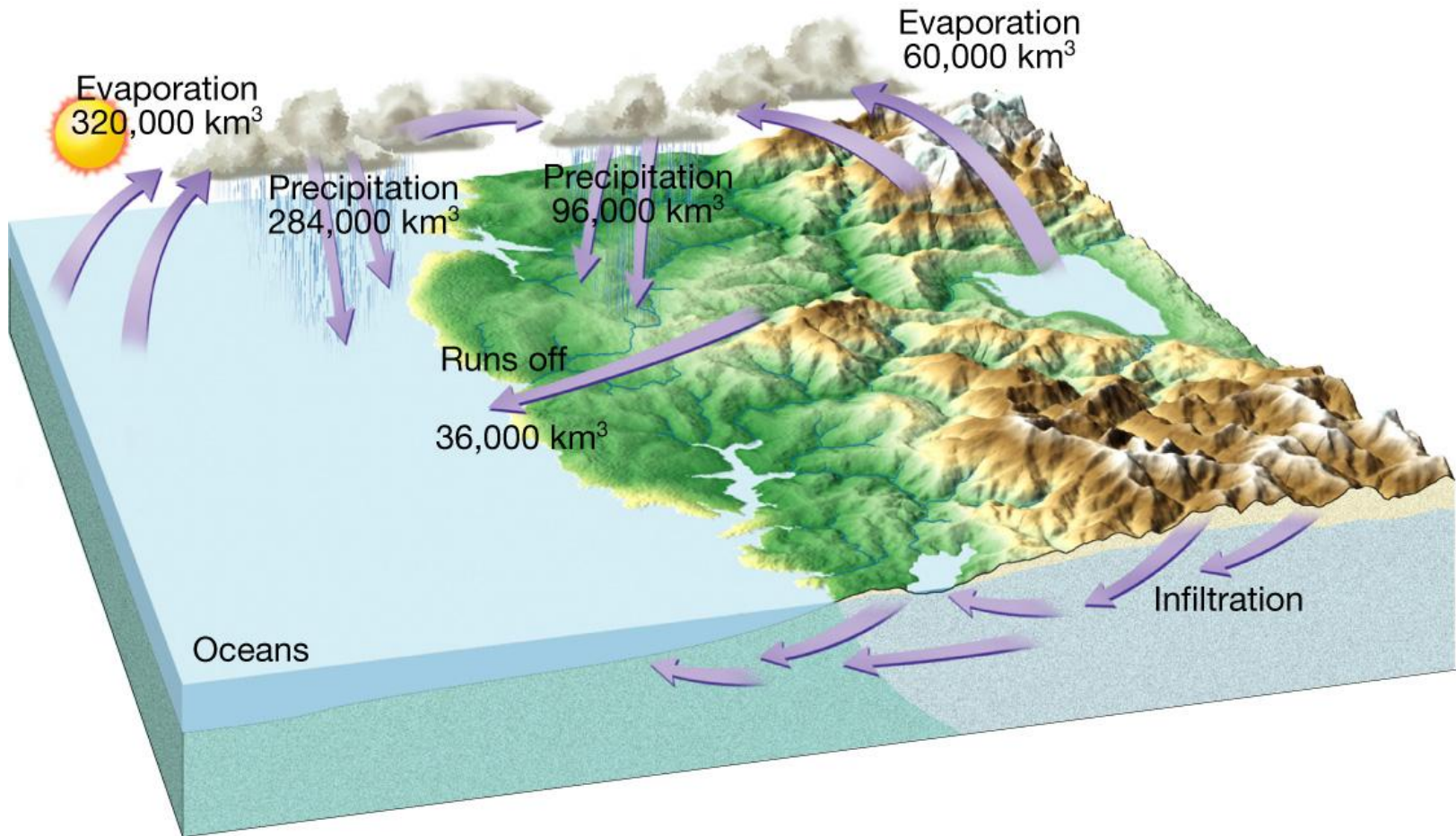
Earth's Water Balance

- ◆ Balance in the water cycle means the average annual precipitation over Earth equals the amount of water that evaporates.

Distribution of Earth's Water



The Water Cycle



Running Water

Streamflow

- ◆ The ability of a stream to erode and transport materials depends largely on its velocity.
 - **Gradient** is the slope or steepness of a stream channel.

Running Water

Streamflow

- Channel Characteristics
 - The **stream channel** is the course the water in a stream follows.
 - Shape, size, and roughness
- **Discharge** of a stream is the volume of water flowing past a certain point in a given unit of time.

Running Water

Changes from Upstream to Downstream

- ◆ While gradient decreases between a stream's headwaters and mouth, discharge increases.
- ◆ Profile
 - Cross-sectional view of a stream
 - From head (source) to mouth
 - Profile is a smooth curve
 - Gradient decreases from the head to the mouth

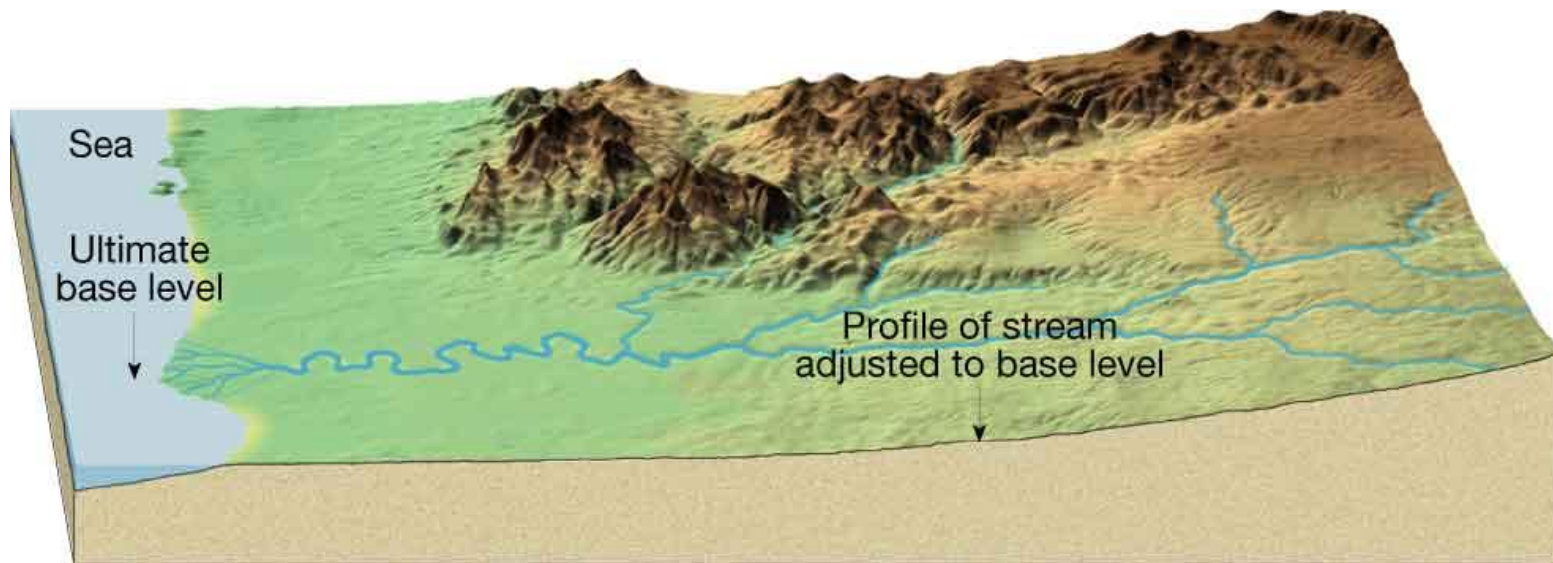
Running Water

Changes from Upstream to Downstream

◆ Profile

- A **tributary** is a stream that empties into another stream.
- Factors that increase downstream
 - velocity
 - discharge
 - channel size

Sea Level and Streams



Running Water

Changes from Upstream to Downstream

◆ Profile

- Factors that decrease downstream include
 - gradient, or slope
 - channel roughness

Rivers with Many Meanders



Running Water

Changes from Upstream to Downstream

◆ Base Level

- Lowest point to which a stream can erode
- Two general types
 - ultimate—sea level
 - temporary, or local
- A stream in a broad, flat-bottomed valley that is near its base level often develops a course with many bends called **meanders**.

The Work of Streams

Erosion

- ◆ Streams generally erode their channels, lifting loose particles by abrasion, grinding, and by dissolving soluble material.

The Work of Streams

Deposition

- ◆ A stream's **bedload** is solid material too large to carry in suspension.
- ◆ The **capacity** of a stream is the maximum load it can carry.
- ◆ Deposition occurs as streamflow drops below the critical settling velocity of a certain particle size. The deposits are called **alluvium**.
- ◆ **Deltas** are an accumulation of sediment formed where a stream enters a lake or ocean.
- ◆ A **natural levee** parallels a stream and helps to contain its waters, except during floodstage.

The Work of Streams

Stream Valleys

◆ Narrow Valleys

- A narrow V-shaped valley shows that the stream's primary work has been downcutting toward base level.
- Features often include
 - rapids
 - waterfalls

The Yellowstone River Is an Example of a V-Shaped Valley



The Work of Streams

Stream Valleys

◆ Wide Valleys

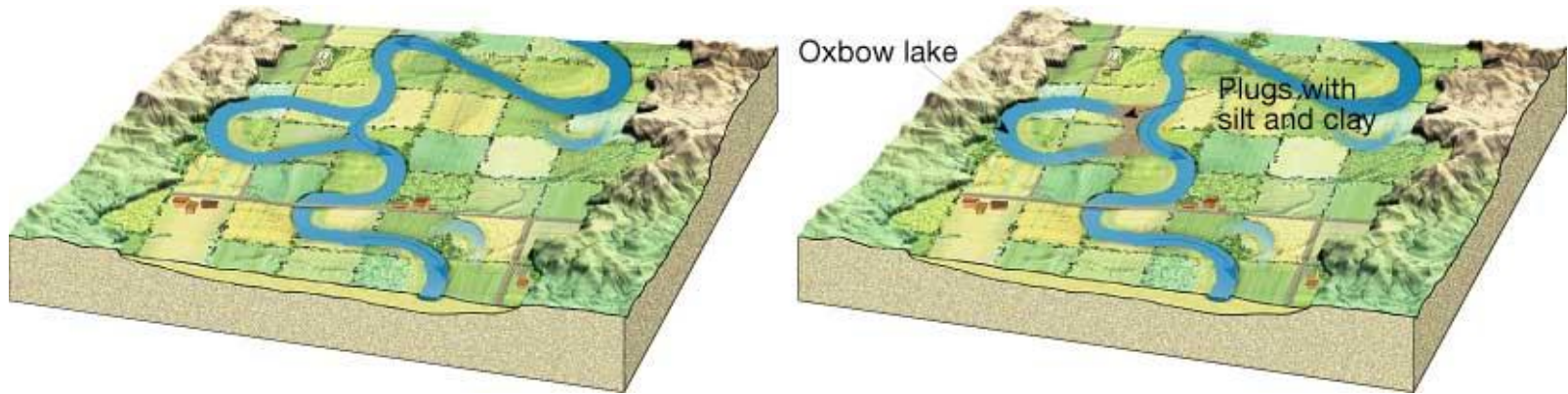
- Stream is near base level.
 - Downward erosion is less dominant.
 - Stream energy is directed from side to side.
- The **floodplain** is the flat, low-lying portion of a stream valley subject to periodic flooding.

The Work of Streams

Stream Valleys

- ◆ Wide Valleys
 - Features often include
 - meanders
 - cutoffs
 - oxbow lakes

Formation of a Cutoff and Oxbow Lake



The Work of Streams

Floods and Flood Control

- ◆ A **flood** occurs when the discharge of a stream becomes so great that it exceeds the capacity of its channel and overflows its banks.
- ◆ Measures to control flooding include artificial levees, flood control dams, and placing limits on floodplain development.

Ohio River Flooding



The Work of Streams

Drainage Basins

- ◆ A **drainage basin** is the land area that contributes water to a stream.
- ◆ A **divide** is an imaginary line that separates the drainage basins of one stream from another.

Water Beneath the Surface

Distribution and Movement of Water Underground

- ◆ Much of the water in soil seeps downward until it reaches the zone of saturation.
- ◆ The **zone of saturation** is the area where water fills all of the open spaces in sediment and rock.
 - **Groundwater** is the water within this zone.
 - The **water table** is the upper level of the saturation zone of groundwater.

Water Beneath the Surface

Distribution and Movement of Water Underground

◆ Movement

- Groundwater moves by twisting and turning through interconnected small openings.
- The groundwater moves more slowly when the pore spaces are smaller.

Water Beneath the Surface

Distribution and Movement of Water Underground

◆ Movement

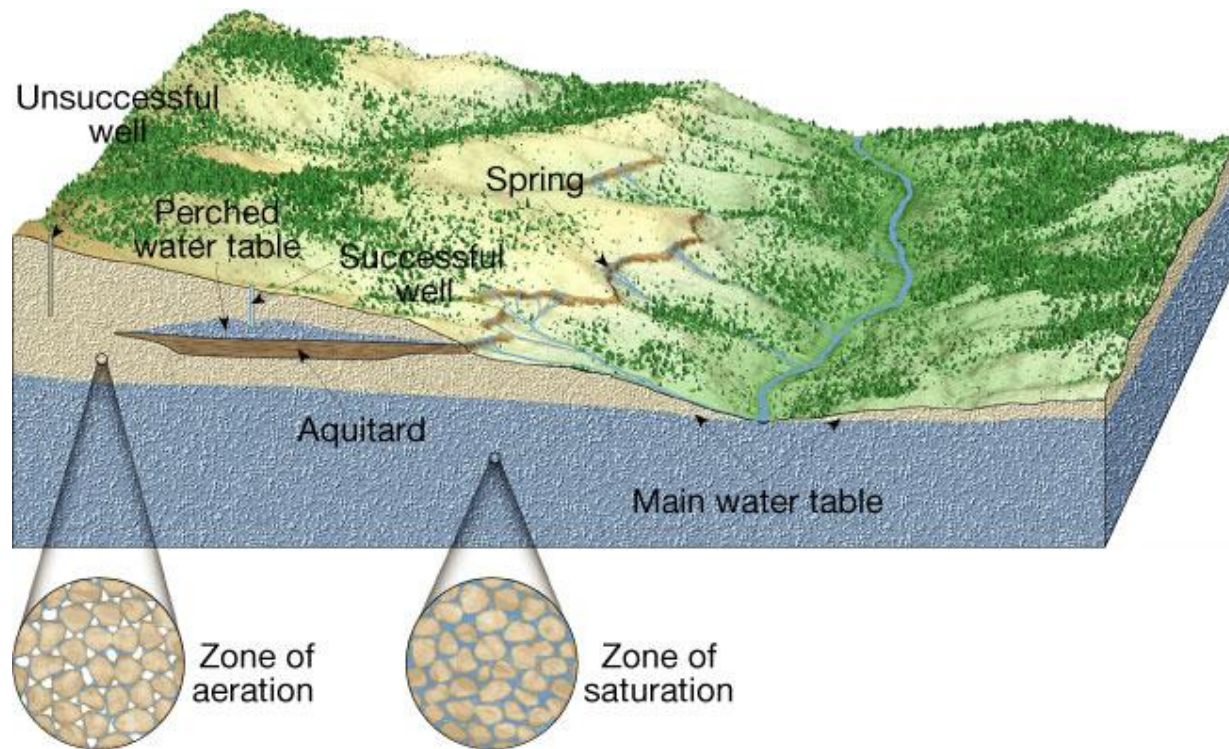
- **Porosity**

- The percentage of pore spaces
- Determines how much groundwater can be stored

- **Permeability**

- Ability to transmit water through connected pore spaces
- **Aquifers** are permeable rock layers or sediments that transmit groundwater freely

Features Associated with Subsurface Water

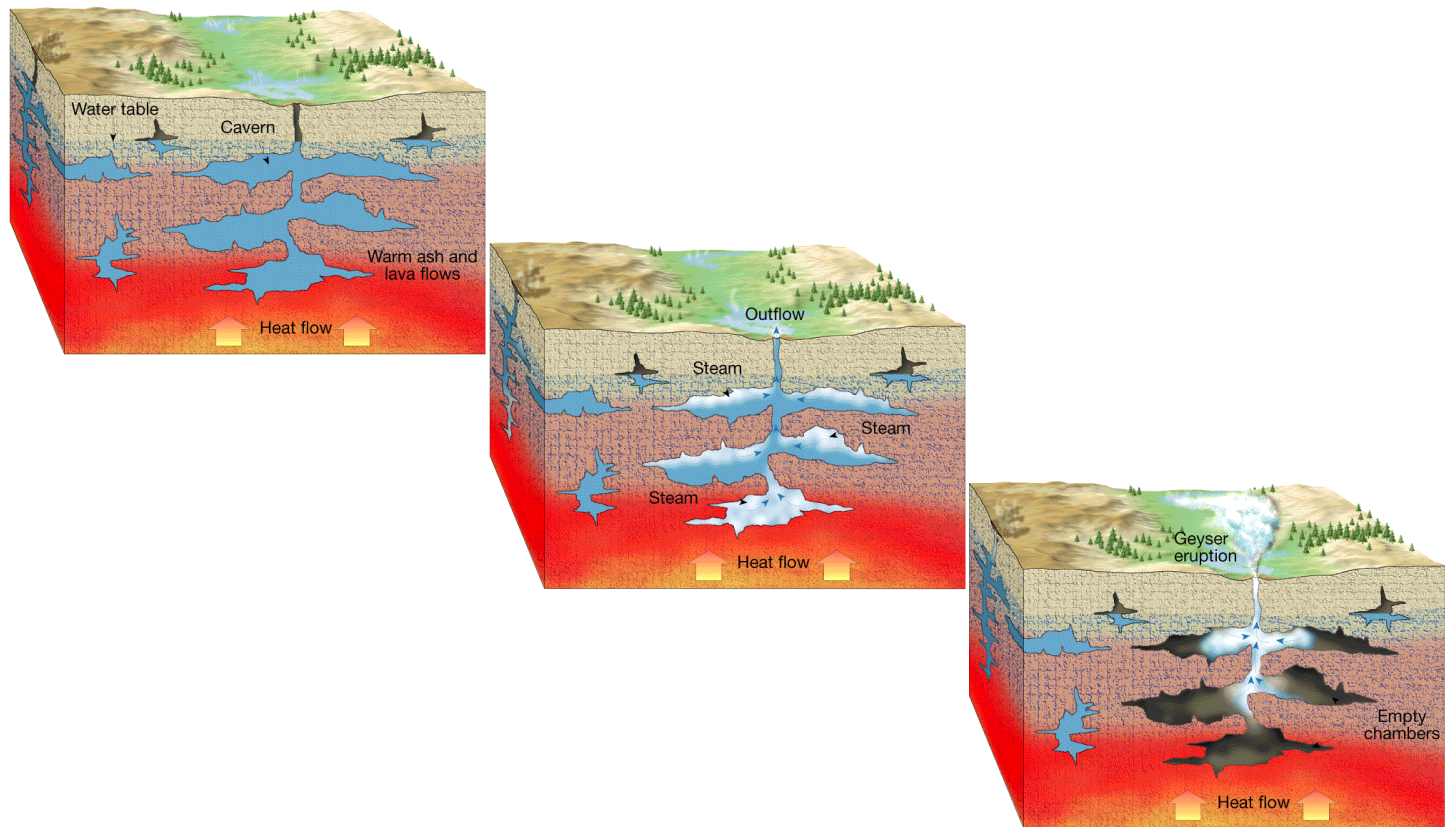


Water Beneath the Surface

Springs

- ◆ A **spring** forms whenever the water table intersects the ground surface.
- ◆ Hot Springs
 - Water is 6–9°C warmer than the mean air temperature of the locality.
 - Water is heated by cooling of igneous rock.
- ◆ **Geysers**
 - Intermittent hot springs
 - Water turns to steam and erupts.

Geyser Eruption Cycle

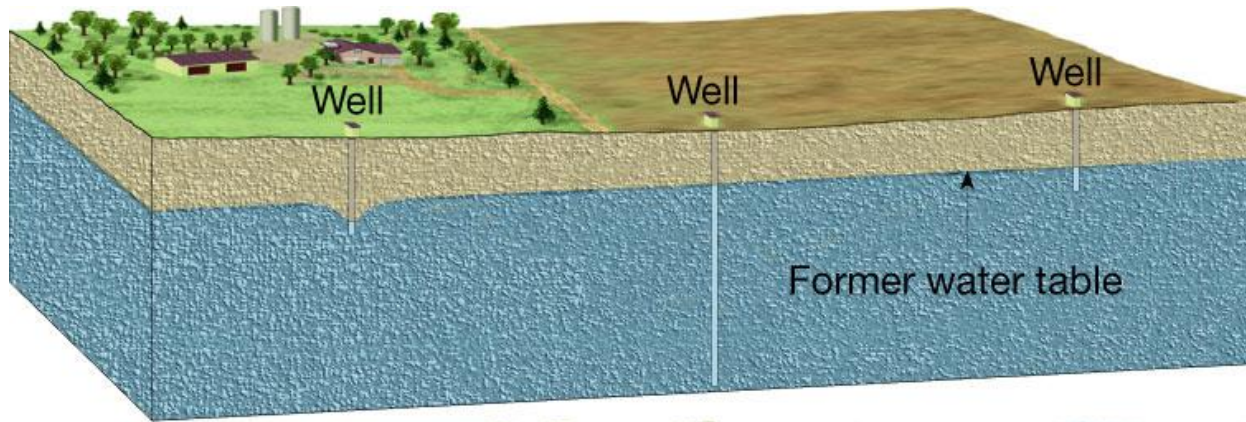


Water Beneath the Surface

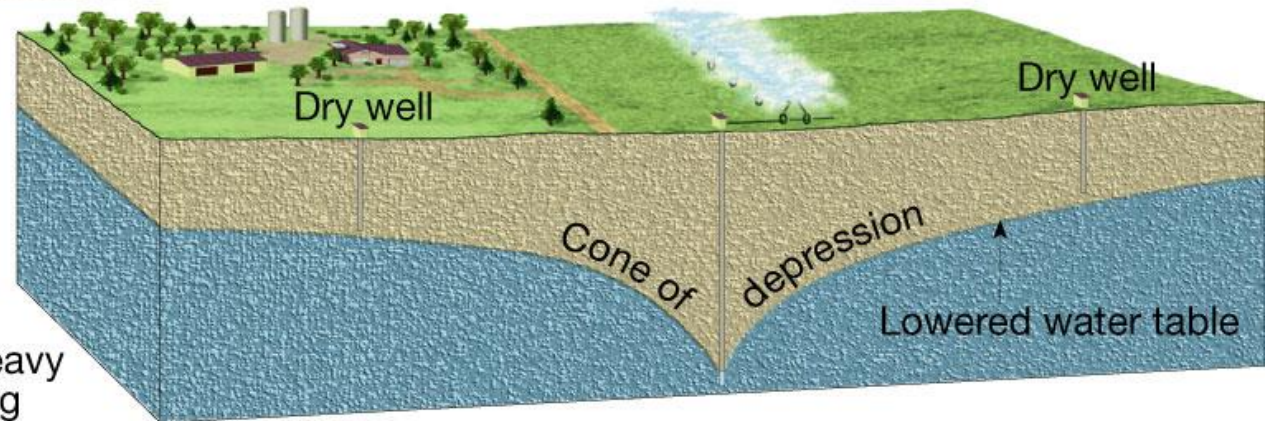
Wells

- ◆ A **well** is a hole bored into the zone of saturation.
 - An **artesian well** is any formation in which groundwater rises on its own under pressure.
 - Pumping can cause a drawdown (lowering) of the water table.
 - Pumping can form a cone of depression in the water table.

Cone of Depression



Before heavy pumping



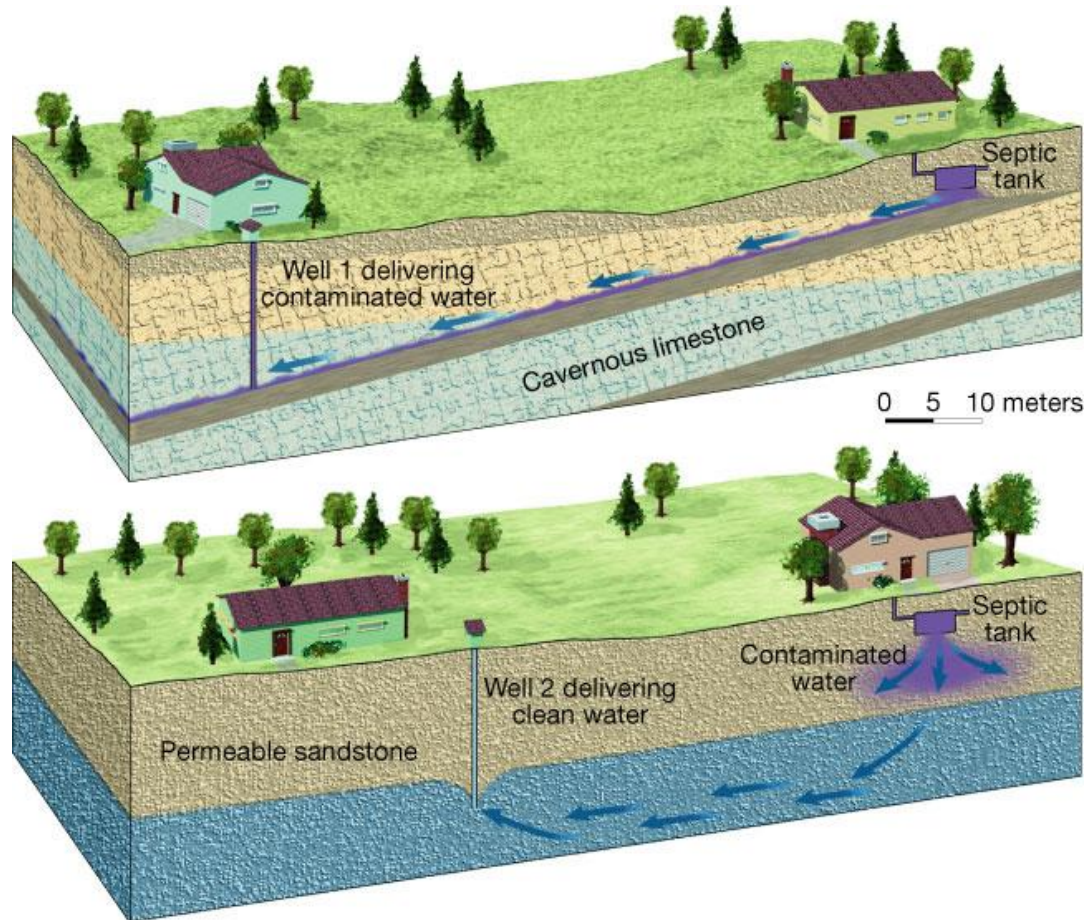
After heavy pumping

Water Beneath the Surface

Environmental Problems Associated with Groundwater

- ◆ Overuse and contamination threatens groundwater supplies in some areas.
 - Treating it as a nonrenewable resource
 - Land subsidence caused by its withdrawal
 - Contamination

Groundwater Contamination



Water Beneath the Surface

Caverns

- ◆ A **cavern** is a naturally formed underground chamber.
- ◆ Erosion forms most caverns at or below the water table in the zone of saturation.
- ◆ **Travertine** is a form of limestone that is deposited by hot springs or as a cave deposit.

Dissolving of Groundwater Creates Caverns



Water Beneath the Surface

Caverns

- ◆ Characteristics of features found within caverns
 - Formed in the zone of aeration
 - Composed of dripstone
 - Formed from calcite deposited as dripping water evaporates
 - Common features include stalactites (hanging from the ceiling) and stalagmites (growing upward from the floor).

Water Beneath the Surface

Karst Topography

- ◆ Formed by dissolving rock at, or near, Earth's surface
- ◆ Common features
 - **Sinkholes**—surface depressions
 - Sinkholes form when bedrock dissolves and caverns collapse.
 - Caves and caverns
- ◆ Area lacks good surface drainage.

Sinkhole Formation

