



AP* ENVIRONMENTAL SCIENCE

WATER AND WATER POLLUTION

Student Packet



Water and Water Pollution

Water as a Resource

Water covers over seventy percent of the earth's surface. Several properties of water are responsible for life as we know it.

- Water has a **high specific heat** that allows for constant temperatures.
- Its buoyant nature minimizes the energy spent by organisms in the constant struggle with gravity.
- Dissolved nutrients are easily obtained by aquatic organisms. No plant or animal can survive without water.
- Water is a major force in **weathering** and mitigates the world's climates with its redistribution of solar heat.

Ninety-seven percent of all water is saltwater or marine. The remaining three percent is fresh water and its distribution is illustrated in figure 1¹.

Water as a resource is used in the United States in the following ways:

- 41% - irrigate farm land (agriculture)
- 38% - energy production
- 11% - industry
- 10% - public

The water needed to fill these needs is obtained from several sources.

Surface Water consists of streams, lakes, wetlands, and reservoirs. These bodies of water are fed by the **watershed** (a region from which water drains).

Reservoirs and man-made lakes are created by dams. These dams not only provide a means for water storage but can also be used to produce electricity through hydroelectric means. There are problems associated with the promulgation of dams:

- dams can reduce biodiversity
- dams trap sediments
- dams greatly disrupt the flow of rivers.
ex. China's Three Gorges project (Yangtze River)

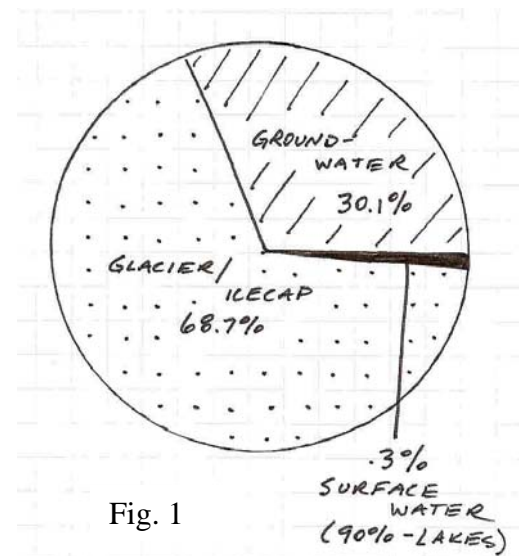


Fig. 1

¹ <http://ga.water.usgs.gov/edu/waterdistribution.html>

Groundwater is water found below the surface. Figure 2 illustrates an aquifer and key terms associated with the surrounding area.

Water Table - the surface of the zone of saturation

Aquifer - porous sand, gravel or bedrock through which groundwater flows

Recharge area - an area of land through which water passes downward or laterally into an aquifer

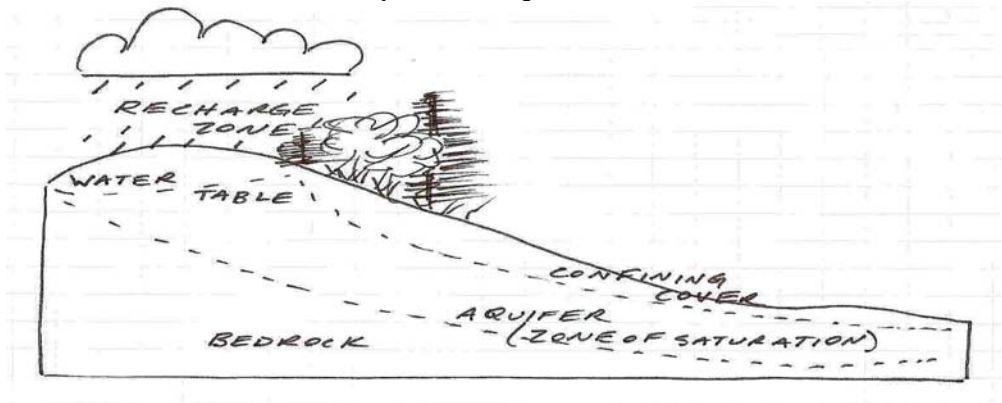


Fig. 2

Problems: Overuse of groundwater can cause land to subside or sink. Removal of freshwater also allows saltwater to intrude into the aquifer.

Desalination is another way of producing freshwater. This is accomplished through distillation or reverse osmosis. There are problems associated with desalination, however.

- The process uses large quantities of energy.
- The water produced by this method is very expensive.
- The process produces large quantities of brine as a by-product.

In order to meet the needs of an ever-growing human population, steps will need to be taken to provide water to the places that need it. However, these projects often prove to be detrimental to the nature and culture of the areas. **James Bay Watershed** and the **Aral Sea Project** are two examples of diverting water. Both of these projects have not come without cost to the environment.

The water supply could best be increased with conservation practices and more efficient technology. Over sixty percent of the water used throughout the world is wasted through evaporation and leaks. In many developed countries, water is wasted because of its low, government-subsidized prices.

Using less water in homes and industry would require municipalities to maintain water lines and eliminate leaks more efficiently. **Xeriscaping** could replace traditional landscaping. This requires much less water and maintenance. Incentives could also be offered for the installation of more efficient appliances, showers, etc.

Using less water in agriculture would consist of changing irrigation practices. **Drip irrigation** systems are ten percent more efficient than the most efficient center-pivot sprinkler system. Organic farming also uses much less water than conventional farming.

Water Pollution

Water pollution is classified as any physical, biological, or chemical, change in water that will affect the organisms that live in it or its quality for consumption. **Point sources** of water pollution have a specific location and are generally to find and control. **Non-point sources** of water pollution cannot be attributed to one site. This is often associated with agriculture. Water pollution has been divided into several classes.

Organic wastes that deplete dissolved oxygen from water during their bacterial decomposition. The term **biological oxygen demand (BOD)** is a measure of the oxygen used by microorganisms to decompose this waste. Higher concentrations of waste demands more oxygen and will result in a higher BOD. An oxygen sag curve can be used to illustrate the effects pollution has on streams and rivers. (Fig. 3)

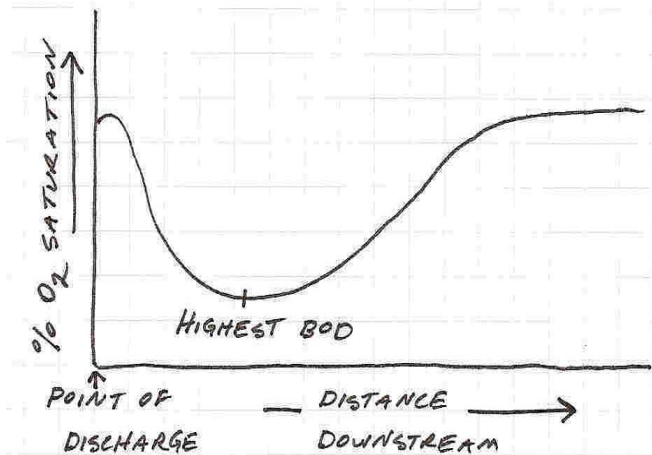


Fig. 3

Excess nutrients like nitrates and phosphates found in many fertilizers can lead to **algal blooms** (rapid growth of algae). Once these limiting nutrients are depleted the algae dies and their decomposition leads to the depletion of dissolved oxygen. This often leads to massive fish die offs. Cultural eutrophication is the term used to describe anthropogenic enrichment of lakes or reservoirs that lead to excessive plant growth.

Sediments are one of the largest classes of water pollution. They cloud water which reduces photosynthesis. This in turn disrupts food webs. It also fills in reservoirs and lakes and reduces flow in channels.

Thermal pollution is another class of water pollution that is often overlooked. It is the rise in water temperature usually due to the discharge of heat in water used to cool power plants. **Thermal shock** can weaken organisms and disrupt food chains.

Toxic waste, such as pesticides, petroleum products and heavy metals threatens humans and all aquatic organisms.

Nonnative species are also genetically polluting many bodies of water. The zebra mussel causes millions of dollars of damage each year in the Great Lakes.



Water pollution is detected in a variety of ways. It can be evaluated through chemical analysis. This includes pH, dissolved oxygen (DO) and nitrate levels. Macro-invertebrates will also indicate the quality of water with the absence and presence of certain species. Another good indicator for the quality of drinking water is the number of **coliform bacteria** colonies present.



Multiple Choice

1. Most water in the United States is used for

- A. Industry
- B. Irrigation
- C. Public use
- D. Aquaculture
- E. Energy production

Questions 2-4 refer to the following water diversion projects

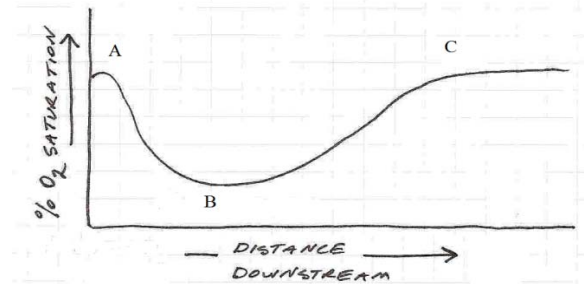
- A. Aral Sea
- B. Caspian Sea
- C. Three Gorges Dam
- D. James Bay Watershed Project

2. Largest hydroelectric dam in the world. Spans the Yangtze River.

3. Shrinking inland sea located in the former Soviet Union. Irrigation practices have led to its reduction of water.

4. Site of several major hydroelectric projects found in Canada

Questions 5-6 refer to the following graph



5. Point of pollution discharge.
 6. Highest biological oxygen demand.
7. All of the following are problems associated with the overuse of groundwater **except**
 - A. Land subsidence
 - B. Aquifer depletion
 - C. Saltwater intrusion
 - D. Gray water increase
 - E. Declining water quality
 8. All of the following statements are true about desalination projects **except**
 - A. Use distillation
 - B. Low-energy use
 - C. Use reverse osmosis
 - D. Relied on heavily in the Middle East
 - E. Production of large amounts of brine



9. Which of the following types of water pollution is often associated with electricity production?
- A. Toxic waste
 - B. Organic waste
 - C. Genetic pollution
 - D. Thermal pollution
 - E. Sediment pollution
10. Which of the following types of irrigation conserves the most water?
- A. Terracing
 - B. Flooding
 - C. Long lining
 - D. Center-pivot
 - E. Drip irrigation



Free Response

The Yangtze, the third longest river in the world, snakes 3,900 miles across China before reaching the East China Sea. In 2009, the Three Gorges Dam will be completed across the river, making it the largest hydroelectric project in the world.

- A. Describe two additional benefits other than electricity production of a large-scale water diversion project.

- B. Describe two environmental problems associated with large-scale water diversion projects.

- C. Give an example of another large-scale water diversion project and where it is located.

- D. List two practices that would increase water supplies besides creating reservoirs.