APES SPECIAL STUDY GUIDE from a text excerpt in "Living in the Environment"

Read the text excerpt provided then answer the questions below. You must handwrite your responses. Do not skip the critical thinking questions! They are old FRQs and will provide valuable practice.

1. Describe the relationship between a **dam** and a **reservoir**.

2. Describe FOUR benefits of large dams. *Memorize these!*

3. Describe TWO consequences of damming rivers. *Memorize these too!*

4. The benefits of dams and reservoirs may be limited however. Explain TWO ways in which the efficiency of dams may be compromised over time.

5. Dams can starve coastal estuaries of water and nutrients, as in the case of the Colorado River delta.

a. Identify TWO specific uses for the water supplied by the reservoirs created along the Colorado River.

b. What role has government subsidies played in the use of water along the river.

c. Describe FOUR measures the water experts say will alleviate the water supply problems along the Colorado River.

Dick Ireland/U.S. Geological Survey

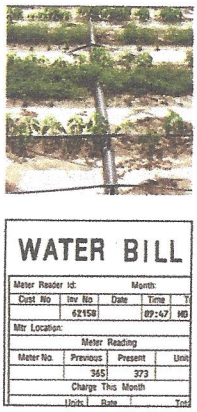
Figure 13-15 This pole shows subsidence from overpumping of an aquifer for irrigation in California's San Joaquin Central Valley between 1925 and 1977. In 1925, this area's land surface was near the top of the pole. Since 1977, this problem has gotten worse.

Solutions

Groundwater Depletion

Prevention

- Use water more efficiently
- Subsidize water conservation
- Limit number of wells
- Stop growing water-intensive crops in dry areas



Control

- Raise price of water to discourage waste
- Tax water pumped from wells near surface water
- Build rain gardens in urban areas
- Use permeable paving material on streets, sidewalks, and driveways

Figure 13-16 There are a number of ways to prevent or slow groundwater depletion by using freshwater more sustainably. ***Questions:*** Which two of these solutions do you think are the most important? Why?

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Second, little is known about the geological and ecological impacts of pumping large amounts of freshwater from deep aquifers. *Third,* some deep aquifers flow beneath more than one country and there are no international treaties that govern rights to them. Without such treaties, wars could break out over this resource. *Fourth,* the costs of tapping deep aquifers are unknown and could be high.

13-3 Can Surface Water Resources Be Expanded?

CONCEPT 13-3

Large dam-and-reservoir systems have greatly expanded water supplies in some areas, but have also disrupted ecosystems and displaced people.

Use of Large Dams Provides Benefits and Creates Problems

A **dam** is a structure built across a river to control its flow. Usually, dammed water creates an artificial lake, or **reservoir**, behind the dam (Figure 13-2). The main goals of a dam-and-reservoir system are to capture and store the surface runoff from a river's watershed, and release it as needed to control floods; to generate electricity (hydropower); and to supply freshwater for irrigation and for towns and cities. Reservoirs also provide recreational activities such as swimming, fishing, and boating. Large dams and reservoirs provide benefits but have drawbacks (Figure 13-17).

The world's 45,000 large dams—those that are 15 meters (49 feet) or higher—capture and store about 14% of the world's surface runoff, provide water for almost half of all irrigated cropland, and supply more than half the electricity used in 65 countries. GOOD NEWS The United States has more than 70,000 large and small dams, capable of capturing and storing half of the country's entire river flow.

By using dams, we have increased the annual reliable runoff available for our uses by nearly 33%. As a result, the world's reservoirs now hold 3 to 6 times more freshwater than the total amount flowing at any moment in all of the world's natural rivers. On the down side, this engineering approach to river management has displaced 40–80 million people from their homes, flooded an area of mostly productive land totaling roughly the area of the

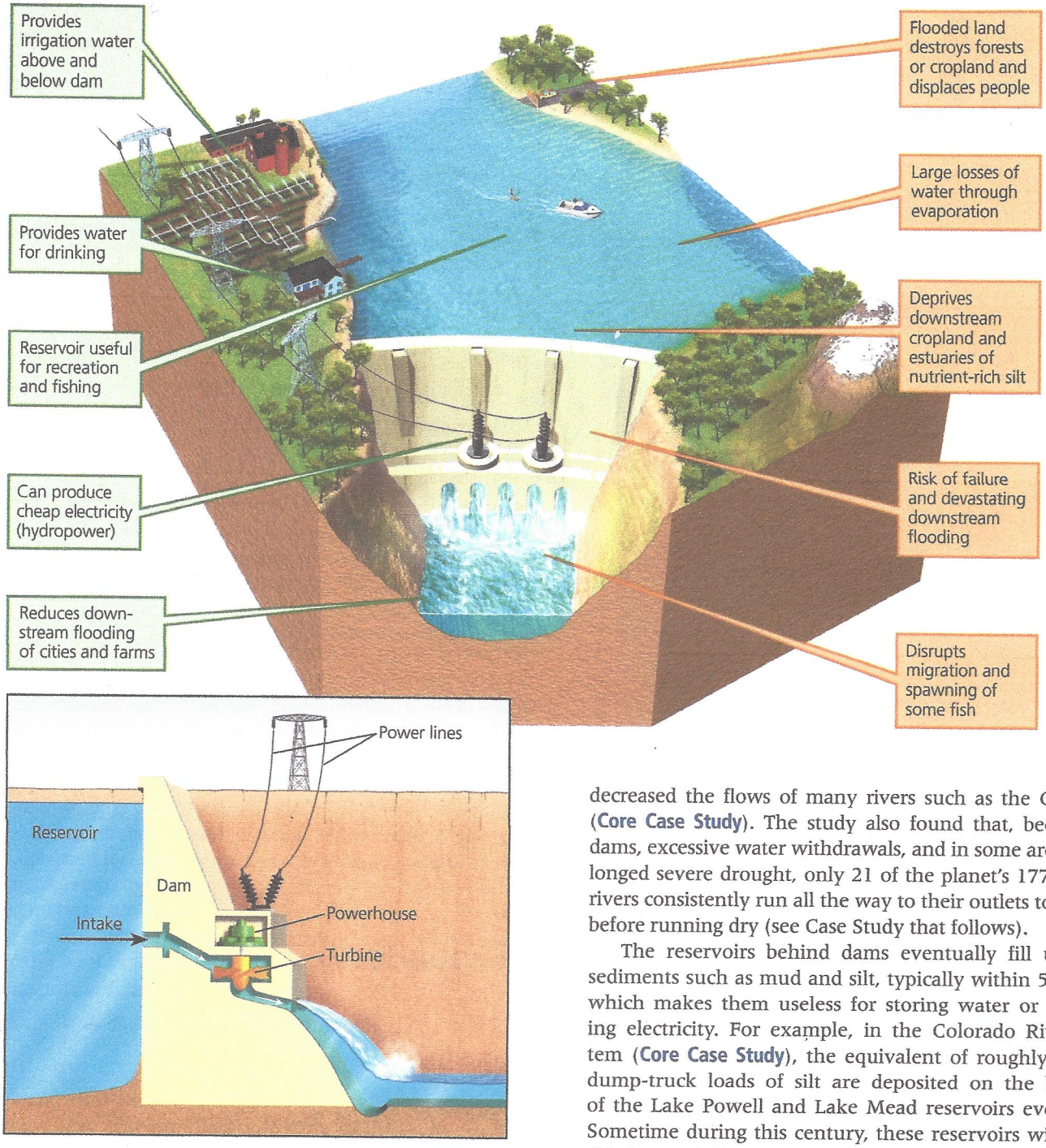


Figure 13-17 **Trade-offs:** Use of large dams and reservoirs has its advantages (green) and disadvantages (orange) (Concept 13-3). ***Questions:*** Which single advantage and which single disadvantage do you think are the most important? Why?

U.S. state of California, and impaired some of the important ecosystem services that rivers provide (see Figure 8-14, left, p. 178, and Concept 13-3).

A 2007 study by the World Wildlife Fund (WWF) estimated that about one out of five of the world's freshwater fish and plant species are either extinct or endangered, primarily because dams and water withdrawals have sharply decreased the flows of many rivers such as the Colorado (**Core Case Study**). The study also found that, because of dams, excessive water withdrawals, and in some areas, prolonged severe drought, only 21 of the planet's 177 longest rivers consistently run all the way to their outlets to the sea before running dry (see Case Study that follows).

The reservoirs behind dams eventually fill up with sediments such as mud and silt, typically within 50 years, which makes them useless for storing water or producing electricity. For example, in the Colorado River system (**Core Case Study**), the equivalent of roughly 20,000 dump-truck loads of silt are deposited on the bottoms of the Lake Powell and Lake Mead reservoirs every day. Sometime during this century, these reservoirs will probably be too full of silt to control floods or to store enough water for generating hydroelectric power. About 85% of all U.S. dam-and-reservoir systems will be 50 years old or more by 2025, and some of those aging dams are being removed because their reservoirs have filled with silt.

If climate change occurs as projected during this century, it will intensify shortages of water in many parts of the world. For example, mountain snows that feed the Colorado River system (**Core Case Study**) will melt faster and earlier, making less freshwater available to the river system when it is needed during hot summer months.

Nearly 3 billion people in South America, China, India, and other parts of Asia depend on river flows fed

by mountain glaciers, which act like aquatic savings accounts. They store precipitation as ice and snow in wet periods and release it slowly during the dry season for use on farms and in cities. In 2010, according to the World Glacier Monitoring Service, many of these mountain glaciers had been shrinking for 19 consecutive years, mostly due to a warming atmosphere. For a while, their melting will likely increase water supplies. However, if these glaciers eventually disappear, most of those 3 billion people will likely be short of water for all purposes, including food production.

CASE STUDY

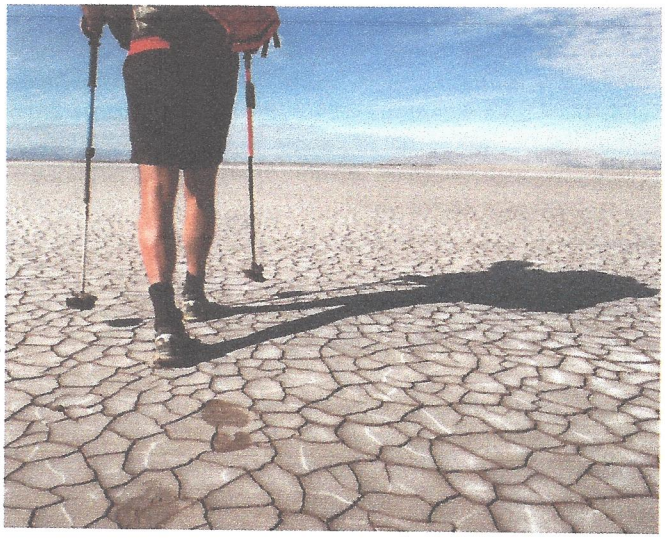
How Dams Can Kill an Estuary

Since 1905, the amount of water flowing to the mouth of the heavily dammed Colorado River (**Core Case Study**) has dropped dramatically. In most years since 1960, the river has dwindled to a small, sluggish stream by the time it reaches the Gulf of California.

This is the subject of an online video by National Geographic Explorer Alexandra Cousteau (see Individuals Matter 8.1, Chapter 8, p. 183), called *Death of a River.* In that film, Cousteau explains that the river once emptied into a vast jungle *delta,* the wetland area at the mouth of a river containing the river's estuary. The Colorado's delta covered an area of more than 800,000 hectares (2 million acres)—the size of the state of Rhode Island. It hosted forests, lagoons, and marshes rich in plant and animal life and supported a thriving coastal fishery for hundreds of years.

Since the damming of the Colorado—within one human lifetime—this rich ecosystem has collapsed and is now covered by mud flats and desert (Figure 13-18). The dams upstream have cut off the water supply that kept the system alive. All but one-tenth of the river's flow was diverted for use in seven U.S. states. Most of the remaining 10% is assigned to farms and to the growing cities of Mexicali and Tijuana in Mexico. The delta and its wildlife are now mostly gone and its coastal fishery that fed many generations of area residents is disappearing.

Historically, about 80% of the water withdrawn from the Colorado has been used to irrigate crops and raise cattle. That is because the government paid for the dams and reservoirs and has supplied many farmers and ranchers with water at low prices. These government subsidies have led to inefficient use of irrigation water for growing crops such as rice, cotton, and alfalfa that need a lot of water. However, much of this water is lost to the river system before it can be used. For example, there are huge losses of water in the Lake Mead and Lake Powell reservoirs due to evaporation and seepage of water into porous rock beds under the reservoirs.



PeteMcBride/National Geographic Creative

Figure 13-18 The Colorado River delta once contained a rich variety of forests, wetlands, and wildlife. Now it is covered mostly by mud flats and desert.

To deal with the water supply problems in the dry Colorado River basin, water experts call for the seven states using the river to enact and enforce strict water conservation measures and to slow population growth and urban development. They also call for phasing out state and federal government subsidies for agriculture in this region, shifting water-thirsty crops to less arid areas, and banning or severely restricting the use of surface water and groundwater to keep golf courses and lawns green in the desert areas of the Colorado River basin (Figure 13-1). They suggest that the best way to implement such solutions is to sharply raise the historically low price of the river's freshwater over the next decade—another application of the full-cost pricing **principle of sustainability**. According to Cousteau, if just 1% of the river's flow were restored to the delta area, much of it could be partially restored and its fisheries might begin to rebound.

CONSIDER THIS. . .

THINKING ABOUT The Colorado River

What are three steps you would take to deal with the problems of the Colorado River system?