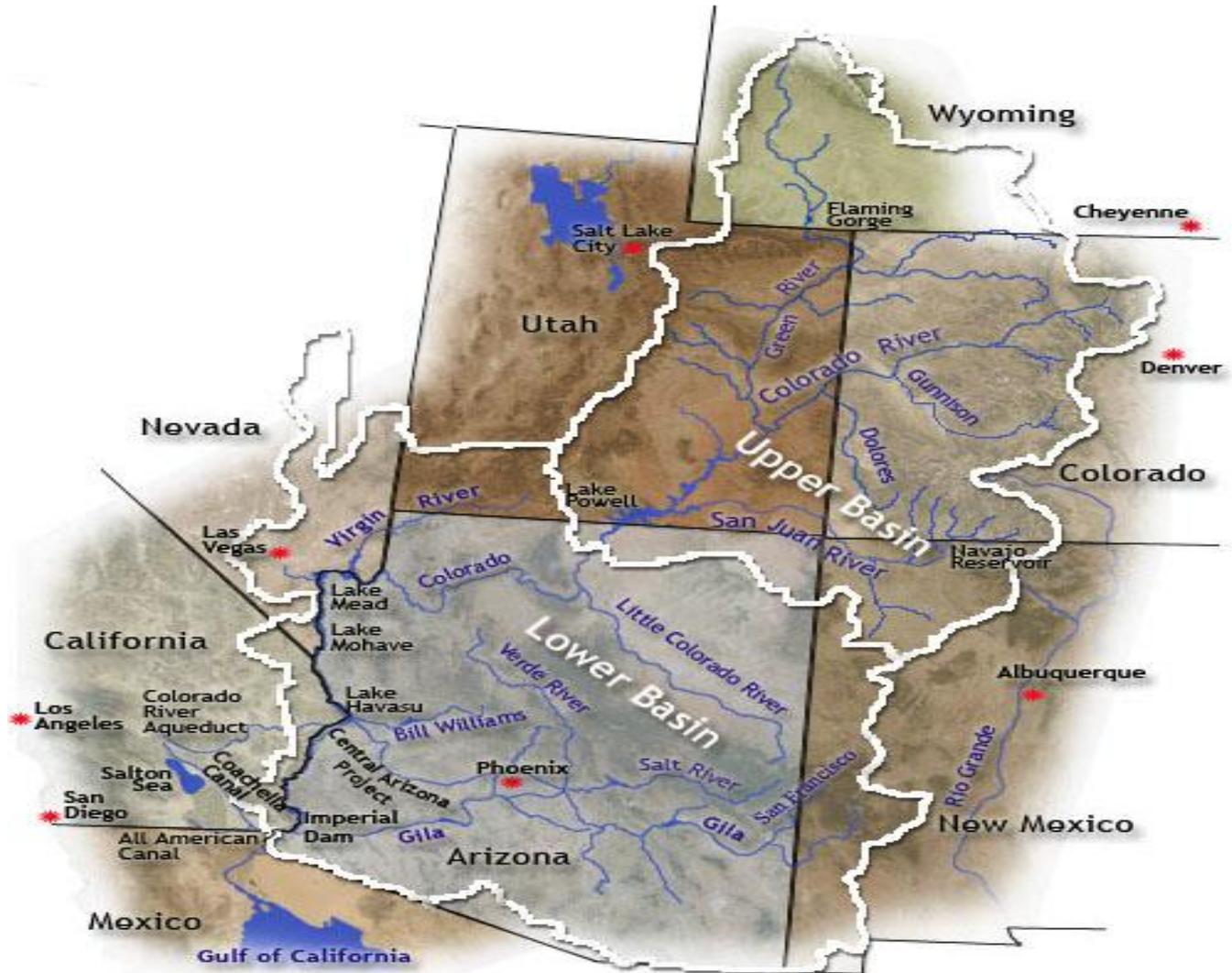


## The Colorado River Basin



### Arizona Water History

During the early 1900's, the seven states sharing the Colorado River Basin - Arizona, California, Nevada, New Mexico, Wyoming, Colorado, and Utah - debated for shares of Colorado River water. In 1922, representatives from the seven states and the United States government created the Colorado River Compact, which divided the states into upper and lower basins. Each basin had 7.5 million acre-feet of water annually to split amongst themselves.



## Assignment and Assessment for Grades 6-8

Interstate political and legal disagreements over Colorado River water dominated the relationship among lower basin states throughout the next 22 years. Arizona was the last state to approve the compact in 1944, ensuring 2.8 million acre-feet of water per year for the state. The Boulder Canyon Project Act of 1928 provides California with 4.4 million acre-feet of water per year and Nevada with an annual allocation of 300,000 acre-feet. Arizona, California, and Nevada comprise the lower basin and are responsible for splitting the 7.5 million acre-feet allotment.

One of the most popular recreation areas in America, Lake Mead, is located in the lower basin state of Nevada. As the Colorado River exits the Grand Canyon it enters Lake Mead created by the Hoover Dam. As the Colorado River travels south it meets the Central Arizona Project's aqueduct and the Colorado River Aqueduct. The Colorado River Aqueduct is 242 miles long and diverts water west over state lines and across the Mojave and Colorado Deserts. To the south of the aqueduct in California is the Salton Sea, an inland salt-water lake.

Colorado, Utah, New Mexico and Wyoming make up the four upper basin states. Colorado has the largest share of the of all the upper basin states. Next largest is Utah with 23 percent, Wyoming with 14 percent, and finally New Mexico with 11.25 percent. Located in northern Colorado, the Big Thompson Project stores, regulates, and diverts water from the Colorado River on the western slope of the Continental Divide to the eastern slope of the Rocky Mountains. Also located in the upper basin is the Navajo Indian Irrigation Project. Built by the Bureau of Reclamation in Northwestern New Mexico, it is used exclusively for Navajo lands on or next to the Navajo Reservation.

In many areas of Arizona, people pump more water from the ground than nature can replenish, so Central Arizona Project (CAP) was built to help conserve groundwater supplies. CAP's aqueduct system is 336 miles long and delivers 1.5 million acre-feet of water to its customers in Maricopa, Pima and Pinal counties annually. Central Arizona Project has more than 80 customers which fall into three groups: municipal, agricultural, and Indian users. Agriculture uses about eighty percent of the water resources in Arizona. CAP's vision includes delivering its full allocation of Colorado River water to central Arizona reliably, cost effectively and in an environmentally sound manner with the highest regard for employee safety and health, evolving public needs and customer satisfaction.

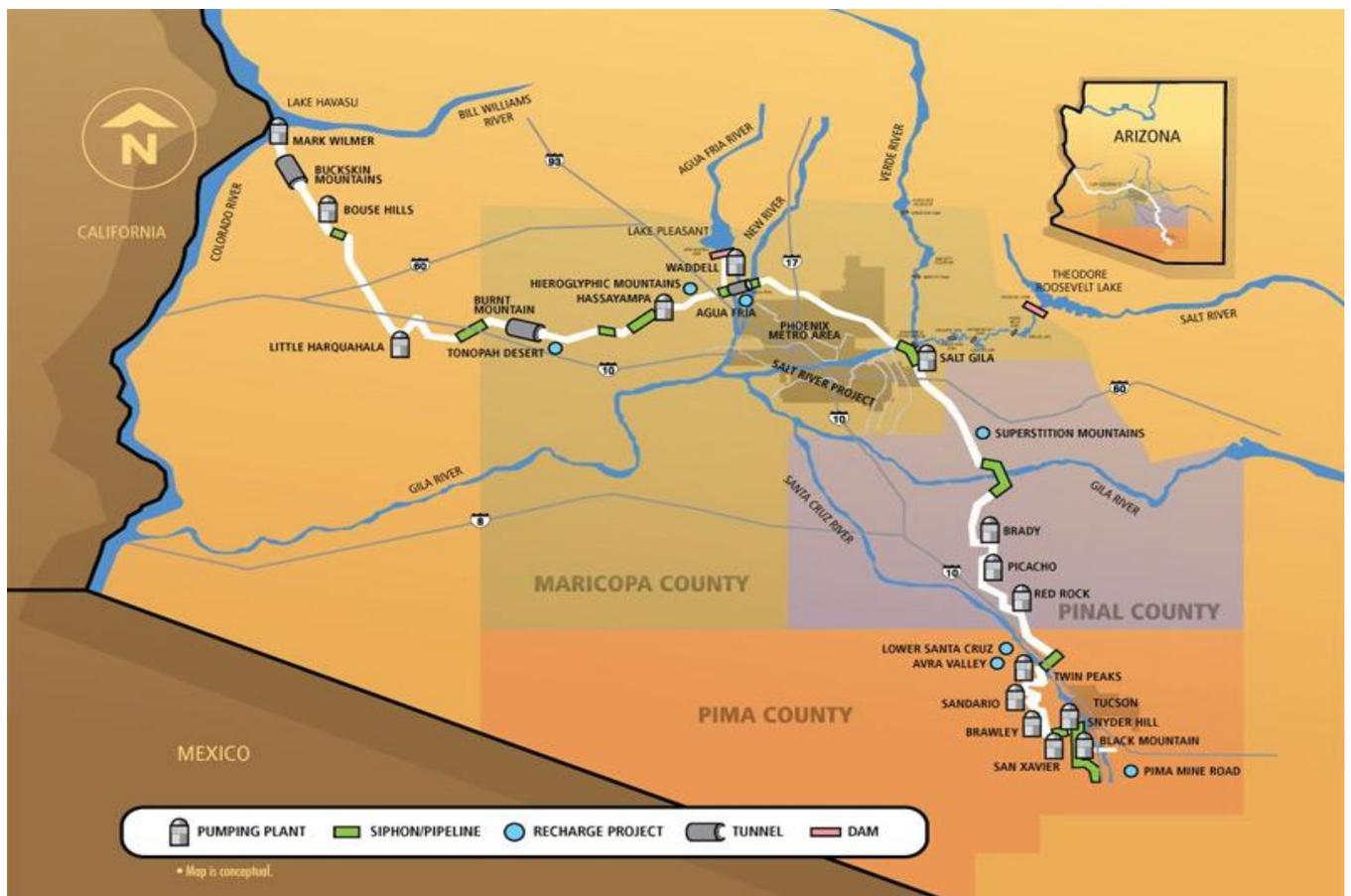
The CAP water intake at Lake Havasu is located in a bay-like feature that is the mouth of the Bill Williams River. CAP then moves water through the system by lifting the water using pumping plants and then releasing the water to flow through the canal by gravity. The power to operate CAP's pumping plants comes primarily from the Navajo Generating Station. CAP stores water in Lake Pleasant, filling the lake during the winter months and releasing water during the dry, hot summer generating hydroelectricity. The lake level fluctuates 75 feet in an average year.

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The Lower Santa Cruz Recharge Project was developed in a partnership between Central Arizona Project and Pima County Department of Transportation and Flood Control District (Pima County). The project is located in Marana. Mark Wilmer Pumping Plant contains six, 60,000 horsepower pumps which lift the water 824 feet up Buckskin Mountain. The Santa Cruz River flows out of the Santa Rita Mountains, into Mexico and back north towards Tucson. Sabino Creek flows out of the Santa Catalina Mountains into Tucson.

### The Central Arizona Project Water Delivery System



### CAP History

Arizona's early business and government leaders dreamt of creating desert oases that would attract both people and prosperity to the state. In order to accomplish their ambitious goals, they understood that abundant and reliable supplies of fresh water would be needed. They set to work developing a plan to build an impressive aqueduct



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that would stretch some 336 miles. It would be designed to deliver reliable and plentiful supplies of Colorado River water to industry, agriculture and the residents of the most populous central and southern portions of Arizona. Though it required half a century, intense legal wrangling and nearly four billion dollars in construction costs, our forefathers' vision has become reality and continues to benefit millions of Arizonans every day.

Today, Central Arizona Project delivers more than 1.5 million acre-feet of Colorado River water to 57 large wholesale water providers. An acre-foot of water equals about 326,000 gallons, roughly enough water to serve two families for one year. About 35% of deliveries are to municipal and industrial users, 25% of the water goes to agriculture, 10% to Indian communities and 30% is banked underground for the future. At any given moment, nearly 8 billion gallons of water are managed by CAP.

### **Recharge**

In 1996 Central Arizona Project began recharging water in an effort to increase the reliability of long-term water supplies. The recharging process involves systematically flooding a site and allowing water to percolate down through the soil, replenishing underground aquifers. This "recharged" water may then be pumped out and used at a later date. There are a number of issues involved in identifying an appropriate underground storage site and CAP evaluates each site thoroughly before making a selection. CAP tests and confirms that the soil is not contaminated and that it has adequate permeability. In addition, the site's proximity to the canal and the storage capacity of the local aquifer are also considered. CAP operates more than half a dozen underground storage projects which can store more than 300,000 acre feet of surplus water underground per year. These sites are an important component of operations and will provide Arizonans with a water supply they can rely on for years to come.

Since Colorado River water is available to Arizona farmers, they can use surface water supplies instead of groundwater to irrigate farmland. This means less groundwater is pumped by farmers for watering their crops. Cities are treating Central Arizona Project water for drinking and reducing groundwater pumping.

### **Reclaimed Water**

Reclaimed water is treated wastewater from homes and businesses. It is the water that has already been used and can be collected and treated so it is usable once again. The reclaimed water is delivered through a separate system. It is usually used for grass facilities like parks and golf courses. It can also be used to cool power plants and irrigate agriculture.



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### **Emerging Water Issues**

The Colorado River Basin is one of the fastest growing regions in the country and it depends on the river's bounty to support its large population and dynamic economy. However, the Colorado River is stretched to its limits: over allocation, drought, and ever increasing demands mean that action must be taken now to prevent harmful shortages in the future. Augmentation, which means adding to the amount of water available by getting it from other sources, is one of several solutions.

### **Personal Water Conservation**

Individual people can also conserve water in many ways. Look for leaks in toilets and sinks and fix them. Use water efficient plumbing fixtures and appliances that use less water than older fixtures. Take shorter showers. Turn off the tap when you are brushing your teeth. Keep a jug of water cooling in the refrigerator rather than running water from the tap until it turns cool. Running the dishwasher only when it is full can save a household 10-20 gallons of water per day. Outdoors, savings of water can result from sweeping sidewalks and driveways instead of hosing them down. In addition, desert landscaping can reduce outdoor water use by 50 percent. On average, desert landscaping needs about 15 gallons of water per square foot each year while grass needs about 27 gallons.

### **Water Quality**

Central Arizona Project delivers raw, untreated water to its customers. Although it does not own or operate any treatment plants, CAP developed a water quality testing program as a service to the cities and utilities that treat the water and the millions of people who drink it. Results from CAP's weekly, monthly, and quarterly water quality tests not only help CAP's customers adjust their water treatment systems, the results are used to protect the quality of the water used for recharge so it can be safely retrieved for the future.

Like most river water, CAP water displays characteristics of hard water and can cause spots on dishes or scale to form on showerheads and appliances like coffee makers. High levels of calcium and magnesium contribute to water's "hardness." Hard water can be beneficial because high levels of calcium often create a natural protective coating on pipes, preventing lead and copper from entering the water supply. A lot of scientific information also indicates that high levels of hardness contribute to the development of stronger bone structure and low incidence of heart disease.

CAP invests a lot of time and money to minimize manmade pollutants in the water. This



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is good for water quality as well as for the environment. To clean grass out of the recharge basins, goats are used to eat grass and weeds which would otherwise impede flow of water into the ground. In some places, vegetable oil is used instead of petroleum based oil to lubricate machinery which comes into direct contact with water.

Many times, CAP stocks the aqueduct with algae eating fish rather than using chemicals to clean the canal. CAP has a license to stock \$100,000 worth of white amurs or "grass carp" in the canal. CAP has also stocked red eared sunfish to eat clams and mussels.

### **Ecology**

Damming rivers and taking water out of rivers for agriculture and cities does cause environmental change. Central Arizona Project has tried to do whatever it can to lessen the impact of the system on the environment. For instance, before CAP was constructed many archaeological and biological studies were conducted to identify animal migration patterns. Bridges were built in the places identified so deer, kit foxes and desert tortoises can get across.

Six-foot high fences also have been built along the canal to keep people and large animals safe from drowning. Wildlife watering sites were also built away from the canal. Construction near bald eagle nests was scheduled to avoid nesting season. Cacti and other native plants were saved and moved from construction sites to create wildlife habitat in other places in the desert.

Many species of fish are also supported by CAP's system. The Lake Pleasant Striped Bass Project found carp, threadfin shad, channel catfish, largemouth bass, white bass, striped bass, and crappie. One way fish are tracked on an ongoing basis is by implanted sonic tags. As recently as 2006 10 implanted striped bass were monitored on a bi-weekly basis.

### **Canal Safety**

The Central Arizona Project canal can be very dangerous. For instance, an average freight train weighs 12 million pounds while the water in the canal weighs an average of 1.9 billion pounds per 7-mile pool. The amount of power required to stop the train going 50 miles per hour is 1.6 million horsepower, while it takes 12.3 million horsepower to stop the water in the canal flowing at a mere 2.4 miles per hour.

While some canal banks are open for walking, running and bicycling, anyone using canal banks should always keep in mind that the canals and associated facilities are



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maintained for the primary purpose of water distribution. If you are going to walk, jog, or bike along the canal, you should always keep a distance from the edge of the canal and stay away from automated equipment at water delivery gates. Avoid the canals concrete sidewalls, as they can be very slick.

### Canal Challenges

The Lands Department is responsible for managing all the properties owned and operated by CAP. Such properties include: remote, mountainous terrain; vast open deserts; farm and grazing land, and suburban environments. Originally constructed in rural areas, canals are now being surrounded by urban growth and development. This growth and development has presented the Lands Department with challenges, including: trespassing, illegal dumping, off-road ATV, dust control, target shooting, graffiti and encroachments.

### Water Vocabulary

**Acre-Foot** – amount of water it takes to cover one acre of land (about the size of a football field) one foot deep, equal to about 326,000 gallons

**Agriculture** – farming, producing crops, raising animals

**Aqueduct** – a canal or pipe that carries water, CAP's aqueduct system is 336 miles long

**Aquifer** – rocks, sand or gravel that holds water in the spaces between the particles

**Artificial Recharge** – used to store extra water underground

**Atmosphere** – the mass of air surrounding the Earth

**Canal** – an artificial waterway for navigation or for draining or irrigating land

**Colorado River** – provides water to the upper basin and lower basin states, Arizona receives 2.8 million acre-feet per year

**Condensation** – water vapor turning from gas into a liquid

**Dam** – a structure built to hold water back, usually on a river



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**Drought** – a period of dryness especially when prolonged and causing extensive damage to crops or preventing their successful growth

**Elevation** – height above sea level

**Flood** – a rising and overflowing of a body of water especially onto normally dry land

**Generator** – a machine by which mechanical energy is changed into electrical energy

**Groundwater** – water found under the surface of the ground in the spaces between the sands, gravels or silts, or cracks in rocks

**Hydropower** – the making of electricity by water falling through a dam, turning turbines which generate power in the form of electricity

**Kinetic Energy** – the energy of motion determined by an object's mass and speed

**Overdraft** – pumping more water out of an aquifer than is replaced by recharge (water soaking into the ground)

**Pollutant** – any substance introduced into the environment that adversely affects the usefulness of a resource

**Precipitation** – a deposit on Earth of hail, mist, rain, sleet, or snow; also the quantity of water deposited

**Recharge** – water soaking into the ground to be stored in the spaces in the aquifer in the form of groundwater

**Reservoir** – an artificial lake formed behind a dam where water is stored

**Resource** – an available material that can be used, like water

**Ridge Lines** – points of higher ground that separate two adjacent streams or watersheds

**Saturated** – when all the spaces in an aquifer are filled with groundwater

**Snowmelt** – runoff produced by the melting of snow

**Spillway** – a passage for surplus water to run over or around a dam



## Assignment and Assessment for Grades 6-8

**Subsidence** – when the ground level sinks because the spaces between dirt particles in an aquifer collapse

**Toxin** – poisonous materials harmful to humans, plants and animals

**Tributaries** – river or stream flowing into a larger river or lake

**Voltage** – electric pressure that exists between two points and is capable of producing a flow of current when a closed circuit is connected between the two points

**Water Cycle** – made up of evaporation, condensation, precipitation, and collection

**Water Table** – the top level of the groundwater, below which the ground is saturated with water

**Watershed** – a region of land where water runs off the land and drains into a series of streams and eventually, a river



## Assignment and Assessment for Grades 6-8

1. Which of the following make up the lower Colorado River Basin states?
  - A Arizona, Colorado, Wyoming
  - B California, Arizona, Nevada
  - C Utah, New Mexico, Wyoming
  - D California, Nevada, Colorado
  
2. What was built by the Bureau of Reclamation in the upper basin area of Northwestern New Mexico?
  - A Colorado River Aqueduct
  - B Hoover Dam
  - C Big Thompson Project
  - D Navajo Indian Irrigation Project
  
3. As the Colorado River exits the Grand Canyon it enters Lake Mead, one of the most popular recreation areas in America. In what state is Lake Mead located?
  - A Arizona
  - B California
  - C Nevada
  - D Utah
  
4. As the Colorado River travels south it meets near this lake and splits to form the Central Arizona Project and Colorado River Aqueducts. What is the name of the lake?
  - A Lake Powell
  - B Lake Havasu
  - C Lake Mead
  - D Lake Mohave



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5. What is **NOT** included in Central Arizona Project's vision?
- A Provide water to California and Nevada
  - B Provide water in an environmentally sound manner
  - C Provide water in a reliable manner
  - D Provide water cost-effectively
6. Central Arizona Project's customers fall into three groups. Which of the following is **NOT** one of the groups?
- A Agricultural Users
  - B Indian Users
  - C Foreign Users
  - D Municipal Users
7. There are many smaller rivers that merge into the Colorado River. What word is used to describe the smaller rivers?
- A Spillways
  - B Reservoirs
  - C Tributaries
  - D Turbines
8. In what year did Arizona approve the *Colorado River Compact*?
- A 1920
  - B 1924
  - C 1940
  - D 1944



## Assignment and Assessment for Grades 6-8

9. The *Colorado River Compact* divided the seven basin states into upper and lower basins. How much water did it allocate for each basin?
- A 10 million acre-feet
  - B 15 million acre-feet
  - C 2.8 million acre-feet
  - D 7.5 million acre-feet
10. CAP moves water through the system by lifting the water using pumping plants and then releasing the water to flow through the canal. What makes the water move through the canal?
- A Currents
  - B Waves
  - C Precipitation
  - D Gravity
11. What word describes a region of land where water runs off the land and drains into a series of streams and eventually, a river?
- A Aqueduct
  - B Overdraft
  - C Watershed
  - D Spillway
12. Which of the *recharge projects* is located closest to Lake Pleasant?
- A Tonopah Desert
  - B Hieroglyphic Mountains
  - C Superstition Mountains
  - D Avra Valley



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13. Why did Central Arizona Project begin recharging water in 1996?
- A To decrease the amount of water delivered to residents
  - B To teach people about how to conserve water at home
  - C To confirm the soil is not contaminated with pollutants
  - D To increase the reliability of long-term water supplies
14. Which of the following is **NOT** part of the “recharge” process?
- A Percolating
  - B Flooding
  - C Adding chemicals
  - D Replenishing underground aquifers
15. How are cities reducing groundwater pumping?
- A They are treating CAP water for drinking
  - B They are not allowing people to water their lawns
  - C They are using water from local ponds
  - D They are not allowing businesses to use water
16. When driving on Arizona roads you can sometimes see the Central Arizona Project canal. Which roadway does the CAP water delivery system parallel for the greatest distance?
- A Interstate-17
  - B Highway 93
  - C Highway 8
  - D Interstate-10



## Assignment and Assessment for Grades 6-8

17. If the Central Arizona Project's aqueduct travels almost one and a half times more miles than the 242-mile Colorado River Aqueduct in California, how many miles does it travel?
- A 336 miles
  - B 633 miles
  - C 161 miles
  - D 484 miles
18. Which of the following **best** describes the Central Arizona Project pumping plants?
- A There are a total of 15 pumping plants
  - B They are almost equal distance apart from each other
  - C They are located near recharge projects
  - D There is an equal number located in each county
19. An acre-foot is equal to how many gallons?
- A 326 gallons
  - B 3,260 gallons
  - C 30,260 gallons
  - D 326,000 gallons
20. The Central Arizona Project both delivers and banks Colorado River water. If 35% goes to municipal and industrial users, 25% to agriculture, and 10% to Indian communities, what percentage of water is banked underground for future use?
- A 50%
  - B 40%
  - C 30%
  - D 20%



Assignment and Assessment for Grades 6-8

21. How much water does the Arizona receive from the Colorado River each year?
- A 1.2 million acre-feet
  - B 4.4 million acre-feet
  - C 2.8 million acre-feet
  - D 7.5 million acre-feet
22. What river provides water to the upper basin and lower basin states?
- A Salt River
  - B Colorado River
  - C Gila River
  - D San Juan River
23. How many states are a part of the Colorado River Basin?
- A 3
  - B 5
  - C 7
  - D 9
24. What word describes what is created when water is released from Lake Pleasant during the hot summer months?
- A Hydroelectricity
  - B Toxin
  - C Condensation
  - D Pollutant



## Assignment and Assessment for Grades 6-8

25. The Colorado River is stretched to its limits. Which of the following is probably **NOT** a contributing factor to this dilemma?
- A Drought
  - B Over allocation of water
  - C Population growth
  - D Soil erosion
26. Which answer **best** describes the how often you should run the dishwasher in order for your household to save 10-20 gallons of water per day?
- A Once per week
  - B Only when it is full
  - C Every other day
  - D Every Monday and Tuesday
27. An average desert landscape uses around 15 gallons of water per square foot each year, while grass requires about 27 gallons. How much water per square foot could you save each year if you replaced grass with a desert landscape?
- A 2 gallons of water
  - B 6 gallons of water
  - C 10 gallons of water
  - D 12 gallons of water
28. What is reclaimed water?
- A Wastewater from homes and businesses that has been treated
  - B Water taken directly from the Colorado River
  - C Wastewater from farmers that has been used on their crops
  - D Water taken directly from aquifers



## Assignment and Assessment for Grades 6-8

- 29.** What types of facilities use the most reclaimed water?
- A** Parks and golf courses
  - B** Pools and fountains
  - C** Office buildings and homes
  - D** Schools and libraries
- 30.** What are the benefits of CAP's water quality testing program?
- A** It helps CAP's customers adjust their water treatment systems
  - B** The results are used to protect the quality of the water used for recharge
  - C** It is a helpful service to the cities and utilities that treat the water
  - D** All of the above
- 31.** Why does CAP use goats to clean grass out of the recharge basins and use vegetable oil instead of petroleum based oil to lubricate machinery which comes into direct contact with water?
- A** To test the water
  - B** To save money
  - C** To minimize manmade pollutants in the water
  - D** To minimize the amount of algae in the canal
- 32.** What steps has CAP taken to protect migration patterns?
- A** CAP conducted archaeological studies
  - B** CAP conducted biological studies
  - C** CAP built bridges in migration areas
  - D** All of the above



## Assignment and Assessment for Grades 6-8

- 33.** Instead of using chemicals, what does CAP use to clean the canal?
- A** Steel brushes
  - B** Native plants
  - C** Algae eating fish
  - D** Bald eagles
- 34.** Many species of fish are also supported by CAP's system. What type of fish was not found in CAP's system?
- A** Striped Bass
  - B** Marlin
  - C** Channel Catfish
  - D** Carp
- 35.** What has CAP done to lessen the system's impact on the environment?
- A** Wildlife watering sites were also built away from the canal
  - B** Cacti and other native plants were saved and moved from construction sites to create wildlife habitat in other places in the desert
  - C** Construction near bald eagle nests was scheduled to avoid nesting season
  - D** All of the above
- 36.** What contributes to the "hardness" of water?
- A** Calcium and magnesium
  - B** Algae and fish
  - C** Vegetable oil and petroleum
  - D** Fishing and Canoeing



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37. Read the information about canal safety. What is the author's main message?
- A It takes more energy to stop canal water than to stop a train
  - B The canal is dangerous and you should be careful if you are around it
  - C Canals can be popular recreation areas
  - D The canal sidewalls are slick
38. Why are swimming, tubing, canoeing and fishing probably **NOT** mentioned as recreational activities in the canal safety information?
- A The author does not like those activities
  - B The author did not think to mention them
  - C They should not be conducted at the canal
  - D They are only done during the summer
39. Which of the following **best** identifies the people with the greatest responsibility for canal safety?
- A Central Arizona Project security personnel
  - B Local law enforcement
  - C Homeowners association members
  - D Individual citizens
40. Which of the following **best** identifies a challenge faced by the Lands Department that can potentially contaminate the water?
- A Encroachments
  - B Illegal dumping
  - C Trespassing
  - D Vandalism



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**ANSWER SHEET**

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