H2O4U

Learning Unit Lesson Plans for Grades 9-12

Lesson 1

Mission: Access Water—Colorado River

Time: 50 minutes

Content Areas: Science, Social Studies, Language Arts, Workplace Skills

Lesson Overview/Purpose

During this lesson you will engage in a simulated convention to resolve disputes over the distribution of among the 7 Colorado River Basin States. Using 1920s census data you will formulate an oral argument to present at the convention. Afterwards, you will learn about how the U.S. government and the states agreed to split Colorado River Basin water between states. Finally, you will analyze and summarize the oral histories of people with personal experiences related to the Colorado River Basin.

Objectives

Students will:

- Analyze data to formulate an argument on a given topic.
- Argue a point supporting a particular position.
- Assess arguments and make a decision on an issue based on the information presented.

Vocabulary

- Acre Foot
- Aqueduct
- Basin
- Convention
- Oral History
- Tributary
- Watershed

Online Resources

- CAP Videos: YouTube Channel

Supplies/Materials/Equipment

- Internet connection and computer
- Notebook for journal entries
- Handouts provided in the lesson

Procedures

Step 1:

- Review key vocabulary that will be addressed in this lesson.

Step 2:

- Read the passage on the ***History of the Colorado River Basin.***
- Create a "tree-map" or other graphic organizer to summarize your reading.

Step 3:

- Analyze the 1920s census data on the chart provided and make a list of arguments that Arizona representatives might have used as they engaged in the debates over Colorado River water.

Step 4:

- Summarize your learning by responding to the following questions in your journal.
    - What were some reasons for the debate over the Colorado River water resource in the 1920s?
    - What factors did you consider when solving the problem?
    - How might the lack of water to the various states affect the quality of life? Water quality? Population density?
    - What might be some of the economic advantages for a state to have large quantities of water? Disadvantages?
    - Why did it take Arizona so long to sign the Compact?
    - What economic effects do you think the allocated water has had on each state, both positive and negative?
    - Based on the 2007 census data, do you think the water allocations had an affect on the population growth within each state, decades later? Explain your answer.

Step 5:

- Expand on your learning by going to the CAP website and reading some of the oral histories of elderly individuals who tell about their experiences with the Colorado River or CAP water delivery system.
- Write a 1-2 page summary of what you learned from the oral histories.

Lesson 1—Activity 1: Review the key vocabulary that will be addressed in this lesson.

Vocabulary List

Acre-Foot	**a • cre-foot** *n* 1. The volume of water that would cover an area of one acre to a depth of one foot, equivalent to 1,244.5 cu. M/43,560 cu. ft. 2. The equivalent of 325,851.43 gallons
Aqueduct	**aq • ue • duct** *n* 1. a pipe or channel for moving water to a lower level, often across a great distance 2. a structure in the form of a bridge that carries a canal across a valley or river
Basin	**ba • sin** *n* 1. a broad area of land drained by a single river and its tributaries, or draining into a lake 2. any depression in the Earth's surface that contains water 3. a bowl-shaped depression on land or on the ocean floor into which sediments may be deposited
Convention	**con·• ven·• tion** *n* 1. a meeting of delegates representing a party or group
Oral History	**o·• ral his·• to·• ry** *n* 1. the personal recollections of people who participated in historical events, recorded on audio or video tape or told to a younger generation
Tributary	**trib·• u·• tar·• y** *n* 1. a stream, river, or glacier that joins a larger stream, river, or glacier, or a lake
Watershed	**wa·• ter·• shed** *n* 1. the land area that drains into a particular lake, river, or ocean

Sources:

1. Encarta® World English Dictionary © 1999 Microsoft Corporation. Developed for Microsoft by Bloomsbury Publishing Plc.
2. CAP *

Lesson 1—Activity 2: Read the following passage. Create a "tree-map" or other graphic organizer to summarize your reading.

History of the Colorado River Basin

Located in the southwestern United States and northwestern Mexico, the Colorado River is 1,450 miles (2,330-kilometer) long with its headwaters in the Rocky Mountain National Park in north-central Colorado. The river is the primary source of water for a region that receives little annual rainfall. More than 1,000 years ago, Native Americans irrigated their crops with the waters from the river.

The Colorado River system, including the Colorado River, its **tributaries**, and the lands that these waters drain, is called the Colorado River **Basin**, or **watershed**. The Basin drains an area of 246,000 square miles (637,000 square kilometers), including parts of seven western U.S. states (Wyoming, Colorado, Utah, New Mexico, Nevada, Arizona, California) and Mexico. Three-fourths of the Colorado basin is federal land comprised of national forests, national parks, and Indian reservations. The drainage basin's total runoff is about 700 cubic meters (24,700 cubic feet) per second. It is the international boundary for 17 miles (27 kilometers) between Arizona and Mexico.

During the early 1900s, the states sharing the basin debated for shares of the Colorado River. In 1922, representatives from the seven states and the United States government created a compact allocating 15 million acre-feet to be shared by the states.

In 1922, representatives from the seven states and the U.S. government created the Colorado River Compact, which divided the states into upper and lower basins with provisions of 7.5 million acre-feet to be split among the states within each basin. The Boulder Canyon Project Act of 1928 was enacted to end pursuing interstate disputes. The act authorized specific water provisions for the lower basin states of Arizona, California, and Nevada. Specifically, California would receive an annual allocation of 4.4 million acre-feet; Nevada 300, 000 acre-feet; and Arizona 2.8 million acre-feet. However, political and legal interstate disagreements ensued over for another 16 years, with Arizona being the last to sign the compact in 1944.

As a result of these agreements, various dams, lakes and **aqueducts** were formed with water feeding from the Colorado River Basin. Lake Mead a popular United States recreation site, located in the upper basin state of Utah, is created by the Hoover Dam, which holds Colorado River water as it exits the Grand Canyon. As the river travels south it meets the Central Arizona Project's (CAP) aqueduct and the Colorado River Aqueduct (CRA). The CAP aqueduct diverts water 336 miles east and then south from

Lake Havasu to Tucson, while the CRA aqueduct diverts the river water 242 miles west across the Mojave and Colorado Deserts and south to the Salton Sea (an inland salt-water lake) in California.

Colorado, Utah, New Mexico, and Wyoming make up the four upper basin states. Colorado has the largest share of upper basin water allocation, with Utah at 23%, Wyoming at 14%, and New Mexico with 11.25%. The Big Thompson Project, located in Colorado 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. The upper basin also encompasses the Navajo Indian Irrigation Project, situated in on part of the Navajo Indian Reservation located in Northwestern New Mexico. The Project, built by the U.S. Bureau of Reclamation, is used exclusively for Navajo lands on or next to the reservation.

Lesson 1—Activity 3: Analyze the 1920s census data on the chart. Make a list of arguments that Arizona representatives might have used as they engaged in the debates over Colorado River water in the space provided.

1920s Census Data for the Seven Colorado River Basin States

State	Statehood Year	Population 1920	Population 2007	Density* 1920	Density* 2007	Urban Residents 1920	Rural Residents 1920	Value of Crops (per square acre)
Arizona	1912	334,162	6,338,755	2.9	45	35.2	64.8	$102.49
California	1850	3,426,861	36,553,215	22.0	217	68.0	32.0	$137.06
Colorado	1876	939,629	4,861,515	9.1	41	48.2	57.8	$51.48
Nevada	1864	77,407	2,565,382	0.7	18	19.7	81.3	$37.41
New Mexico	1912	360,350	1,969,915	2.9	15	18.0	82.0	$48.74
Utah	1896	449,396	2,645,330	5.5	27	48.0	52.0	$59.43
Wyoming	1890	194,402	522,830	2.0	5	29.5	70.5	$30.76
United States	--	105,710,620	304,105,724	35.5	--	51.4	49.6	--

* Number of Persons per Square Acre (population/square miles)
Source: U.S. Census Bureau

Lesson 1—Activity 4: Expand on your learning by going to the CAP website and reading some of the oral histories of elderly individuals who tell about their experiences with the Colorado River or CAP water delivery system.

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Lesson 2

The CAP Water Delivery System & Water Careers

Time: 50 minutes

Content Areas: Science, Social Studies, Language Arts, Workplace Skills

Lesson Overview/Purpose

During this lesson you will lean about the Central Arizona Project (CAP) water delivery system and its role in delivering its allocation of Colorado River Basin water in a cost-effective and environmentally sound manner throughout Pima, Pinal, and Maricopa Counties. You will identify some of the careers or jobs associated with the water delivery system and analyze the skills and knowledge necessary to fill such positions.

Objectives

At the end to lesson you will be able to:

- Summarize information presented using a graphic organizer.
- Devise a game that incorporates information presented.
- Develop a recruitment brochure highlighting a career related to water management and delivery.
- Evaluate a product using a rubric.

Vocabulary

• Agricultural	• Aquifer	• Hydrology	
• Municipal	• Percolate	• Recharge	• Siphon

Online Resources

- CAP Videos
- View the Know Your Water News downloads page and read the Conservation and Climate Change fact sheets.

Supplies/Materials/Equipment

- Internet connection and computer
- Notebook for journal entries
- Handouts provided in the lesson
- Poster board or chart paper

Procedures

Step 1:

- Review key vocabulary for this lesson.

Step 2:

- Welcome to Central Arizona Project
- Read the CAP Recharge StoryMap
- Use the CAP Water Delivery System map to highlight parts of the system identified in the videos.

Step 3:

- Use the Internet to identify and research careers in water management and delivery systems.
- Create a job ad for a career from the list provided.
- Include the following details:
    - Required skills, knowledge, and education—field of study or major (engineering, science), if applicable
    - Duties
    - Rate of pay
    - Work hours
    - Work area (e.g. indoors, outdoors, rural area)
    - Any other important details

Step 4:

- Record and respond to the following questions in journal.
    - What is the main goal of the Central Arizona Project?
    - What is recharging? Why is it necessary?
    - What governing entities must collaborate to ensure that the CAP water delivery system operates? What would happen if they did not collaborate?
- Write a summary of what you learned about water management and delivery systems in journal.

Lesson 2—Activity 1: Review the key vocabulary that will be addressed in this lesson. You will this sheet again for Activity 3.

Vocabulary List

Agricultural	**ag • i·• ul • tur • al** *adj* 1. involving or relating to agriculture 2. with farming as the dominant way of life
Aquifer	**aq • ui·• fer** *n* a layer of permeable rock, sand, or gravel through which groundwater flows, containing enough water to supply wells and springs
Hydrology	**hy • drol • o·• gy** *n* the scientific study of the properties, distribution, use, and circulation of the water of the earth and the atmosphere in all of its forms
Municipal	**mu·• nic·• i·• pal** *adj* 1. relating to a town, city, or region that has its own local government
Percolate	**per·• co·• late** *v* 1. vi to pass slowly through something or spread throughout a place
Recharge *	**re • charge** *vt* 1. the addition of surface water to an aquifer. 2. natural recharge occurs when naturally occurring surface water infiltrates through the unsaturated zone (vadose zone) and is stored in an aquifer as groundwater. 3. artificial recharge is an engineered system (either natural or human designed system) designed to store surface water in an aquifer. Artificial recharge occurs in two ways: surface infiltration and direct injection.
Siphon	**si·• phon or sy·• phon** *v* 1. vt to transfer liquid from one container to another through a tube using atmospheric pressure to make it flow

Sources:

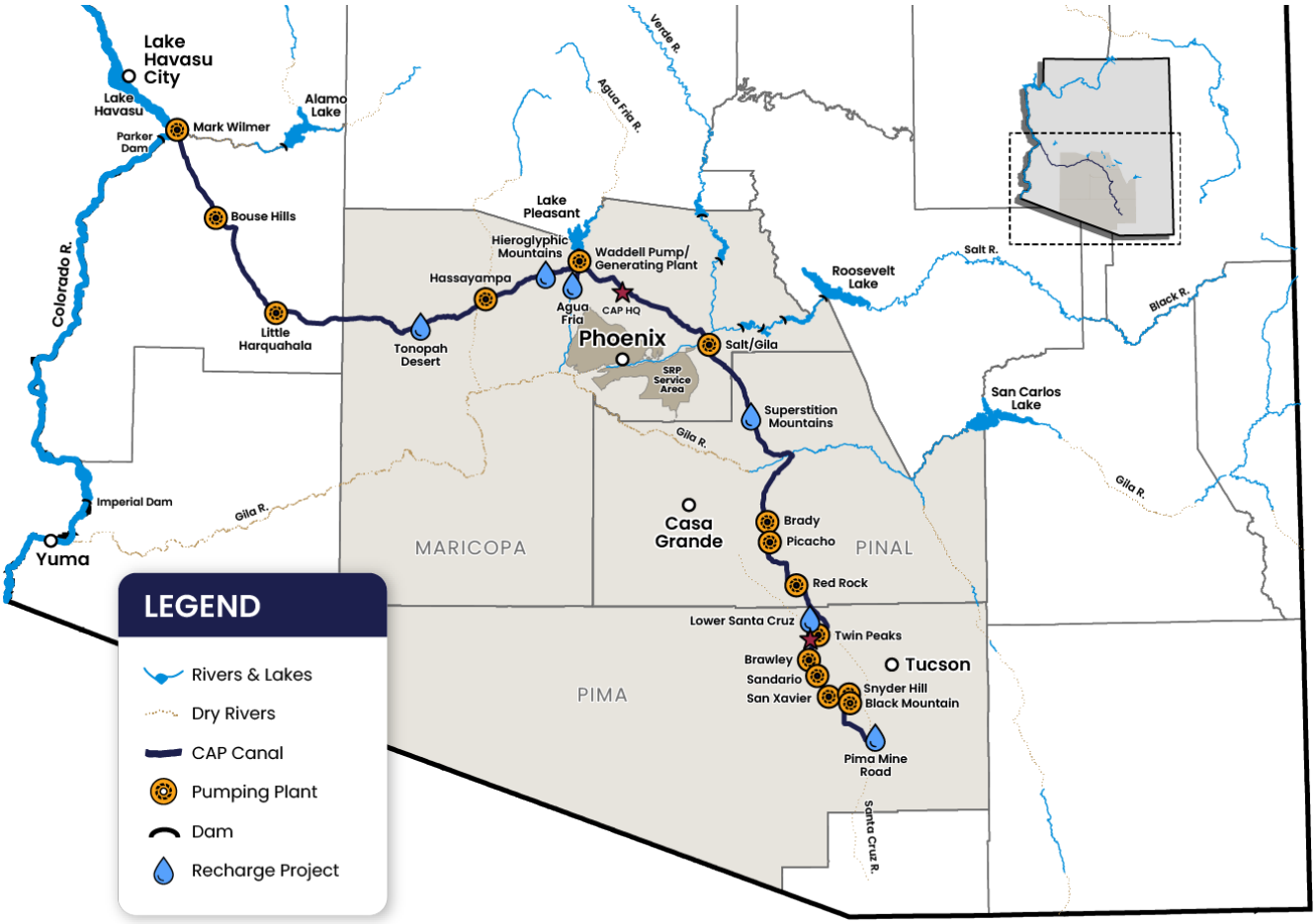
1. Encarta® World English Dictionary © 1999 Microsoft Corporation. Developed for Microsoft by Bloomsbury Publishing Plc.
2. CAP *

Lesson 2—Activity 2: Read/view the following resources:

- Welcome to CAP video
- CAP Recharge StoryMap
- CAP System StoryMap

Use the map on the next page to track parts of the Central Arizona Project's water delivery system highlighted in the videos.

Central Arizona Project Water Delivery System Map



Lesson 2—Activity 3: Use the Internet to identify and research careers in water management and delivery systems. Create a job ad for a career from the list provided on the next page. Include the following details:

- Required skills, knowledge, and education—field of study or major (engineering, science), if applicable
- Duties
- Rate of pay
- Work hours
- Work area (e.g. indoors, outdoors, rural area)
- Any other important details

Use the space below to write your final draft.

Water Delivery Systems and Management Careers

- Water Operator
- Land and Water Use Analyst
- Hydrologist
- Geologist
- Land Surveyor
- Security Maintenance
- Systems Operator
- Hydroelectric Power Utility Engineer
- Control Engineer
- Electrical Engineer
- Engineering Geologist
- Automobile Mechanic
- Groundskeeper
- Heavy Equipment Mechanic
- Hydroelectric Plant Electrician Apprentice
- Hydroelectric Plant Electrician
- Hydroelectric Plant Mechanic Apprentice
- Hydroelectric Plant Mechanic
- Hydroelectric Plant Operator Apprentice
- Hydroelectric Plant Operator
- Draftsperson
- Environmental Scientist
- Information Systems Analyst
- Information Systems Technician
- Junior Chemist
- Public Health Chemist
- System Software Specialist
- Attorney
- Legal Assistant
- Engineer, Water Resources
- Mechanical Engineer
- Photogrammetrist
- Accountant
- Accounting Administrator
- Associate Governmental Program Analyst
- Land Agent
- Management Services Technician
- Right of Way Agent
- Staff Services Analyst
- Maintenance Mechanic
- Utility Craftsworker, Water Resources
- Warehouse Worker
- Water and Power Dispatcher
- Water Resources Technician
- Water Resources Engineering Associate
- Water Services Supervisor

Lesson 4

Canal Safety

Time: 50 minutes

Content Areas: Science, Social Studies, Language Arts, Workplace Skills

Lesson Overview/Purpose
In this lesson you will learn about some of the canal safety issues encountered by CAPs Lands Department. Afterwards, you will discuss these issues and the potential dangerous or negative consequences they pose for both humans and animals. Then, you will work in small groups to design a mascot and coloring booklet or picture booklet for younger students to educate them about canal safety.

Objectives
At the end of the lesson you will be able to:
- Assess a problem to determine potential consequences and solutions.
- Create a product to educate others about a given topic.

Vocabulary
- safeguard

Online Resources
- CAP Videos: YouTube Channel
- See example of Otto the water safety mascot

Supplies/Materials/Equipment
- Internet connection and computer
- Notebook for journal entries
- Handouts provided in the lesson

Procedures

Step 1:

- Review key vocabulary for this lesson.

Step 2:

- Read the list of challenges that the CAP Lands Department has to address.
- Make a list of ways people should and can safeguard the canals.

Step 3:

- Create a coloring or picture book for primary students that teachers them about canal safety.

Step 4:

- Record and answer the following questions in your journal.
  - What are some of the consequences for citizens not behaving responsibly around canals?
  - How can you help to safeguard the canals?
  - How can waste dumping be detrimental to the water?

Lesson 4—Activity 1: Review the key vocabulary that will be addressed in this lesson.

Vocabulary List

Safeguard	**safe·• guard** *n* 1. something intended to prevent undesirable consequences from happening, for example, a safety device or measure, or a proviso in a legal document 2. a document providing safe-conduct *vt* to prevent something or somebody from being harmed, damaged, or lost

Lesson 4—Activity 2: Read CAP Canal Safety Challenges. Then, a list of "things" people should and can do to safeguard the canals in the space below.

CAP Canal Safety 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 lands; 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
- Encroachments

Water Depth and Flow
While the canal waters appear to be calm and dauntless, most people do not realize that the average depth of the CAP canals is 18 feet; the concrete sidewalls are steep and slippery; and flow rates run about 3,000 cubic feet per second or 2 miles per hour.

Vandalism/Theft
CAP has installed security fencing around the canals to prevent entry into the hazardous area by both people and wildlife. When vandals cut the security fencing, it creates holes for small children and wildlife to enter the hazardous area.

Thieves and vandals will often cut through the security fencing to gain access to the canal. In the process they destroy or damage equipment or property. Theft often includes the removal of copper and other valuable metals.

Target shooting not only poses a safety hazard to those nearby the canal, but can also cause significant damage to equipment and other structures. Other common forms of vandalism include graffiti and stolen cars that have been dumped into the canal.

Trespassing
This can often take the form of operating ATVs and motorcycles on the property. Such activity can cause major damage to area vegetation and cause significant dust pollution. CAP is responsible for maintaining dust pollution on the properties and can be penalized for violation, no matter what the cause.

Encroachments
Some people mistake the chain link fencing for CAP's property boundary lines. Unfortunately, this often results in encroachments by developers and new homebuilders. Typical encroachments include: block walls, fences, driveways, walkways, and landscaping.

Illegal Dumping
Often people will dump hazardous waste items, such as oil, paint, construction or landscaping debris, and industrial solvents. This creates a problem, as the chemicals can contaminate the water and are extremely costly to remove.

Trail Development
CAP boundaries are can be located up to ½ mile away from the canal security fencing and about 10-20 feet away on the south or west side. The narrower boundary has been designated for walking and bike paths, and trails to be enjoyed by people residing near the canal. While CAP can facilitate the construction of these upgraded recreational areas, they do not have the legal authority to develop, secure, or maintain them. Developers must incorporate these recreational paths into their development plans, if agreed upon by the municipality. However, it must be decided who will be responsible for the maintenance and oversight of the areas before the developer can proceed with the plans. CAP can only make these agreements with another governmental agency. Often these are homeowners' associations.

Lesson 4—Activity 3: Summarize your learning by creating a coloring book with captions or picture book for primary aged students that educates them about canal safety. Use the space below to create a storyboard, which will serve as a guide when creating your final draft. You can also create a storyboard by printing blank PowerPoint™ slides.