Post-festival Lesson 6.2 Water Web Lesson Plan

Investigative Question:

- How do I use water both directly and indirectly?
- What are the water sources and who are the water users in my community?

Summary: Students define direct and indirect water use and explore how they use water in their daily lives. Students explore local industries in Arizona to see how they use water. Then students model a "water web" to illustrate their dependence on water and the interdependence among water users, producers and people in the community.

Reference: adapted from "Arizona Water Web" Part 1, *Arizona Conserve Water Educator's Guide*, 2007, pg. 190-206 and "Virtual Water", Project WET Curriculum and Activity Guide 2.0, 2011, pg. 289-296.

Time Frame: 50 minutes

Cross Cutting Concepts Demonstrated:

- cause and effect
- systems and system models
- stability and change
- scale, proportion, and quantity

Science and Engineering Practices Integrated:

- develop and use models
- construct explanations and design solutions

Materials Needed:

- Direct and Indirect Water Use worksheet
- Arizona Water Resources and Users
- Copy of Water Users Cards (enough for each group)
- 2 – one-gallon empty milk jugs filled with water – label one "groundwater" and one "surface water" tied together with yarn.
- 1 ball of yarn
- Enough Dixie cups for one per student

Warm Up:

Use the lesson 6 slides to introduce this lesson. Discuss with students: **Direct and indirect water usage, what do you use water for?** Have students quickly brainstorm a list of how they use water at home. Explain that these are direct uses of water. Then ask: **What do you think is meant by the phrase: indirect use of water?**

Post-festival Lesson 6.1 Water Web Lesson Plan

If students do not know, ask them if they think water is used to make the food they eat or tools they use. Explain that producing things requires a lot of water. Water is used when manufacturing products and growing things (two examples of indirect water). For instance, a 2 oz. serving of pasta takes 36 gallons of water to produce the ingredients and make the pasta. Have students name other indirect water uses or users they can think of.

Lesson Sequence:

Investigation:

Give each student a copy of the Direct and Indirect Water Use Worksheet. Using the information they discussed in the warmup, have **students fill out Tables 1 and 2**. (If students are not able to use the form, they can write answers in their notebooks.) Then students will r**ead about some industries in Arizona** and how they use water directly and indirectly. After, students should **fill out Table 3 using that information**. Have students discuss as a class what they learned about indirect water use in Arizona and how communities might reduce their water usage overall.

Activity – full-body simulation:

In **table groups**, students will look at what happens when everyone in the community shares a common water source and think about ways water usage can be reduced to meet the water supply.

1) Summarize what students know so far about indirect water users in Arizona. **Who are the indirect water users in Arizona that they have learned about in this lesson so far? Divide Students into 8 groups and each group will get one of the water user cards.**
2) **What are our water sources in Arizona?** Each group of students should **identify their local water sources** and discuss where their user might be in the state (multiple places possibly). They can use the AZ Water Sources by Festival document if they don't know.
    a) While students discuss in their groups, you should clear an area in the middle of the room and place the two milk jugs on a desk or chair. Make sure they are labeled ground water and surface water and draw a line of where the water level is currently on each, so it is visible to all students. Also pass out one dixie cup to each student.
3) Have a **volunteer from one of the groups read the description of the water user** they represent. Also have students explain if as that user they most likely use surface water or groundwater, or both. Then **connect the ball of yarn from that group of students and loop it through one of the handles on the jug and then back to their group.** The yarn indicates that this water user consumed water.

    a) After the student is done reading the card, also **have each student in that**

Post-festival Lesson 6.1 Water Web Lesson Plan

group come up and fill their Dixie cup with water from one of the jugs.

4) **Ask students in other groups to raise their hand if they use the goods or services offered by that group** (this can be repeated after each time a new group reads a card so students can see all the connections). Have students consider how they depend on products and services supplied by others. Example a car manufacturer is dependent on the power plant, the steel plant and the water used to create it.
5) Tell the students with the yarn to **pass the ball to a student in a different group and have them read the description of the water user they represent**. Have them explain if as that user they most likely use surface water or groundwater, or both. Then **connect the ball of yarn from that group** of students to the jugs again and each student in this group **now also fills up their Pixie cup**.
6) Repeat the process for all water user groups **until each group is connected to a jug and each student has a Dixie cup full of water**.
7) Look at the **level of the water now in the jugs**… has it gone down? Why? Have the students gently pull on their yarn. Students should feel these tugs and see that the water supply becomes unstable. **What do these tugs represent in the real world?** The water use of one water user affects all the other water users.
8) Discuss: **What would happen to the water in the jugs if each student had had two dixie cups to fill instead of one?** The level of water in both jugs would be lower or might run out. **What would happen if some water users had more dixie cups than other users? Do all users use the same amount of water?** When others use more, then there is less for others.
9) **What will need to happen to make the water level go up again?** More water will need to come into the water supply. **Ask students, what is another way we can keep the water supply up?** We can each use less water.

Wrap-Up:

Discuss as a class:

1) Have each group of students think of **one way they can reduce their water usage in their production process or service**. Then as that group shares their water reduction strategy, each student in the group should **pour half the water back from their Dixie cup into their water supply**. Repeat this until each group gets to go again.
2) **What does reducing the amount of water they use do for the amount of water available?** It increased the available water. **What does this mean for the availability of water for the whole community?** There is more for everyone.
3) **If there are water shortages, what are some solutions for coping with the problem without causing hardships for a community or water users?** Students should think of other ways their community can decrease water usage and save water.

DIRECT AND INDIRECT WATER USE WORKSHEET

How do we use water?

Water can be used for direct and indirect purposes. When you use water for things like bathing, drinking, or cooking it is direct use. In other words, if you turn on the tap and use the water then it is considered direct use.

Indirect water use is when water is used to produce or make the goods that people need. Water is being used during the growing, production, and delivery of those goods. An example of indirect water use would be making paper. In this example water is used to grow the tree that eventually is cut down for paper and water is used in the process that makes the actual paper.

Table 1. At home what are some examples of direct water use? Give 3 examples of direct water use and estimate or guess how much water it takes to do each of those.

	Direct water use	How much what do you think it takes?
1.		
2.		
3.		

Arizona's diverse land and climate give us the opportunity to have many kinds of industries that produce goods that we consume, use, or need. Water is used in the production of those goods.

Table 2. At home what are some items that were produced with indirect water use? Give 3 examples.

	Indirect Water Use Items
1.	
2.	
3.	

DIRECT AND INDIRECT WATER USE WORKSHEET

Did you know? Read about industries in Arizona that use water.

Frito-Lay: is part of the Pepsi Company. It has 29 snack brands! The company has a manufacturing facility in Casa Grande, Arizona where they produce your favorite chips like Ruffles, Fritos, Tostitos, Doritos and Cheetos. It turns about 500,000 potatoes into potato chips every day. It takes about 49 gallons of water to produce a small bag of potato chips. The water is used to rinse the potatoes and water is also mixed with potatoes to make a chip. There is additional water used when making plastic bags and growing the potatoes. The Casa Grande facility generates its own power and generates nearly zero waste! This means they use recycled water during the production! If they do need additional water, they use groundwater.

Cattle Ranching: Ranchers are one of the largest land users in Arizona. In Arizona 73% of Arizona's total land area is used for grazing livestock. Meaning most of the land in Arizona is used to raise cattle. There are approximately 1 million cattle which equals 455.7 million lbs. of red meat (beef). Beef provides 10 essential nutrient that includes zinc, iron, protein, and B vitamins. Ranchers not only produce beef, but they also produce milk. There are 4.5 billion lbs. of milk produced each year from 205,000 cows! It takes 48 hours for the milk to get from the dairy farm to the store. Water is used in every step on the production of beef and milk! Specifically, to make a hamburger patty it takes approximately 660 gallons of water and 50 to 60 gallons of water for a small glass of milk (~8 oz). Water is used to clean cattle, for cows to drink, to wash cut meat, to clean equipment, and water is also mixed with milk. There are 3 main water sources: Groundwater, Surface water (lakes and rivers), and Colorado River water (brought through canals called Central Arizona Project).

DIRECT AND INDIRECT WATER USE WORKSHEET

Intel: A technology company, Intel has been in Chandler, Arizona for over 40 years! And is one of the largest manufacturing companies in the state. It produces small microchips made of semiconducting materials for your computer. The microchips are super small but during manufacturing it is important to keep parts clean, so ultra-pure water is used (water that has no minerals). So much water is used during production, ~2 million gallons per day (30,000 bathtubs)! To reduce water use Intel recycles the water. After manufacturing, water is collected and cleaned. The cleaned water can then be used again during the production process or is sent to irrigate golf courses and replenish urban lakes around the City of Chandler. Water from the Salt River Project and the Central Arizona Project Canal, along with groundwater, is brought to the facility through pipes.

Freeport-McMoRan Copper & Gold Mines: One of the largest copper companies in the world. Copper mining is an industry that helped found Arizona's economy and it's represented in the seal of Arizona. In 2014 Arizona produced ~65% of the country's copper. Copper is essential in the production of smart phones, mobile devices, airplanes, solar panels systems, home plumbing, vehicles, and medical care products. Copper also kills bacteria! Copper is extracted from hard rocks that are crushed into smaller rocks. Water is used to keep dust down during mining and crushing. Also, water is used to extract the copper from the rocks. Freeport uses about 18 billion gallons of water per year between all its 5 mines in Arizona. It takes about 400 to 800 gallons of water to produce one ton of copper (or 2,000 pounds), that is like a very large boulder or rock! Because of the location of the mines, more of the water used is groundwater.

DIRECT AND INDIRECT WATER USE WORKSHEET

Your Turn:

Table 3. Using what you read above, fill in the information on the table below.

Item or activity	How much water does it take?	How is water being used?	Where is the water coming from?
Small bag of potato chips			
Hamburger (including bread, meat, lettuce, tomato)			
One ton of copper			
Small glass of milk			
Semiconductors (per day by company) (see Intel below)			
Flush toilet	1.6-7 gallons	Direct use.	
Shower (5 minute)	27 gallons	Direct use.	

Some more interesting indirect water use numbers -

- **One sheet of paper**: ~3 gallons. It takes water to harvest the trees. Wood is made in to pulp in which water is used.
- **One apple**: ~17-22 gallons. It takes water to harvest the trees and to rinse and sanitize the fruit.
- **One slice of cheese**: ~40 gallons. This includes water used for raising and grazing cattle. It requires water during the production process of making milk to cheese.

To find more water footprints of other items we use visit:

https://www.watereducation.org/post/food-facts-how-much-water-does-it-take-produce

https://www.watercalculator.org/water-footprints-101/

COOPERATIVE EXTENSION
Arizona Project WET
Arizona Water Festival

Arizona Water Resources and Users by Water Festival and Location

Notes when using this resource:

- CAP (Central Arizona Project) is Colorado River water and a separate water resource from in-state rivers
- Salt River, Verde River, and Agua Fria River are in-state rivers
- SRP (Salt River Project) water is Salt and Verde River water

Festival	City or Area	County	Water Service Provider/s	Water Sources	Major Water Users*
Apache Junction	Apache Junction	Pinal	Arizona Water Company, City of Apache Junction	CAP, groundwater	Business and industry, mining, agriculture
Bisbee	Bisbee	Cochise	Arizona Water Company	groundwater	Agriculture, tourism/recreation, US Army Intelligence and Fort Huachuca
Buckeye	Buckeye	Maricopa	City of Buckeye	groundwater (98%), CAP (2%), treated effluent (irrigation use only)	Business and industry, agriculture, tourism/recreation, energy production
Casa Grande	Casa Grande	Pinal	Arizona Water Company	groundwater	Business and industry, mining, agriculture
Chandler	Chandler	Maricopa	City of Chandler	SRP, CAP, groundwater, reclaimed water (outdoor and irrigation uses)	Business and industry, agriculture, tourism/recreation, energy production
Flagstaff	Flagstaff	Coconino	City of Flagstaff	Inner Basin Spring water (4%), Lake Mary Reservoir (17%), groundwater (58%),	Northern Arizona University, business and

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				reclaimed water (21%)	industry, tourism/recreation
Florence	Florence	Pinal	Florence Public Works Dept and Johnson Utilities (EPCOR)	groundwater	Business and industry, mining, agriculture
Gilbert	Gilbert/Mesa	Maricopa	Town of Gilbert	SRP, CAP, groundwater	Business and industry, agriculture, tourism/recreation, energy production
Goodyear	Goodyear	Maricopa	City of Goodyear	groundwater	Business and industry, agriculture, tourism/recreation, energy production
Lake Havasu	Lake Havasu/Needles, CA	Mohave	Lake Havasu City	CAP, groundwater	Energy production, agriculture, business and industry
Litchfield	Litchfield Park/Avondale/Buckeye	Maricopa	City of Avondale, Liberty, EPCOR	Avondale: CAP, SRP, groundwater, reclaimed, recharge EPCOR: CAP, Agua Fria River water captured at Lake Pleasant, groundwater	Business and industry, agriculture, tourism/recreation, energy production

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				Liberty: groundwater	
Littleton	Avondale/Tolleson	Maricopa	City of Avondale	CAP, SRP, groundwater, reclaimed, recharge	Business and industry, agriculture, tourism/recreation, energy production
Madison	Phoenix	Maricopa	City of Phoenix	SRP, CAP, groundwater, reclaimed water (irrigation uses and aquifer recharge)	Business and industry, agriculture, tourism/recreation, energy production
Marana	Marana/Tucson	Pima	Town of Marana, Tucson Water	CAP, groundwater	Business and industry, Davis-Monthan Airforce Base, education, and agriculture
Maricopa	Maricopa	Pinal	Global Water Resources, Inc.	groundwater	Business and industry, mining, agriculture
Nogales	Nogales/Patagonia	Santa Cruz	City of Nogales, Town of Patagonia	Patagonia: groundwater	Agriculture (beef cattle operations), winter produce warehousing (from Mexico Farms), tourism/recreation
Osborn	Phoenix	Maricopa	City of Phoenix	SRP, CAP, groundwater,	Business and industry,

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				reclaimed water (irrigation uses and aquifer recharge)	agriculture, tourism/recreation, energy production
Payson	Payson/Strawberry	Gila	Town of Payson Water Department	groundwater pumped from Payson's fractured granite aquifer	Livestock ranches, mining, construction companies, San Carlos Apache Reservation Sawmill
Peoria	Peoria/Glendale	Maricopa	City of Peoria	CAP (43%), SRP (30%), groundwater (33%), reclaimed (3%)	Business and industry, agriculture, tourism/recreation, energy production
Roosevelt	Phoenix	Maricopa	City of Phoenix	SRP, CAP, groundwater, reclaimed water (irrigation uses and aquifer recharge)	Business and industry, agriculture, tourism/recreation, energy production
Sahuarita	Sahuarita and Green Valley	Pima	Community Water Company of Green Valley, Farmers Water Company, Las Quintas Serenas Water Company, Quail Creek Water	groundwater	Business and industry, Davis-Monthan Airforce Base, education, and agriculture

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			Company, Sahuarita Village Water, Sahuarita Water Company, Valle Verde Del Norte Water Cooperative, Inc.		
Sierra Vista	Sierra Vista	Cochise	Liberty, Arizona Water Company, Pueblo Del Sol Water Company	Liberty: groundwater	Agriculture, tourism/recreation, US Army Intelligence and Fort Huachuca
Southern Gila	Globe/Miami	Gila	**City of Globe,** Arizona Water Company	groundwater	Livestock ranches, mining, construction companies, San Carlos Apache Reservation Sawmill
Tempe	Tempe	Maricopa	Tempe Water Services Utilities Division	SRP, CAP, and groundwater	Business and industry, agriculture, tourism/recreation, energy production
Tucson – Amphi	Oro Valley/Tucson	Pima	Tucson Water	groundwater, CAP, and effluent	Business and industry, Davis-Monthan Airforce

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					Base, education, and agriculture
Verde Valley	Cottonwood/Camp Verde/Clarkdale	Yavapai	City of Cottonwood, Town of Clarkdale, Town of Camp Verde	Cottonwood: groundwater Clarkdale: groundwater Camp Verde: groundwater primary (residential/municipal), surface water (agriculture), CAP (small—contract exchange)	Agriculture (livestock ranches), business and industry, tourism/recreation
West Valley	Surprise/Glendale/El Mirage	Maricopa	City of Surprise, City of Glendale, EPCOR, City of El Mirage	Surprise: groundwater, CAP, reclaimed Glendale: SRP, CAP, groundwater, effluent	Business and industry, agriculture, tourism/recreation, energy production
Yuma	Yuma	Yuma	City of Yuma	Colorado River water, Ground Water	Agriculture and related industries, tourism/recreation

*Major water users do not include all water users, just those with the largest water use footprint.

In addition to the descriptions listed below, students may research a specific water user during the week prior to this activity.

Agriculture:

Water is used to produce food and fiber for processing and consumption.

Sugar cane grower: Uses water to irrigate crops and transport chemicals (pesticides and fertilizers) to crops.

Cattle rancher: Uses water to grow food and provide drinking water for cattle and to clean their areas for living and feeding, transporting waste to holding ponds.

Wheat farmer: Uses water to irrigate crops.

Dairy farmer: Uses water to grow food and provide drinking water for cows and to sanitize milking equipment and stalls.

Mining:

Water is used in the extraction process of raw materials (coal, iron, gold, copper, sand and gravel).

Miner: Uses water to carry and wash rock material during the mineral removal processes.

Sand and gravel company: Uses water to wash fine soil and rock material out of sand and gravel formations. Sand and gravel are used in cement and road construction.

Logging:

Water is used to grow and harvest trees.

Forest manager: Uses water to support tree growth and control fires.

Logging company: Uses water to float rafts of logs (on rivers and lakes) to collection points.

Transporting/Shipping:

Water (rivers, seas, oceans) is used to transport raw materials and finished products to points of distribution (ports).

Slurry pipeline owner: Uses water to transport pulverized coal through pipelines to distant coal-fired power plants.

Ship's crew: Uses water to haul raw materials (e.g., logs, oil, gas, wheat) and finished products (e.g., automobiles, appliances, processed food) to points of transfer.

Business/Industry:

Water is used in the processing and manufacturing of goods (e.g.,cars, food, medical supplies, etc.).

Steel producer: Uses large volumes of water to process iron ore into steel.

Textile manufacturer: Uses water to wash and process raw materials (e.g., wool, cotton, mohair). Dye is mixed with water to color fabric.

Paper mill: Uses water to transport pulp fibers for paper making and to carry away waste.

Wildlife:

Water provides habitat for countless plant and animal species.

Mammals: Beavers, muskrats and otters live in and near waterways.

Fish: Trout, salmon and carp live in water and eat organisms that live in water.

Insects: Aquatic insects are a food source for many other organisms.

Vegetation: Trees and other plants use water in photosynthesis and to transport nutrients.

Recreation:

People recreate in and around water for exercise and enjoyment.

Cruise ship: People travel to many parts of the world in cruise ships.

Fishing: People catch fish in rivers, lakes and oceans.

Water theme park: Uses water to transport people on exciting and fun rides.

Scuba diver: People enjoy exploring underwater environments.

Winter sports: Snow and ice provide fun for skaters, skiers and sledders.

Power Generation:

Water is used to generate electricity.

Hydropower plant: Water flowing in rivers is stored behind dams in reservoirs. As water is released by the dam, it turns turbines that generate electricity.

Nuclear power plant: Uses water in cooling towers to maintain safe operating temperatures.

Coal-fired power plant: Burning coal produces steam heat that turns turbines, creating electricity.

Community:

Water is used by community members for domestic, maintenance and recreational purposes.

Domestic users: Water is used in a multitude of ways in and around the home.

Fire department: Uses water to extinguish fires.

Street cleaner: Uses water to wash oil, litter and other materials from streets.

Restaurant owner: Uses water to cook meals, clean the restaurant and water lawns/grounds.

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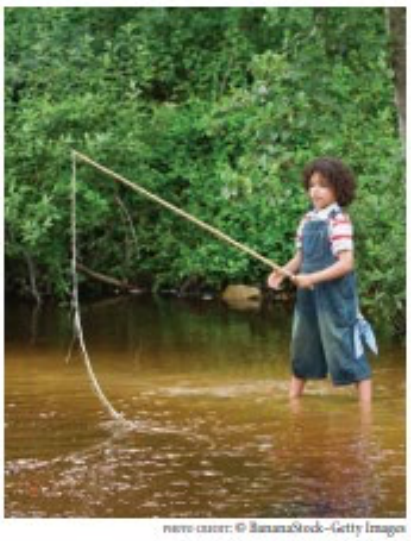

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