



## DESCRIPTION

Students compete in a water allocation relay to (1) learn about tradeoffs in allocating scarce resources and (2) receive an introduction to the water-use variables in the dataset they will use for the rest of the project. Students learn about water-use data for six user groups in Doña Ana County, New Mexico: residential, agricultural, livestock, commercial, power, and industrial/mining.

## GRADE LEVEL 6-12

## OBJECTIVES

Students will:

- Understand that allocating water to six user groups requires difficult decisions because there is not always enough water to meet all needs, especially during times of drought

## TIME 45 MINUTES

## LESSON OPTIONS:

There are two options for delivering this lesson. Option 1 is a hands-on activity that requires the materials listed below. Option 2 is a five-minute video, which is best for educators with limited time or resources.

### OPTION 1: HANDS-ON WATER ALLOCATION RELAY

#### MATERIALS

- Computer and projector for educator
- [Powerpoint presentation](#)
- Two 1,000 mL graduated cylinders
- Empty Water Bottles [1 of each size]
  - o 1 Gallon
  - o 1 Liter
  - o 16 oz.
  - o 8 oz.
- Twenty 5-oz. clear plastic cups
- Two overflow containers, shallow plastic 9-cup containers (Figures 1 and 2)
- Paper towels
- Timer
- If a sink is not available, an empty 5-gallon container in which to dump water from the relay is needed
- An alternative to the in-class relay is to have students watch the [Water Allocation Video](#). The video transcript is [available here](#).

#### PREPARATION

1. Set up a projector and computer to display the slide presentation.
2. Set up the Water Allocation Relay supplies (Figures 1 and 2). Before the relay, label the cups, graduated cylinder, water bottles, and overflow container.
  - a. The Year of Plenty setup (Figure 1) includes:
    - i. 1 gal container of water labeled **groundwater**
    - ii. 1 L container of water labeled **surface water**
    - iii. 100 mL graduated cylinder labeled **Doña Ana County Population**
    - iv. 8-cup plastic container labeled **WCDJ Water Allocation Relay Year of Plenty**
    - v. Ten 5 oz. cups labeled as follows:
      1. 1 cup labeled **human needs**
      2. 1 cup labeled **industry needs**

3. 5 cups labeled **agriculture needs**
  4. 3 cups labeled **agriculture needs - surface water**
  - b. The Year of Drought setup (Figure 2) includes:
    - i. 16 oz. container of water labeled **groundwater**
    - ii. 8 oz. container of water labeled **surface water**
    - iii. 100 mL graduated cylinder labeled **Doña Ana County Population**
    - iv. 8-cup plastic container labeled **WCDJ Water Allocation Relay Year of Drought**
    - v. 10 5 oz. cups labeled as follows:
      1. 1 cup labeled **human needs**
      2. 1 cup labeled **industry needs**
      3. 5 cups labeled **agriculture needs**
      4. 3 cups labeled **agriculture needs - surface water**
  3. Plan to divide the class into two teams:
    - a. Year of Plenty group
    - b. Year of Drought group
2. **Slide 2:** we will examine the major water users of Doña Ana County because these are also the major water users throughout New Mexico. In our water allocation relay, we will use different-sized water bottles to represent water found on the surface and water from underground, called groundwater. These sources will need to meet the needs of Doña Ana County. Surface water is a body of water that is above ground, such as lakes, rivers, and arroyos. The water from the ground is from aquifers. Most water for residential use in New Mexico comes from groundwater.
  3. **Slide 3:** the unit for the water data is acre-feet. One acre-foot is the amount of water that would cover one acre (approximately the size of a football field from goal post to goal post) at one foot of depth. It is equivalent to 325,851 gallons. [This is an animated slide that auto-plays and repeats.]
    - a. The total withdrawal from both surface and groundwater in Doña Ana County each year is 382,501 acre-feet, which is more than 124 billion gallons.
  4. **Slide 4:** we will represent the water withdrawal for six common water users in Doña Ana County: residential, agricultural, livestock, commercial, industrial & mining, and power. The total amount of water in each sector will be represented by 10 cups.
    - a. To simplify the distribution for the Water Allocation Relay, each cup will represent a range from 2-18% or 8,330 to 68,850 acre-feet of the total withdrawal.
  5. **Slide 5:** approximately 10% of the total water use is for residential users (37,605 acre-feet). The cup representing this will be called **human needs**. In Doña Ana County, all the water for residential use comes from groundwater. This use category includes community water systems, which are metered, and domestic private wells, which are estimated. This is the water that comes to your house for you to drink, bathe, wash clothes, do dishes, and perform other household chores.
  6. **Slide 6:** irrigated agricultural use and livestock use are combined in this relay for a total of eight cups. These combined categories make up 88% (336,566 acre-feet) of total water use in Doña Ana County. To meet these needs, farmers use a combination of surface water and groundwater. Groundwater withdrawal for agriculture will be represented by five cups. Surface water

## PROCEDURES

1. **Slide 1:** today, we will learn how we use and allocate water through a water resource relay. You will be looking at water use data in this



Figure 1. Year of Plenty setup, including 10 small cups, one 1000-mL graduated cylinder, a one-gallon bottle filled with water, a 1-L bottle filled with water, and an overflow container

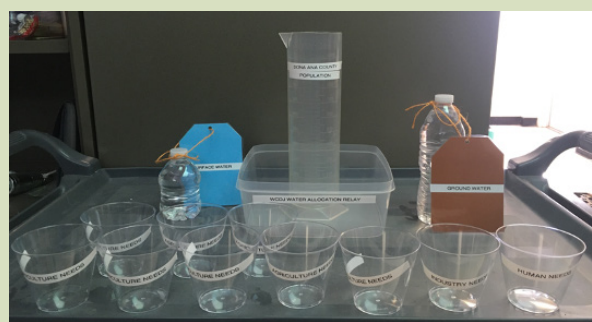


Figure 2. Year of Drought setup, including 10 small cups, one 1000-mL graduated cylinder, a 16-oz. bottle filled with water, a 8-oz. bottle filled with water, and an overflow container

withdrawal for agriculture will be represented by three cups. This is the water used to irrigate all crops, farm use, ranch use, and wildlife. Soil types and water requirements for each crop type are used to estimate water use. Meters are used when farms are irrigated with surface water. Farmers are only allowed a certain allotment of surface water per acre.

7. **Slide 7:** the last cup will combine water use for industry, commercial, mining, and power; these are combined in our relay because they do not use a large percentage of the total water use. These uses combined make up about 2% (8,330 acre-feet) of total water use. All of this water comes from groundwater.
  8. **Slide 8:** separate students into two groups: one group for the year of plenty and one group for the year of drought.
    - a. The goal for each group is to use the ground and surface water resources they have to meet the needs of the population.
      - i. All the cups must be filled with water, then emptied into the Doña Ana County Population graduated cylinder. The winning team is the one with the most water in their graduated cylinder at the end.
      - ii. Cups labeled "surface water" must be filled from the surface water container. All other cups will be filled from the groundwater container.
    - b. The amount of water each group has depends on whether it is a year of plenty or a year of drought. However, the demand of the population as a whole is constant, represented by the graduated cylinder. Each group is trying to meet the population's needs by filling up the graduated cylinder.
    - c. Each team will do their best to fill the cups in order to meet
      - iii. Students will line up in front of their station, Year of Plenty or Year of Drought.
      - iv. The first student in line will fill one cup with water from either the groundwater or surface water container, then move to the back of the line. If water is running low, students may need to make choices about which cup should be filled first.
      - v. The next students will do the same until all the cups have been filled.
      - vi. Once all the cups have been filled, the next student in line will pour one cup into the Doña Ana County Population graduated cylinder, then move to the back of the line.
      - vii. The next students will do the same until all the cups have been emptied.
      - viii. Once all of the cups have been emptied into the Population graduated cylinder, the process is repeated until water or time runs out.
  - d. Team members can keep pouring water into the cups and then from the cups into the graduated cylinders until they run out of water or time, whichever comes first. People want their water needs met instantly, so we will only have three minutes to get water to the population.
  - e. **Set timer for three minutes -** Students in the relay will follow the instructions to pour water from the containers to the cups to the cylinders during this time until they run out of water or time is up.
  - f. Water for the year of plenty will overflow the population container to indicate that there was plenty of water to meet the needs of the population. Water for the year of drought will be limited, and students will have to make decisions about where to allocate their water.
2. **Slide 9:** what is the main lesson from this demonstration?
  - a. Refer to the year of plenty and then to the year of drought and ask the class the following:
    - i. Was there enough water to support the citizens of Doña Ana County? Were you able to fill up the Population graduated cylinder?
    - ii. Was there any waste (spills)? Did it matter?

## OPTION 2: WATER ALLOCATION VIDEO

### PREPARATION

1. Set up a computer and projector or student computers, and ensure the ability to watch and project the YouTube video.
2. Alternatively, you can set up an assignment using your virtual learning platform (Canvas, Google Classroom, etc.).
  - a. Students will need access to the [Water Allocation Video](#).

- b. Suggested text for online assignment: Learn about how water is used in New Mexico by watching this video: [https://youtu.be/28RfGMvr\\_QM](https://youtu.be/28RfGMvr_QM)

### PROCEDURES

1. Have students watch the [Water Allocation Video](#) (4:38 minutes). This can be done in class using a projector or student computers.

Alternatively, the video can be assigned as an online assignment or as homework. The video discusses the six major water use categories (residential, agricultural, livestock, commercial, industrial & mining, and power), introduces the unit acre-feet, and demonstrates that water is a scarce resource in New Mexico.