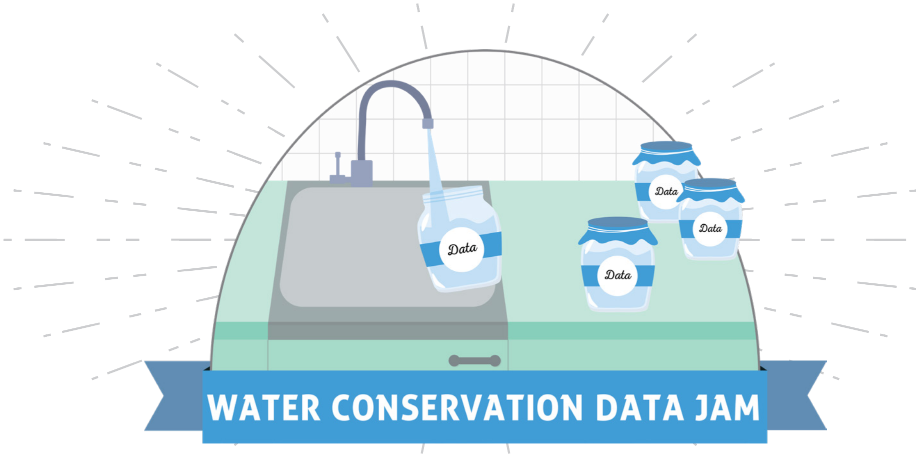



# WATER CONSERVATION DATA JAM

## DESCRIPTION

Students analyze charts and data to construct an argument about climate change and water in the southwestern United States, develop a creative project to communicate data trends to nonscientists, and create an action project.

## PHENOMENON

Data provide evidence for the importance of water conservation in the Southwest, and we can share that information creatively and provide possible solutions.

## GRADE LEVEL

**6-12**

## OBJECTIVES

Students will:

- Construct an argument about the future of water resources in the Southwest
- Analyze long-term, local water use data to identify a data trend
- Develop a creative project to portray a data trend and communicate scientific data to nonscientist audiences
- Develop and implement an action project to address water use issues

## TIME

**5 HOURS TOTAL OVER 5 DAYS**

## COMMON CORE STATE STANDARDS

***English Language Arts***

6.RI.7 Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.
6-8.L.1 Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.
6-8.L3 Use knowledge of language and its conventions when writing, speaking, reading, or listening.
9-12.L.1 Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.
6-8.WHST.1 Write arguments to support claims with clear reasons and relevant evidence.
6-8.WHST.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to the task, purpose, and audience
9-12.WHST.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to the task, purpose, and audience.

***Mathematics***

6.RP.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.
6.RP.3 Use ratio and rate reasoning to solve real-world and mathematical problems.
6.SP.5 Summarize numerical data sets in relation to their context.
8.SP.1 Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities.
9-12.S.ID.6 Represent data on two quantitative variables on a scatter plot and describe how the variables are related.

## NEXT GENERATION SCIENCE STANDARDS

| Science & Engineering Practices | Disciplinary Core Ideas | Crosscutting Concepts |
|---|---|---|
| Asking Questions and Defining Problems (MS, HS)<br><br>Developing and Using Models (MS, HS)<br><br>Analyzing and Interpreting Data (MS, HS)<br><br>Constructing Explanations and Designing Solutions (MS, HS)<br><br>Engaging in Argument from Evidence (MS, HS) | ESS3.A Natural Resources (MS, HS)<br><br>ESS3.C Human Impacts on Earth Systems (MS, HS)<br><br>ETS1.A Defining and Delimiting Engineering Problems (HS) | Patterns (MS, HS)<br><br>Stability and Change (MS, HS) |

## AGRICULTURE, FOOD, AND NATURAL RESOURCES (AFNR) CAREER CLUSTER CONTENT STANDARD

CS.04.02 Assess and explain the natural resource-related trends, technologies, and policies that impact AFNR systems.

## STRUCTURE

Day 1: Introduction to water resources in the Southwest
Days 2, 3, 4: Water Conservation Data Jam
Day 5 and Beyond: Action project

## BACKGROUND

Water is an essential resource, and its scarcity is often apparent in arid southwestern states. The National Integrated Drought Information System uses data to create weekly maps showing the percentage of states and regions experiencing various degrees of water scarcity, ranging from "abnormally dry" to "exceptional drought." Since 2000, vast areas of the Southwest have routinely been abnormally dry, meaning that the soil moisture across the region is low and the danger of possible wildfires is serious (NIDIS 2021).

Climate change is expected to exacerbate water scarcity through higher temperatures, changes in precipitation patterns, and increased evaporation. As temperatures rise, less winter snowpack will accumulate in mountains because early and late precipitation will be more likely to fall as rain rather than snow, and snowpack will start melting earlier. Less snowpack in the spring will mean less water in rivers in the summer when it is most needed for agriculture and domestic use.

At the same time that the Southwest faces prolonged and persistent water scarcity, the human population is steadily increasing by approximately 23% annually in the western United States (US Census 2023). Population increases without massive water conservation efforts increase water demand. Thus, water demand is growing at the same time that water is becoming more scarce.

Water scarcity affects many sectors. Some of the most notable effects are on ecosystems and agriculture. Drought can cause changes in plant communities, which has cascading effects in ecosystems. When drought leads to a lack of surface water for livestock and crops, farmers must drill even further to reach underground water sources to supplement their production, increasing costs. Between 1980 and 2020, 26 droughts cost the United States an estimated $249 billion. Hurricanes were the only costlier weather and climate-related events (Smith, 2020).

Water scarcity is a top concern for local and regional governments. Because local water needs, uses, and resources vary drastically, local and regional water conservation efforts can have large impacts. Many jurisdictions choose to combat drought risk through public education campaigns to raise awareness of drought conditions and provide recommendations for conserving water. The Water Conservation Data Jam aligns perfectly with this strategy. Empowering students to learn about water issues, interpret and communicate water use data, and propose water conservation actions will help our leaders of tomorrow ensure a livable future in the southwestern United States.

## MATERIALS

- Water Conservation Data Jam handout- fill out the data table on page 3 before making copies for students.
- Water Use Scenario Cards [1 set per 3-5 students]
- Meter sticks
- Calculators
- PowerPoint presentation
- Computer and projector/screen
- A variety of craft supplies for creative projects
- Optional: How Much Water Do You Use? handout

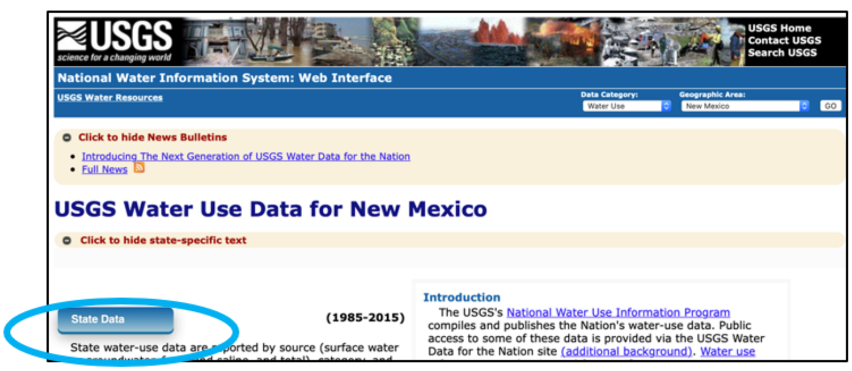
# PREPARATION

1. Optional Introduction activity: How Much Water Do You Use? Educator Guide and Handout.
2. Prepare the water use dataset using the instructions below. Download the PDF of the Water Conservation Data Jam handout and fill in the table on page 3.
3. Note: We suggest providing students with data on Domestic and Irrigation water use. However, teachers may want to include data relevant to their area and community (ex: livestock or mining).
4. Print and cut out Water Use Scenario Cards.
5. Gather materials for creative projects on days 2-4.

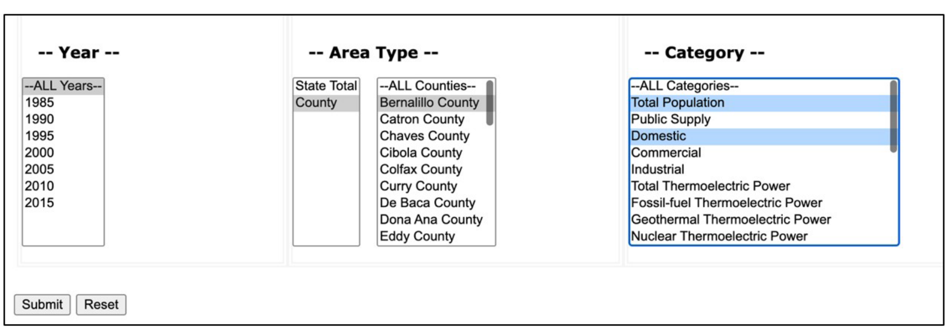
# GATHERING WATER DATA

1. Go to the *USGS Water Use Data for the Nation* webpage: https://waterdata.usgs.gov/nwis/wu
2. Select a state from the **Geographic Area** drop-down menu in the upper right.

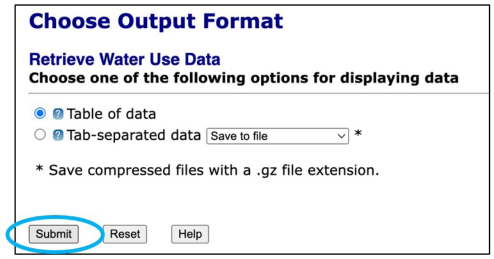

3. Click the **State Data** button to enter the data portal.



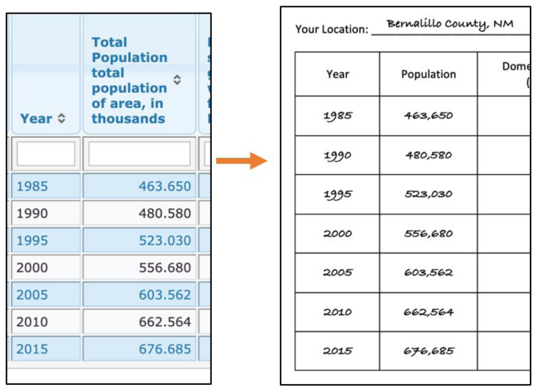

4. Select Year (ALL Years), Area Type (State Total or choose a County), and Categories (**Total Population, Domestic,** and **Irrigation, Total**), then click Submit. Use Command+Click (Mac) or Ctrl+Click (Windows) to select multiple categories.



5. You can view the **data table** online or download the data as a **tab-separated data file**, then click **Submit**.




6. On page 3 of the student handout, record Years in column 1 of the data table. Record the total population in column 2. Note that the population is given in thousands, so you need to convert these data by replacing the decimal point with a comma.

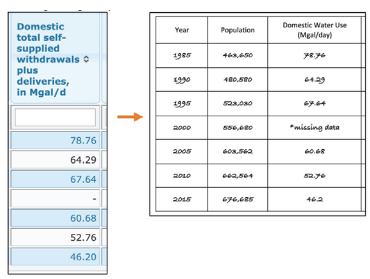


| Year | Total Population total population of area, in thousands |
|---|---|
| 1985 | 463.650 |
| 1990 | 480.580 |
| 1995 | 523.030 |
| 2000 | 556.680 |
| 2005 | 603.562 |
| 2010 | 662.564 |
| 2015 | 676.685 |

Your Location: Bernalillo County, NM

| Year | Population | Dome… |
|---|---|---|
| 1985 | 463,650 | |
| 1990 | 480,580 | |
| 1995 | 523,030 | |
| 2000 | 556,680 | |
| 2005 | 603,562 | |
| 2010 | 662,564 | |
| 2015 | 676,685 | |

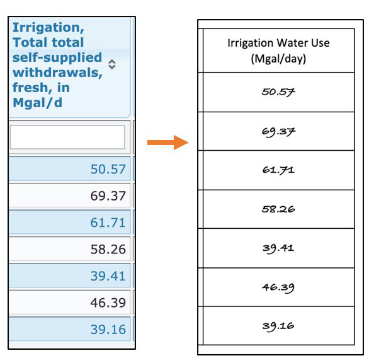
7. In column 3 of the data table, record domestic water use data. This is listed as "Domestic total self-supplied withdrawals plus deliveries in Mgal/day." This includes self-supplied water (water sourced by an individual user from groundwater [such as via a private well] or surface water instead of from the public water supply) and deliveries from public supply. **1 Mgal/day = 1 million gallons per day**



| Domestic total self-supplied withdrawals plus deliveries, in Mgal/d |
|---|
| 78.76 |
| 64.29 |
| 67.64 |
| - |
| 60.68 |
| 52.76 |
| 46.20 |

| Year | Population | Domestic Water Use (Mgal/day) |
|---|---|---|
| 1985 | 463,650 | 78.76 |
| 1990 | 480,580 | 64.29 |
| 1995 | 523,030 | 67.64 |
| 2000 | 556,680 | *missing data |
| 2005 | 603,562 | 60.68 |
| 2010 | 662,564 | 52.76 |
| 2015 | 676,685 | 46.2 |

8. In column 4 of the data table, record irrigation (total) water use data. This includes totals for crops and golf courses. Record "Irrigation total self-supplied withdrawals, fresh, in Mgal/day." Note: if any values are given for saline, add that value to fresh.



| Irrigation, Total total self-supplied withdrawals, fresh, in Mgal/d |
|---|
| 50.57 |
| 69.37 |
| 61.71 |
| 58.26 |
| 39.41 |
| 46.39 |
| 39.16 |

| Irrigation Water Use (Mgal/day) |
|---|
| 50.57 |
| 69.37 |
| 61.71 |
| 58.26 |
| 39.41 |
| 46.39 |
| 39.16 |

# PROCEDURES

## DAY 1 - INTRODUCTION TO THE WATER CONSERVATION DATA JAM

1. Introduce climate change and water use in the Southwest.
   a. Watch Where's Our Water? Part 1 video (4:46), video transcript. Pause the video at the indicated times and discuss the following questions as a class:
      i. (0:54) The water level at Lake Mead has decreased over the past 20 years. What do you think caused this change? [Drought, growing populations, and higher water use]
      ii. (1:47) What is happening to temperatures where you live? How might this affect the amount of water in the Southwest? [Help students make the connection between higher temperatures and increased evaporation and aridity]
      iii. (2:39) Has the Southwest gotten wetter, drier, or stayed the same? [drier]
      iv. (3:59) What's happening to snowpack in the western U.S.? How will this affect the amount of water in the Southwest? [snowpack is decreasing, which means there will be less water flowing into rivers and lakes, like Lake Mead]
   b. After watching the video, direct students to answer questions 1-3 on their handout. They should use the graph and maps on their handout to answer the questions.
   c. If time allows, have students share their arguments with the class.
2. Get to know the dataset.
   a. Introduce the variables students will be using for their Data Jam project.
      i. Discuss where (state, county, or region) these data are from and the year and population columns.
      ii. Explain that these data come from the United States Geological Survey (USGS). The USGS estimates and publishes water use data for the entire country every five years. State-level estimates have been published since 1950, and county-level estimates since 1985.
      iii. Our dataset gives an estimate for two categories – domestic (or household) and irrigation (for crops, golf courses, parks, etc.), but point out that those are just a few of the water uses in our communities.
3. Understand water use categories.
   a. Pass out the Water Use Categories Definition page from the scenario cards and have students read the definitions of water use categories; discuss if needed. The students have a simplified version of the definitions from https://www.usgs.gov/mission-areas/water-resources/science/water-use-united-states
   b. Split students into groups of 3 to 5 and give each group a set of Water Use Scenario Cards. Students will try to match each water use with the correct water use category. The answer key can be found here.
   c. Set a timer for 4 minutes, and see how many scenarios they can sort into the correct water use categories. If time allows, go over the answers.
4. Introduce the Water Conservation Data Jam project.
   **a.** **Slide 2**: scientists around the world are collecting vast amounts of data every day. However, the general public often learns very little, if anything, about the information that scientists have amassed. There is a gap in the communication of scientific information to nonscientists.
   **b.** **Slide 3**: the goal of a data jam is to design a creative project and presentation that explains water use data to an audience not familiar with this information.
   **c.** **Slide 4**: here is an example of an effective way to communicate data. This infographic is interesting and easy to understand because it puts data into a context most people in the continental United States can relate to. Simply stating that Major League Baseball players ran a total of 1,245 miles in 2006 may be considered by some to be a dry statistic. However, scaling a baseball diamond to represent 1,245 miles and overlaying it on a map of the continental United States may help people understand how large the distance is and inspire them to take an interest in the statistic.
   **d.** **Slide 5**: this is an example of using music to communicate data. A University of Minnesota student, Daniel Crawford, created a song to represent the increase in average global temperatures since 1880. He was looking for a method to communicate scientific data in a way that would be more appealing to nonscientists and "people who would get more out of [a song] than maps, graphs, and numbers." His video may inspire students to be creative with their projects. (essential information at 0:35-0:50, the song starts at 1:32)
   **e.** **Slide 6**: here is an example of a student using painting to communicate data. The amount of paint used in the artwork was scaled to reflect the amount of solar radiation, soil temperature, air temperature, and precipitation over several 4-year periods in Las Cruces, New Mexico.
   **f.** **Slide 7**: this is an example of a student using dance to communicate data. The height of the student's foot was scaled to represent the amount of precipitation received every two years in Las Cruces, New

Mexico. The ribbon tied to her foot helps visualize the differences each year.

g. **Slide 8**: discuss the expectations and guidelines for the Water Conservation Data Jam project.
   i. Students may work individually or in teams of up to three students. Larger groups are not recommended for this project because of the difficulties of ensuring that all group members are equally involved.
   ii. Students should develop a creative project to represent the data and appeal to nonscientists. The project should not be a graph or table. Instruct students to use their imaginations to design an attention-grabbing and appealing project. Example products could include songs, demonstrations, poems, children's stories, newscasts, physical models, infographics, and skits.
   iii. Students must scale the data to represent the numbers from the data table accurately.

h. **Slide 9**: a good Data Jam project is clear in that it accurately represents the data in a way that is understandable to nonscientists. The data must be scaled correctly, and a legend explaining how the data are represented must be included. The project should also be creative. Think of an imaginative way to get the attention of nonscientists. Finally, the project should be concise. Focus on one important trend, and explain it well.

i. **Slide 10**: present the timeline of each step of the project. Today, we introduced the project and the data we will be using. Next, we will find data trends, make a creative project, and plan and conduct presentations. Teachers can choose to have students give short formal presentations to the entire class, or set up a gallery walk with half of the groups presenting and half of the groups listening, then switch. Last, we will create an action project to address the water use problems identified in our Data Jam project.

## *DAY 2 - PROJECT PREPARATION*

1. Understanding Our Units
   a. **Slide 11**: Ask students to look at the data table and identify the units for water use: Mega gallons per day, or one million gallons per day.
   b. Ask students to picture a gallon milk jug in their heads and hypothesize how many gallons of water could fit in their classroom. Consider showing an actual gallon jug as a visual.
   c. Have students measure the length, width, and height of the classroom in meters (or convert feet to meters). You can work as a class to save time or allow students to work in small groups to measure and calculate the volume of the room.
   d. On their worksheets, students multiply the length x width x height to get a volume measurement in $m^3$. Then follow the equations on the worksheet to convert from $m^3$ to mega gallons.
      i. 1 $m^3$ = 1000 liters (multiply room volume value times 1000 to get liters)
      ii. 1 liter = 0.264 gallons
      iii. 1 gallon = 0.000001 Mgal
2. Remind students about the data jam project and ask students to look at the data table to find a data trend.
   a. **Slide 12**: A data trend is a sentence that summarizes a graph. A data trend might sound like this: In New Mexico, water use for irrigation is decreasing.
      i. Use the graphs to complete the 2 data trends shown in the slide
         1. Since 1895, drought severity in the southwestern U.S. has [increased]
         2. From 2000 to the present, water levels in Lake Mead have [decreased]
   b. Emphasize that students should represent a trend or trends in the data in a creative way rather than making a graph. For example, water use for a specific year could be represented in a physical model with multiple water drops that each represent 100 Mgal/day of water instead of simply stating that the county used Mgal/day of water.
   c. Ensure that students understand the word **trend** by asking for a volunteer to define it [answer: the general direction in which something is changing. For example, our county is increasing in population but decreasing in the total amount of water used for irrigation.]
   d. Students may go beyond the data and begin to examine the implications; however, their projects must also include representations of the data trend. For example, a student could write a rap song with a hypothesis about why the amount of water used for irrigation is decreasing in their county. Still, they must also incorporate a clear, accurately scaled description of the trend in the data.
3. Give students the rest of class to find a data trend and come up with a creative way to show it.
   a. Start the data jam project by filling out the brainstorming section on the worksheet.
   b. Have students graph the data (by hand or use Excel/Google Sheets, etc.) if they aren't noticing data trends.
   c. Have them fill out the Presentation section of the

handout as a checklist for their project.

d. By the end of this class, groups should have selected a data trend.
e. Provide guidance while students are planning their creative projects. This may take several forms, and the level of support needed will vary by group. Students may need help with interpreting data, scaling, project ideas, technical issues, and obtaining materials.

## DAY 3 - PROJECT PREPARATION

1. Give students time to put together their creative projects and plan their presentations.

## DAY 4 - PRESENTATIONS

1. Give students a little time to put the finishing touches on their projects.
2. Give each group five minutes to present their project or set up a gallery walk with half of the groups presenting at one time while the others rotate through groups, then switch roles and give the other half of the groups time to present.
3. Optional extension: have students give peer feedback.

## DAY 5 AND BEYOND - ACTION PROJECT PLANNING

1. You will not be able to get through all these stages in one day; the engineering process goes through stages of planning, execution, and evaluation. You can choose to make this action project as large or small as you like. You may ask students to make a plan but not execute it. If you do not require students to execute the plan, encourage them to think big. If you want students to carry out their plan either inside or outside of class, set constraints for the students (time, cost, materials, etc.). Work through each stage below, giving students time to work between each stage.
2. Based on the data trends students identified on days two and three, discuss why conserving water in the Southwest is important.
3. Watch the Where's Our Water Part 2 video (4:09) video transcript.
   a. Extension or alternative to complete action project: Where's Our Water Engineering Project, see Extension #3 below.
4. Students will create an action project to solve a water issue related to the data trend they presented in their data jam project. For example, if a student's data trend showed that irrigation water use was increasing, their action project should aim to decrease water use for irrigation.
   **a.** **Slide 13**: When engineers work to solve problems, they go through an eight-step engineering design process. We will use a simplified version of this process to design and implement our projects. Notice that stages 3, 4, and 5 have two-way arrows. This symbol means that groups should move freely between these stages according to the results and needs of their projects.
   **b.** **Slide 14**: Stage 1: Identify the Problem and the Constraints. Students should be thinking about the problem they are trying to solve throughout the planning process. The problem should be related to the data trend they saw in the water use data or should relate to conserving water in the future of climate change. Have students write the problem they are trying to solve on #1 of the Action Project section of their handout.
      i. Students should also consider what constraints will be in place as they move forward. Teachers should set the project constraints, which can be broad (e.g., public attitude) or specific (e.g., location, time, cost, materials). They should include details such as group size, amount of money available for the projects, locations, deadlines, etc. Have students write these constraints on question #2 of the Action Project section of their handout.
   **c.** **Slide 15**: Stage 2: Brainstorm and Select the Best Solution: While we have found that students feel empowered when allowed to participate in the project brainstorming and decision-making process, this may not be realistic in your classroom based on time or other constraints. Another option is to have ideas that you present to your students as their options for projects.
      i. Follow the link for example water conservation projects that classes have implemented: Examples
      ii. If your students choose their projects, remind them to make sure their projects solve the problem we identified and work within the framework of the constraints you outlined.
   **d.** **Slide 16**: Stage 3: Plan the Prototype Project. We encourage students to plan before executing their projects. Detailed planning may be unfamiliar to many students. Here are some considerations for guiding your students through project planning:
      i. Have students make a list of every task that needs to be completed. If each task has a specific deadline, it can keep the project moving forward. There is an example on this slide.
      ii. It may be worthwhile to require students to submit a plan and have it approved before executing their project.
      iii. Encourage students to assign specific group members to tasks. This way, everybody has a role

in making the project a success.

iv. Remind students that plans change, and while they will likely be adding and removing things from their plan as challenges arise, starting with a framework for how they will solve the problem identified in Stage 1 is vital.

e. **Slide 17**: Stage 4: Execute the Project. Once students have planned their project, they are ready to execute it. Here are some things to consider when supporting your students in project execution:

i. Encourage communication within groups. Communication could be daily or weekly check-ins regarding the status of their project. If students are in sub-groups, each sub-group needs to report to the whole group on their tasks. Bigger groups require more intentional communication.

ii. Remind students that their plans may change as they execute their project, which is a normal part of project planning.

iii. Encourage students to keep their problem and proposed solution in mind and constantly evaluate if they are on track to meet their end goal.

f. **Slide 18**: Stage 5: Evaluate Progress Throughout and Identify Ways to Improve the Project. Let students know they should constantly evaluate their project and look for ways to improve it. This step is a critical component of engineering design. The Action Project section of their handout instructs students to reflect on successes (#6) and challenges (#7) at least once during the project period. Still, you should encourage students to improve their projects as they execute them.

i. At the end of the project, students should evaluate their project's success in solving the problem they identified in Stage 1 (#8). They should provide evidence to support their claim. Finally, students should reflect on changes they would make if they were starting their project again.

### *EXTENSIONS*

1. Modification for high school students: let students use the USGS website to choose their location and water use categories.
2. Have students track their water use over one day with this worksheet: How much water do you use?
3. Where's Our Water Engineering project: Have students design, build, and test their waffle gardens or a model rooftop rainwater harvesting system after watching the Where's our Water? Part 2 video. Handout pages 3 and 4.
4. Depending on space and tools, teachers can choose to have students do either the land contouring experiment or the rooftop rainwater harvesting design or give students a choice if possible.
5. Give students time to explore real water conservation projects in the Southwest on the Water Adaptation Techniques Atlas, an interactive map created by the USDA Southwest Climate Hub of recent or ongoing water conservation projects and their outcomes. The atlas uses jargon, so this may not be an appropriate tool for middle schoolers.
6. Research existing local laws, regulations, or guidelines for water use to understand what is already being done to promote water conservation.

## ADDITIONAL RESOURCES

Environmental Protection Agency (EPA). Drought Resilience and Water Conservation. Updated Sept. 2020. Web. Accessed 15 Apr. 2021.

National Integrated Drought Information System (NIDIS). U.S. Drought Monitor. Updated 21 March 2023. Web. Accessed 13 March 2023.

Smith, Adam. NOAA Climate.gov. 2010-2019: a landmark decade of US billion-dollar weather and climate disasters. 08 Jan. 2020. <https://www.climate.gov/>

United States Geological Society (USGS). Water Use Data for the Nation. Updated 07 Nov. 2022. Web. Accessed 07 Nov. 2022. <https://waterdata.usgs.gov/nwis/wu>