

Water Conservation Engineering

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Water conservation lessons including rainwater capture systems, water filters, and water pollution.

Curriculum Overview:

Lesson 1: Rainwater Capture Systems

Lesson 2: Water Filtration

Lesson 3: Water Pollution/Conservation

Themes:

- Water conservation
- Pollution
- Engineering and design

Curriculum Goals / Background information:

The goals of this lesson are to provide students with a well rounded compilation of water conservation tools and knowledge. The engineering aspects of building a rainwater capture system and a water filtration system provide the students with hands on problem solving and real world application skills. The final lesson provides a space for discussions and critical thinking, focusing on why water pollution is detrimental to the environment and how we can make an impact. Overall the three lessons work in tandem to provide building skills, problem solving, and create opportunities to share knowledge with the community.

Lesson 1 - Rainwater Capture Systems

Background Information:

This lesson introduces students to the concept of rainwater harvesting as a sustainable solution to water scarcity. Students learn how rainwater can be collected from surfaces such as roofs and stored for later use, reducing reliance on treated water sources. Through hands-on engineering, students explore how design choices—such as roof angle, shape, and materials—impact water flow and collection efficiency. The lesson emphasizes collaboration, iterative problem-solving, and the real-world importance of conserving water resources.

Learning Objectives:

1. Students will be able to explain why water conservation is important for sustainability
2. Students will be able to apply the engineering design process (plan, build, test, improve) to create a rainwater collection system
3. Student will be able to use scientific principles such as gravity, water flow, and material properties to improve their designs
4. Students will be able to collaborate with peers and communicate design decisions and results

Key Vocabulary:

Sustainable
Conservation
Engineering
Rainwater Harvesting

Key Concepts:

Rainwater harvesting
Engineering design process
Water conservation

Audience: 4th-6th Grade Students

Prep Time: 1 hour

Duration: 1.5 to 2 hours

Materials Needed:

- One 10-12 qt bin per group (\$4)
- Cardstock (\$5 for 100 sheets)
- Plastic wrap (\$2)
- Tin foil (\$2)
- Masking tape (\$2)
- Toilet paper tubes (crowd source)
- Popsicle sticks, approx. 20 per group (\$2)
- 2 plastic cups per group, plus 2 with holes in the bottom (\$3)
- 1 Liter of water per group
- 1 small whiteboard + marker per group (\$2.50 each)
- 1 large easel whiteboard + marker
- Science notebooks (\$10 for 12)

Total cost (if 2 groups): \$39

Subjects: Science, Engineering, Math, Environmental Science

Lesson Overview:

Step 1: Group discussion about water use, rainwater, and conservation.

Step 2: Teams plan and design a rainwater collection system.

Step 3: Students build and test their systems

Step 4: Teams analyze results, revise designs, and retest.

Step 5: Final discussion and reflection on results and real-world applications.

Discussion and Roof Engineering

Part 1: Introduction to Rainwater Conservation

Talk about the connection between water and students' everyday lives.

- How do you use water each day?
- What happens to rainwater when it falls on streets and buildings?
- Why might it be helpful to collect rainwater instead of letting it run off?

Introduce the idea of water scarcity.

- Explain that some regions have droughts or limited access to clean water
- Discuss how rainwater harvesting helps conserve water and support sustainability
- Rainwater is typically not safe to drink without treatment, but can be used for other purposes



Part 2: Designing and Building Rainwater Collection Systems

- Students are divided into teams of 2-3, and each team brainstorms and draws a roof design and collection system
- Teams must be able to explain why they chose specific materials and shapes
- When designs are approved, teams can begin to build on their bin
- Designs should guide water into collection cups placed next to the bin
- Designs are tested by a teacher "raining" (using the cups with holes in the bottom) on their roofs
- They then measure how much water is collected and record results on a shared data chart and in their journals (or on a piece of paper)

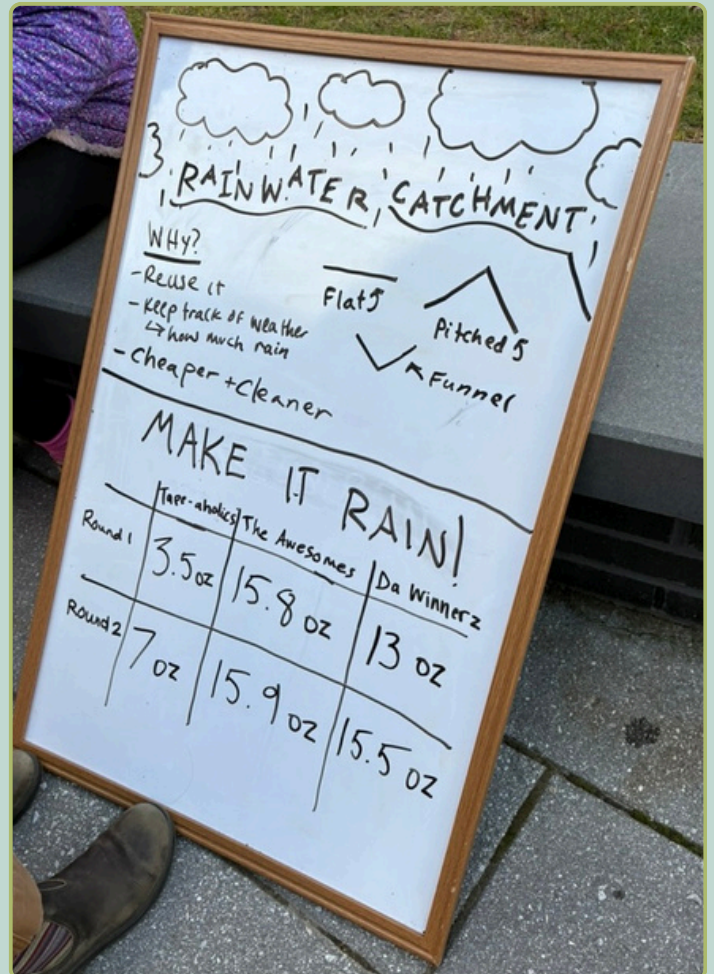
Part 3: Revision and Reflection

After test #1, teams reflect on their results:

- What worked well? What didn't work?
- Which materials worked best and why?
- How did collaboration help your design?

Students revise and improve their designs, then retest using the same amount of water.

- Teams calculate totals and analyze which designs were more effective
- Full group discusses patterns, successful strategies, and scientific explanations behind the results



Extension Activities

Written or Drawn Reflection

Students sketch their final design and write 3-5 sentences explaining how rainwater harvesting conserves water and how they improved their system



Materials Investigation

Test how different roofing materials affect water flow or quality



Scale-Up Challenge

Calculate how much water a full-size roof could collect during a real rainstorm.

Real-World Research

Explore rainwater harvesting in different climates or countries (e.g., Arizona Earthship homes, Massachusetts Hitchcock Center Living Building, etc.)



Lesson 2 - Water Filtration

Background Information:

This lesson educates students on the importance of water filtration and the basic process involved, giving them an understanding as to where their water comes from. They will understand the importance of water conservation and the effort it takes to produce clean drinking water. Using their design skills and information from the previous lesson, students will create their own water filters and ultimately be able to communicate clearly on why materials are good for filtering water.

Learning Objectives:

Students will be able to explain pervious vs. impervious surfaces and the effect they have on water filtration.

Students will be able to use the resources around them to create their own water filters that simulate the natural environment

Students will be able to think critically about where their water comes from and understand that clean water access should not be taken for granted.

Key Vocabulary:

Pervious
Impervious
Watershed
Sediment
Water Treatment

Audience: 4th-6th Grade Students

Prep Time: 45 minutes

Duration: 1 hour 30 minutes

Materials Needed:

- Empty and clean clear plastic bottles
- Sand (\$5 or free)
- Cotton balls (\$2)
- Soil (\$4.50 or free)
- Small rocks (\$5 or free)
- Nature Journals (\$10)
- Very Dirty water (free)
- Small Dixie cups (\$7 for 100)

Total cost: \$33.50

Subjects: English, Science, Environmental Sciences

Key Concepts:

- Water filtration
- Engineering
- Conservation
- Ecology

Lesson Overview:

Step 1: Discussion about water filtration and why it's important we conserve water.

Step 2: Students will build their own water filters.

Step 3: Water filters get tested using dirty water, students have a chance to amend their designs and test again.

Step 4: Compare results from test #1 and test #1 and discuss what went well/not well. Reflect on what was learned.

Discussion and Water Filter Engineering

Part 1: What is water filtration, why is it important?

- Talk about things that pollute water (organic waste, plastic particles, oil, etc).
- Explain that these pollutants need to get filtered out before we drink the water so we don't get sick.
- Discuss ways water gets filtered in the natural environment vs. on the industrial scale.
- Emphasize that clean water is not to be taken for granted, and not everybody has access to it.
- What does pervious/impervious mean? why might that be something to consider when building water filters?

Part 3: revision and reflection

- What went well? What went wrong? Is it what you expected? Why? What could you do differently?
- Give students 5-10 more minutes to revise their filters.
- Save a small amount of water from round one to compare later.
- Test filters again by pouring more dirty water.
- Observe the differences between round 1 and round 2.
- Record in journal.
- What changed if anything? Are you surprised?

Part 2: Building water filters and testing them

- Pair up students and have them draw a prototype for a water filter given the available materials. If doing lesson outside, encourage students to use things they can find in nature.
- Once they demonstrate their drawn prototype to a teacher, pairs are handed a clear plastic bottle that has been cut in half with the lid removed, and the top half placed upside down in the bottom half (resembles a funnel)
- Students have 15 minutes to build a filter in the top segment of their bottle by arranging dirt, sand, cotton balls and other things found.
- Record predictions and methods in journals.
- Teacher will pour dirty water into each filter, and students will observe the difference in appearance when it lands in the bottom.
- Record results in journals.



Extension Activities

Adding in Pollutants

To simulate a heavily polluted body of water, additional, non-organic things can be added to the already dirty water, and students can try the filtration activity again.

- Oil
- Small plastic particles
- Food Dye?
- Cleaning supplies (represents chemicals)

Advanced Filtration devices

Allow students to build their filters using a wider variety of materials.

- Charcoal
- Coffee grounds or coffee filter
- Fabric
- Clay
- Microfiber Cloths



Lesson 3 - Water pollution/ conservation



Background Information/ Goals:

The goals of this lesson are for the students to actively engage in critical thinking, specifically problem solving within Environmental Education topics focusing on water conservation and water pollution. The students will learn the importance of water conservation and how to apply it to their own lives, as well as learning more in depth about various types of water pollutions.

Learning Goals:

By the end of the lesson, students will understand what pollution is and how it impacts the environment.

By the end of the lesson, students will take knowledge from prior lessons and apply it to a play that they can later use to teach their peers and community about water conservation and pollution prevention.

Audience: 2nd, 4th, 5th

Prep Time: 1 hour

Duration: 1 hour and 45 minutes

Materials Needed:

- Science Notebooks (from lessons 1 &2) or \$7
- Whiteboard or Paper
- Large space to run around

Subjects: English, Science, Environmental Sciences

Key Concepts:

- Chemical pollution
- biological pollution
- water conservation
- Water filtration/ purification

Lesson Overview:

Step 1: Introduction and discuss past lessons 15 minutes

Step 2: Water Pollution game/ simulation 35 minutes

Step 3: Water themed play 45 minutes of prep and 10 minutes of performances

Key Vocabulary:

Pollution
Chemical Pollution
Biological Pollution
Conservation

Water Pollution Game/Simulation



Instructions:

Depending on the group size, choose two or three students to be “water pollution” and one or two “water filters.” The rest of the students will be “water.” The water pollution will try to tag as many waters as possible. When a water gets tagged, they will sit down, and then the filter can save the water, and they can join the game again. The filter has immunity, so the filter can not be tagged by the pollution(s). Be sure to set boundaries for the space that the game will be played in. Each round can be long or short depending on how much energy/ time the kids have, and how many different rounds are played.

Round 1:

2 pollution
1 filter

Round 2:

3 pollution
1 filter

Round 3:

2 pollution
2 filters

Optional 4th round:

4 pollution
0 filters

Optional 5th round:

1 pollution
4 filters

Questions to ask before each round (depending on which round):

- What type of pollution are you? All rounds
- What do we think will happen with only one water filter and two pollutants? R1
- What do you think will be different about this round now that we have three pollutants? R2
- What do you think will be different about this round now that equal filters and pollutants? R3
- How will having zero filters impact the game? R4
- How many people do you think the one pollution will tag with four filters? R5

Questions to ask after each round:

- How often did waters get tagged? All rounds
- How quickly did the filter save you? All rounds
- What was different this round? anything after the 1st round
- How did having more pollution impact the success rate of the filter? R2
- How did having more pollution impact the success rate of the filter? R3
- What made this round more difficult? R4
- Did the pollutions have a hard time keeping up with the filters? R5
- What did we learn about being water, filters, and pollutants? After all rounds

Water Themed Play

In this portion of the lesson plan, the students have an opportunity to write a fun play revolving around things they have learned in the past three lessons. The goal of this play is for the students to have an opportunity to share what they have learned with their peers/ community. After writing the play, they will have a chance to perform and share with the class.

Guidelines:

- The theme must be based on water, and include at least three things they have learned about rainwater capture systems, water filters, and water pollution.
- 2-5 minutes long

During the activity:

- Choose a student from each group to write down all of their groups brainstorm ideas.
- Check in to make sure they remember to include things they have learned from previous lessons.
- Regularly remind the students of timing to ensure they are ready.
- Give 5 minute and 2 minute warnings.



Extension Activities

Pollution Tag Simulation Extension:

If a student can not physically participate or if you want to make this game more involved, we can discuss what kind of water pollution may be implemented, and how it is impacting the water. That student can decide if the water is a river, stillwater, ocean etc. They can also decide when each round begins and stops with direction from the teacher.

Water Quiz:

If students want to learn more about their personal water usage, they can take a quiz to see how much water they may be using without realizing.

** See appendix for worksheet**

Appendix:

How much water do YOU use?

Activity	How much water do YOU think you use?	How much water is actually used?
Bath		
Shower (5 minutes)		
Shower with a lo-flow shower head (5 minutes)		
Brushing your teeth		
Flushing the toilet		
Flushing a lo-flow toilet		
Washing dishes (by hand)		
Washing dishes (machine)		
Washing machine		

Talk to your group about water conservation. How can you decrease your water use when:

itP. 25 Activity: How much water do you use?

Answers:

Activity	How much water is actually used?
Filling a bathtub	200 litres
Hot shower (5 minutes)	100 litres
Shower with a lo-flow shower head (5 minutes)	46 liters
Brushing your teeth	20 litres
Flushing the toilet	13-20 litres
Flushing a lo-flow toilet	6 litres
Washing dishes (by hand)	60-100 litres
Washing dishes (machine)	12-16 litres
Washing machine	100 litres

Resources:

All lesson
resources:

