



GRADE 5:  
**TAKE OUT THE  
TRASH: CLEANING  
OUR RIVERS**





## Grade level: 5

**Lesson length:** 2.5 hours, with optional follow-up excursions to nearby river

As students learn about the components of a river ecosystem, they design a means of eliminating the trash that threatens the health of a river system. Students build their devices entirely out of recycled materials in order to understand the challenges engineers face as they try to minimize the amount of raw material used in their work.

## In the Film

As our population grows exponentially, raw materials become more and more limited—so engineers are becoming imaginative in how they recycle and repurpose materials already available to them. Just as the engineers in Haiti, as seen in *Dream Big*, worked under the constraint of using only immediately available materials, all engineers work under resource constraints. In this engineering challenge, students will create a device that cleans plastic pollution from a river system by using only reclaimed plastic from that very system.

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## NGSS Disciplinary Core Ideas

5-LS2.A Interdependent Relationships in an Ecosystem

*Organisms can only survive in environments in which their particular needs are met.*

*A healthy ecosystem is one in which multiple species of different types are each able to meet their particular needs in a relatively stable web of life.*

5-ESS3.C Human Impacts on Earth Systems

*Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space.*

## NGSS Engineering Practices

5-ETS1.A Defining and Delimiting an Engineering Problem

*Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired function of a solution (criteria).*

5-ETS1.B Developing Possible Solutions

*Research on a problem should be carried out before beginning to design a problem. Testing a solution involves investigating how well it performs under a range of likely conditions.*

*At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.*

*Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be changed.*

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*Dream Big: Engineering Our World* is a film and educational project produced by MacGillivray Freeman Films in partnership with the American Society of Civil Engineers and presented by Bechtel Corporation. The centerpiece of the project is a film for IMAX and other giant screen theaters that takes viewers on a journey of discovery from the world's tallest building to a bridge higher than the clouds and a solar car race across Australia. For a complete suite of *Dream Big* hands-on activities, educational videos, and other materials to support engineering education, visit [discovere.org/dreambig](http://discovere.org/dreambig). The *Dream Big* Educator Guide was developed by Discovery Place for the American Society of Civil Engineers. ©2017 American Society of Civil Engineers. All rights reserved. Next Generation Science Standards ("NGSS") is a registered trademark of Achieve. Neither Achieve nor the lead states and partners that developed the Next Generation Science Standards were involved in the production of this product, and do not endorse it.

## Key Words/Vocabulary

**Ecosystem:** Everything living and nonliving in an area.

**Abiotic:** Nonliving. Examples of abiotic factors include soil, water, temperature, and bedrock.

**Biotic:** Living. Examples include producers,

consumers, and decomposers.

**Consumers:** Animals; must eat other organisms to survive.

**Producers:** Plants; make their own “food” via photosynthesis.

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## Materials

### Per group:

- ☐ Materials collected from recycle bins at school for 1–2 weeks prior to lesson (plastic bottles, soda cans, plastic bags, cups, paper, straws, etc.)
- ☐ Nylon string or fishing line
- ☐ Scissors
- ☐ Lego pieces or pool toys that are less buoyant to represent fish
- ☐ Inflatable children’s pool
- ☐ Video “Boyan Slat Unveils the Ocean Cleanup Prototype”: [youtube.com/watch?v=RLAq19hGTBw](https://www.youtube.com/watch?v=RLAq19hGTBw)
- ☐ Means of showing video to class
- ☐ Water Pollution Engineering Sheet

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## Teacher Prep Notes

To test the student devices, inflate the pool and fill it with water. Place materials in it to represent typical human pollution in a water system (plastic straws, fast food cups, and so on).

Place materials in the pool to represent healthy parts of the ecosystem that should remain undisturbed

and not be caught in the pollution cleaning solution (e.g., Lego blocks to represent fish).

Optional: Dye some vegetable oil with black oil-soluble food coloring and place it in the pool to represent industrial oil spills and waste.



# To Do

## Determine the Problem or Question to Solve: 15 minutes

1. Before watching the IMAX movie *Dream Big*, give students an overview of what they are about to experience. This film is about engineering and the ways that engineering can inspire, challenge, and enrich our lives. Give students the following questions to think about as they are watching the film:
  - a. Which engineers wished they had more or different materials to work with as they built their creations?
  - b. How did these engineers find a way to come up with materials that they needed?
2. Debrief as a whole class after viewing the film. Allow students to verbally reflect on the guiding questions you gave them.
3. Introduce the design challenge: Today in class we are going to learn about local river ecosystems and the human actions that threaten their health. Then we are going to get creative in designing a solution to solve the problem of pollution in rivers. We are going to recycle and repurpose the very same pollution that goes into rivers to create a system to clean them. We will test our devices in a small kiddie pool. After, we will decide what parts of the designs in each group worked well to determine a class design to make for a local stream or river. We will then make it and try it in that river system to judge its effectiveness at cleaning a real water system.

## Research and Gather Information: 45 minutes

1. Give an overview of biotic and abiotic factors of ecosystems, in which students learn about the components of a healthy river ecosystem by examining typical river food webs. Guide students to identify the producers, consumers, and decomposers of the river system. Ask students to predict what would happen if one of the members of the food web were removed.
2. Teach students about human factors that can threaten the health of a river ecosystem. Examples are overfishing, animals ingesting plastic debris, and animals being caught in discarded fishing line.
3. Describe the innovative ideas that young engineers are devising to clean water ecosystems. Before watching the Boyan Slat video, explain to students that it's about a teenager who engineered a way to clean up the plastic pollution from the oceans. Though his design is for an ocean ecosystem, we can identify parts of his design that will also work for us in our river system cleanup device. Play Boyan Slat's video on the revealing of his prototype to clean the ocean. Ask students how his device worked and what similar things we could use to collect trash from a river.
4. Show students what recycled materials you have collected over the past few weeks for them to use. Also give them fishing wire that is typically left behind by fishers to use in their designs. Allow students time to use the "brainstorm" part of the Water Pollution Engineering Sheet and come up with ideas for how each material could be used.

## Plan a Solution: 30 minutes

If students are unfamiliar with the concepts of criteria and constraints in engineering, take the time now to introduce these two key fundamental ideas. Engineers look at challenges through the lens of criteria (what does my device have to do) and constraints (what are the limitations I face in making, testing, and using the device). Spend some time with students as a whole class brainstorming the criteria and constraints of this particular engineering challenge.

Organize students into small groups. Show them the materials that they will use and instruct them to begin designing their prototype. The prototype should include a drawing as well as a written description of its functionality. Tell students to use the Plan section of their Water Pollution Engineering Sheet for this step. On their diagram, they should label the material they will use and the amount of that material they will need. Students should write a step-by-step process for how the device will be built and deployed.

## Make It: 30 minutes

Once students have drawn their plan, tell them to begin building their device. As students are building, visit each group, reviewing what they learned about river ecosystems and how the device will capture plastic without capturing members of the food web. Allow students to make mistakes along the way and struggle. When they do, ask questions about what the students observed and what they could change to fix the problem. Avoid offering solutions and instead encourage students to test ideas as they build.



## Test: 20 minutes

Part 1:

- ☐ Prep: Inflate a children's pool and fill it with water and different forms of garbage (Styrofoam cups, soda bottles or cans, straws, Styrofoam peanuts). Also add in a few sinkable items to represent fish and other living organisms.
- ☐ Instruct students to use their device in the pool to remove whatever garbage is accessible. Ask students what the failure point of the system was (where it broke, where it failed to do its job) and what they could do to fix it.

Optional Part 2 (multiple field trips to nearby stream):

If you have a local stream or river nearby, have students improve their device and test it in a true stream environment. Students can leave the device in place for 1–7 days, visiting the device each day and recording the state of the device (is it holding up in the stream environment? Where is it failing?). Students should collect and assess if they were able to gather any plastic or pollution with the device they created.

## Evaluate: 10 minutes

Allow students to reflect on the following questions and to write their answers in the Evaluate section of the Water Pollution Engineering Sheet:

1. How much of the plastic or oil pollution were you able to gather with your device?
2. Did your device interfere with the ecosystem by damaging or capturing animals as bycatch? If so, how?
3. Did your device interfere with the ecosystem by permanently changing any of the abiotic factors in the ecosystem? If so, how?

As time allows, discuss students' thoughts about the success of their devices and what they would do to improve them.



## Taking It Further

Extend the impact of your device: Test within real streams or rivers, increasing the scope and scale of the project as a citizen science/entrepreneurism experiment. Have students educate the public on what they learned. Display the amount of plastic taken out of the river system each week. Have students estimate how much plastic could be taken out of the river if the device lasted all year.

Learn about this engineering in the real world: As we learned about in this lesson, the plastic pollution that enters our riverways eventually drains into

the ocean. Our oceans contain a large percentage of plastic that collects in the center of circular currents called gyres. Engineers are challenged with devising a plan to clean the oceans that will work in a timely manner as well as operate without the environmental stress of using fossil fuels. Learn about the machines they are engineering, the tests they are conducting, and the challenges they face by visiting this site: [theoceancleanup.com](http://theoceancleanup.com)

Document your students' work through our social media outlet: #dreambigfilm

# WATER POLLUTION ENGINEERING SHEET

Name: \_\_\_\_\_

## Problem to Be Solved

Create a system that is capable of catching the plastic and trash from a water system without damaging the ecosystem.

## Research and Gather Information

1. What do we know about river ecosystems?
2. What do we know can threaten river ecosystems?
3. How have other people cleaned water ecosystems?
4. Brainstorm: What could each of the available materials do?

Material	Purpose
Example: plastic water bottles	<ul style="list-style-type: none"> <li><input type="checkbox"/> When the bottle is filled with air and capped, it could float, keeping the device at water level.</li> <li><input type="checkbox"/> If the bottle is cut in half, it could create a barrier to catch plastic floating by.</li> </ul>

## Plan

- ☐ The criteria of the engineering and design challenge are:
- ☐ The constraints of the engineering and design challenge are:

☐ Draw a picture of what you plan to make.

☐ Write a step-by-step process of how to create your design.

## **Make It!**

## **Evaluate**

1. How much of the plastic or oil pollution were you able to gather with your device?
2. Did your device interfere with the ecosystem by damaging or capturing animals as bycatch? If so, how?
3. Did your device interfere with the ecosystem by permanently changing any of the abiotic factors in the ecosystem? If so, how?





# ***DREAM BIG VIDEO SERIES*** ***WATCH WATER WISHES:*** ***ENGINEERING FOR THOSE IN NEED***

What can an engineering student in New Jersey do to help mountain villagers in Peru who lack clean water to drink? Building a safe water system for people halfway across the globe is an example of how Engineers Without Borders and other organizations are helping people build healthier communities. Go to [discovere.org/dreambig/media-assets](https://discovere.org/dreambig/media-assets) and visit Educational Webisodes.

