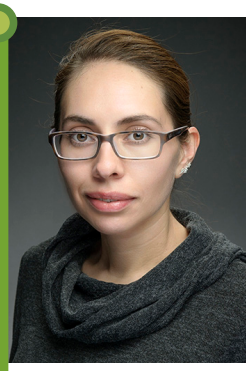
CREWS
Junior Researcher

WATER
Grades 4-12



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Scientists and engineers from around Montana are studying Montana water systems and how our waterways might be impacted by mining, agriculture and energy extraction.

HERE'S A WATER ACTIVITY YOU CAN DO AT HOME!

How does acid mine drainage form?

Acid mine drainage can form naturally due to the interaction of certain solid materials (like rocks) with water, air, and microbes. This process is called **weathering**, and it results in the release of acids, metals, and sulfates into water streams like rivers and creeks. Industrial activity, like mining, can increase the weathering process. The weathering process can result in the pollution and acidification (low pH) of water streams, which can affect the wildlife (animals, plants, microbes) living in or near the stream.

The goal of this experiment is to learn about a natural weathering process that can result in the formation of acidic streams. The pH is a measurement of how acidic or alkaline a substance is, and it ranges from 0 to 14. A pH of 7 is neutral (for example, milk); pH less than 7 is considered acidic (for example, lemon juice); and a pH greater than 7 is considered alkaline (for example, ammonia). The lower the pH value, the more acidic the substance, and the higher the pH value the more alkaline.

YOU WILL NEED

- Several types of solid natural materials like limestone, coal or charcoal, gravel, cement, or other types of rocks or metals like iron, aluminum, or magnesium.
- Several plastic water bottles (all the same size)
- pH strips
- Tap water

GET STARTED!

- Add tap water to the bottles and measure the pH with the pH strips (don't add any solid materials yet).
- Keep one bottle with just water. This is called the **control**. Add one type of solid material to each of the other water bottles (fill about ¼ of the bottle with the solid material). Break apart the solid material into small pieces.
- Every day for four days, measure the pH of each bottle. Take note of the pH and write down if you observe any changes in coloration.

Hi! My name is Erika Espinosa-Ortiz,

and I'm an engineer at Montana State University. I am originally from Mexico City, a place with over 20 million people and serious issues due to water scarcity. This inspired me to become an environmental engineer and look for ways to preserve our water resources. My work focuses on developing technologies to clean up contaminated waters using **microbes**. Besides working, I enjoy traveling around the world, and I have visited almost 100 different cities! My most exciting travel memory is of me riding a camel in the Sahara desert, in Africa.

MY RESEARCH

My teammates and I look for ways to clean water that has been contaminated by coal mining. Streams near mines can contain chemicals that are harmful to fish and plants. We know that **fungi** (a type of living organism, like a mushroom or mold) and **bacteria** (which people often assume are harmful but can also be helpful!) can sometimes make these chemicals less harmful, so we are studying **biofilms**, which are giant communities of fungi and bacteria living together attached to a surface (like a rock). Our team will compare biofilms that we grow in our lab to biofilms we find in streams and soils in the **Powder River Basin** and other places to see which fungi and bacteria might be most helpful for cleaning contaminated water.

The Consortium for Research on Environmental Water Systems (CREWS) is a National Science Foundation-supported partnership between the University of Montana, Montana State University, Montana Technological University, Salish Kootenai College, Little Bighorn College, and business and government partners to study Montana's environmental water systems and specific water quality issues related to hard rock mining, intensive agriculture, and energy extraction. Research activities focus on three representative Montana water systems: hard rock mining in the Upper Clark Fork River; agriculture in the Judith Basin, and energy extraction in the Powder River Basin.

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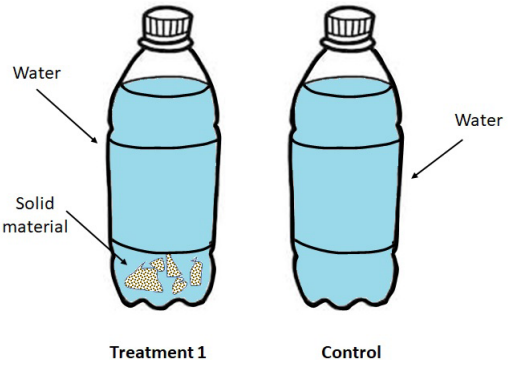
The pH strip will change color according to the acidity or alkalinity of the substance. Dip the pH test strip for two seconds in the substance that you want to test, then wait for 10 seconds and compare the strip against the indicator chart on the packaging.



QUESTIONS

- What materials acidified the water (pH< 7)? What materials alkalized the water (pH>7)?
- After how many days did you observe the formation of acidic water?
- Did you see any change in coloration of the water with a specific material?
- Did the pH of the water in the control change over time? Based on this experiment, can you think of a way in which the formation of acidic streams could be prevented?
- What are your conclusions? Write down what you think.

How could we naturally treat acid mine drainage?

As we discussed above, acid mine drainage can form because of the exposure of water to minerals during mining. There are different chemical treatments used for the **remediation** (cleaning up) of contaminated waters. However, natural processes (also known as **passive treatments**) can also be used to clean up acid mine drainage. The goal of this experiment is to better understand how we can use natural materials to decontaminate acid mine drainage. We will make artificial acid mine water and treat this artificial acidic polluted water using a homemade filter.

YOU WILL NEED:

- Filtering components: cotton, compost, limestone, leaves, gravel, sand, charcoal or activated carbon
- Baking soda
- pH strips
- Coffee filter
- Several plastic water bottles of the same size
- Tap water
- 1 spoon of dirt
- Juice from 10 limes or 1/4 cup of white vinegar

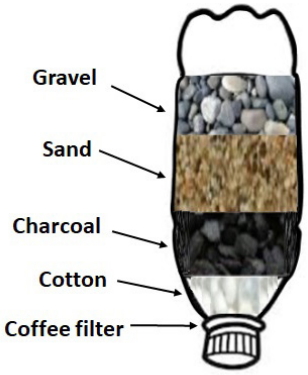
GET STARTED!

- Prepare your artificial acid mine water: 1L of water, the spoonful of dirt, and either the lime juice or white vinegar. Measure the pH using the pH strips.

Experiment 1: Add one natural material (leaves, gravel) and the baking soda to each bottle and add about 250 mL (1 cup) of the artificial acid mine water. Measure the initial pH and write it down. Every day for a 1-week period, measure the pH to see what happens in each bottle. Write down your results.

Experiment 2: Construct a filter.

- Top cut one plastic bottle (opposite end to the cap) to allow water to be poured into a filtration system. Make small holes in the cap of the bottle to let the water drain.
- Build a layer system as shown in the figure. First, put the coffee filter over where the cap should be to keep everything in. Fill your bottle starting with a layer of cotton, then add a layer of activated carbon, add the sand, and finally, add the gravel and leaves. Each layer should be about 1 inch. If you have enough space, repeat the sand and gravel layers. Make sure to leave about 2 inches of free space at the top of the bottle. Pour water (~250 mL or 1 cup) to pass through the filter, collect the water in a container and then measure the pH. Make a note for any observations (for example, change in coloration).



QUESTIONS

- What materials decreased the pH of the water in Experiment 1?
- What materials increased the pH of the water in Experiment 1?
- Did one of your experiments change acidic water to neutral?
- Did you observe a change in pH of the water that passed through the filter?
- What natural materials may be used to treat acid mine drainage?
- Can you create a treatment system using these natural materials?
- What are your conclusions? Write down what you think.

References: Robbins E.I., McSurdy S.L., Craddock T. 2000. Hands-on experiments to test for acid mine drainage. U.S. Geological Survey. Open-File Report 00-369. Online version 1.0. https://pubs.usgs.gov/of/2000/of00-369/
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