Polluted Water: Can We Clean It?

ELABORATION

SAFETY WARNING:

Students will be working with a sample of polluted water from the "Who Polluted the Potomac?" activity. Review the following safety procedures with students.

- DO NOT DRINK the polluted water sample before or after it is cleaned.
- BE CAREFUL not to spill the polluted water sample.
- DO NOT ALLOW the sample to come in contact with your skin or clothes.

BACKGROUND INFORMATION:

In "Who Polluted the Potomac?" students demonstrated the effects of nonpoint source pollution on the Potomac River. Now they will think about how to clean up the watershed and the river.

Water from the river must be treated to make it safe for drinking, recreation, fishing, and transportation. In addition, the Potomac River empties into the Chesapeake Bay. Everyone who lives and works in the Potomac River watershed has the responsibility of keeping the river, and ultimately the Bay, as clean as possible.

In this activity, students will explore how water is cleaned to make it safe for human use. This is an open-ended inquiry activity. It is not expected or required that students use all materials listed below to "clean" their water sample.

PROCEDURE, QUESTIONS, AND POSSIBLE RESPONSES:

1. **"Who Polluted the Potomac?" demonstrated the sources of some Potomac River pollutants. Think about methods you could use to clean this water.**

   Students may think of such ideas as natural filters and aeration in streams, the evaporation and condensation of water, and charcoal filters used in aquariums. Allow students to come up with their own ideas for cleaning the water. They will refine their ideas as they work through the activity.

   Students may need help with some of the scientific terms in the article. If needed, remind them to use the online glossary at fergusonfoundation.org.

Goal:

To design and conduct a procedure to clean a polluted water sample.

Class Time:

90 minutes

Group Size:

Groups of 4

Materials List for Each Group:

- 200 mL of polluted water from "Who Polluted the Potomac?"
- Density separation troughs
- Funnels
- Rubber tubing with pinch clamps
- Filter paper
- Sand
- Straws
- Gravel (pea size)
- Charcoal (available from aquarium stores)
- Paper cups
- Food coloring
- Beakers
- Graduated cylinders
- Gauze or cheesecloth
- Sponge
- Filter
- Floss
- Cardboard
- Baking Soda
- Ferric chloride
- Aluminum sulfate (Alum)
- Stirring rods

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2. Decide what needs to be done to clean the polluted water sample. Discuss your ideas with your team and agree on a cleaning procedure using any of the items from the materials list.

3. List the steps in your procedure and run your procedure.

The main steps in the process are separation, flocculation, and filtration. Allow students to come up with their own plans, but guide them as needed. Students may want to experiment with the sequence of the steps and materials, and try innovative ways to use the available equipment.

Some suggested procedures are given below:

Separation: The first step in municipal water treatment usually involves holding the water in a large basin or lake for a short period of time. This stage allows impurities with different densities to move to different levels in the water sample. Oil products and light materials will float on the surface of the water while dirt and heavier materials will fall to the bottom.

There are two ways to simulate this action in the laboratory for the purpose of removing liquids that cannot mix with each other as well as some of the undissolved solids. You can use either a trough with a drain at the bottom or a funnel connected to a piece of rubber tubing.

i. **Using a Trough:** The trough should have a drain tube in the bottom to which you can connect a rubber tube and a pinch clamp. A plastic tub with a hole into which a stopper can fit will also work. The students pour the sample into the trough and allow it to sit there for about five minutes so that the various substances can separate. Substances will take different times to separate because of the differences in their densities. The pinch clamp is then opened, and the level with the cleanest water is allowed to drain through the tubing into a clean beaker. The object is to collect the water and leave the oil and larger particles in the trough.

ii. **Using a Funnel:** If a trough is not available, a large funnel can be used. Attach a piece of rubber tubing onto the funnel and a place a pinch clamp on the rubber tubing. The students will then pour portions of the sample into the funnel. Each portion should be given time to settle and separate. The pinch clamp is then opened, and the water at the bottom is allowed to drain into a beaker.

Flocculation: This is the part of the process in which chemicals, such as ferric chloride or aluminum sulfate, are added to the water. These chemicals react with suspended particles to form sticky precipitates. The precipitates stick together to form larger and heavier particles that will sink to the bottom or be filtered out of the water. A scoop of either of these chemicals could be added to the beaker of sample water collected.

Filtration: To remove suspended particles, odors, tastes, and colorizing agents, the water can be passed through layers of filters. In a large water treatment plant, the filters would be layers of sand, gravel, and charcoal. Students should be reminded that these are the same substances that are used to filter the water in aquariums and are similar to natural filters in streams and rivers.

4. Students create a data table to record their observations of odor, color, clarity, and volume before and after each step. Approve the students' procedures before they start the cleaning process.

When students have completed the procedure, answer the following questions.

Special Considerations:

Adequate supplies of all the materials listed should be available for all groups.

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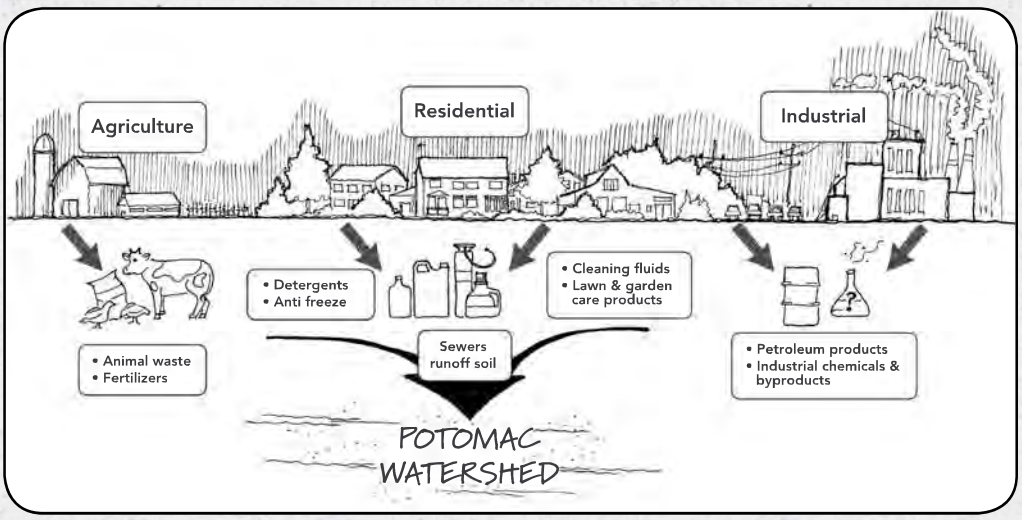
5. **How many milliliters of water did you lose in the cleaning procedure?**

   Answers will vary.

6. **Calculate the percentage of water remaining at the end of your cleaning procedure.**

   Answers will vary.



7. **Explain why is it important to know how much water is lost during water cleaning.**

   This would be especially important in a large water treatment facility. Clean fresh water is a valuable resource. There is a limited amount of water suitable for use by humans. It is vital that people use water efficiently and recycle what is used.

8. **Is this water suitable for drinking? Why or why not?**

   Students should remember that they could use the tests they performed in the park and with the "Who Polluted the Potomac?" activity. They could test the pH, phosphates, nitrates, turbidity, and total dissolved solids. Acceptable levels for these tests are provided in your resource materials. Students should also look for apparent color and odor.

9. **If you had to repeat this procedure what would you do differently?**

   Answers will vary but should demonstrate that the student recognized parameters that could be improved or ways to reduce the loss of sample in the cleaning process.

10. **Compare the apparent color, odor, pH, orthophosphates, nitrates and turbidity reading for the three trials.**

11. **What "factor" do you think affected the apparent color, odor, pH, orthophosphates, nitrates and turbidity? Why?**

12. **What cleaning procedure do you think worked best for apparent color, odor, pH, orthophosphates, nitrates and turbidity? Why?**

13. **Could the cleaning procedure be adapted to clean water on a large scale?**

14. **Read "Imitating Nature to Clean Our Water" in the Resources to find out how pollutants are removed from municipal water. Discuss the article with your team members to help you determine how to remove undissolved solids, immiscible liquids, odors, and colors with minimal water loss.**