BEACH CONTAMINATION

This lesson plan developed by:

Monterey Bay Aquarium®

Overview:

How can hazardous waste be cleaned up with the least impact on the environment while keeping within a budget? How does hazardous waste end up on our beaches? How easy is it to clean up? In this simulation, students are challenged to find and remove a baking soda contaminant from an aluminum shoebox filled with damp sand. Working in groups, they create a plan that has the least impact on the environment and keeps within their budget. Students then conduct the clean up and learn it may be more difficult than they think to clean up a contaminated beach.

Key Concepts:

Students will be able to:

- Explain why it is difficult to clean up a contaminated environment
- Develop a plan, create a budget and select appropriate tools to solve a problem
- Recognize that there are economic and environmental costs associated with environmental contamination by hazardous waste
- Identify individual actions to reduce the amount of hazardous waste

Materials:

- Shoebox-sized aluminum pan filled with damp sand
- Quart bottle filled with water
- Measuring syringe: to inject or withdraw water/chemicals from sand
- 2 teaspoons baking soda hidden in one spot in the sand
- Vinegar: for a chemical test (when added to baking soda creates carbon dioxide gas)
- Clear drinking straw: coring devices
- Coffee filters: to clean contaminated water
- Cotton balls: to clean contaminated water
- Several cups

Beach Contamination (cont.)

- String: laying out a grid of the area for location and/or removal of contamination
- Teaspoons: bulldozers
- Poker chips or other items to represent money
- Gloves (remind students the material is potentially hazardous)

Set-up Prior to Activity:

1. Read over the procedure and decide which student pages to use.
2. Create a "beach" per group of students at least an hour before the activity. Pack the sand into the containers. Wet the sand until it is just damp enough to stick together.
3. With a spoon, dig a small hole in the sand and carefully pour in 2 teaspoons of baking soda. Fill in the hole with sand and smooth the surface of each beach.

Duration:

1 hour

Physical Activity:

Moderate

Background:

The Environmental Protection Agency (EPA) defines hazardous waste as "waste that is dangerous or potentially harmful to our health or the environment." Some hazardous waste causes cancer, catches fire easily, explodes, emits toxic fumes or is corrosive.

Hazardous waste can be liquid, sludge, gas or solid and can include discarded commercial products like cleaning fluids or pesticides as well as by-products of manufacturing processes. Automobile oil, herbicides, pool chemicals, cleaning supplies, paint, gasoline and compact fluorescent light bulbs (CFLs) are examples of hazardous waste generated by households.

Hazardous waste needs to be specially disposed of and not discarded in regular garbage bins. Sometimes waste can be treated by specially trained hazardous materials (hazmat) teams to physically, chemically or biologically change the waste into a form that is no longer hazardous. Before and after treatment occurs, however, the waste needs to be stored in containers, tanks or other storage units, which are often underground. Occasionally, these containers develop

Beach Contamination (cont.)

leaks, allowing hazardous waste to find its way into the local watershed through groundwater or surface flows, causing contamination. Contaminated water may enter agricultural and municipal water systems through wells and irrigation. Cleaning up the contaminated environment is often difficult and costly, both financially and environmentally. Read more about cleanup methods at the EPA's technology innovation site: www.clu-in.org/products/citguide/.

Hazardous waste leaks can be prevented by stricter regulation of waste storage and disposal, limiting amounts of waste produced and providing incentives for waste reduction. Individuals can help reduce water contamination by reducing the amount of hazardous materials we use, buying items with fewer hazardous waste by-products, properly disposing of hazardous household waste (reading labels for how to do so), using all of a product, reusing materials as much as possible and recycling and composting. Educating our friends, families and neighbors about proper disposal techniques helps, too.

Activity:

Part 1: Introduction

1. Share the question: *How can hazardous waste be cleaned up with the least impact on the environment while keeping within a budget?* You may write it up on the whiteboard or have students add it to their science notebook. Give students time to write their initial thoughts down or discuss with a partner. Depending on their prior knowledge, you may need to spend some time exploring the concept of contamination first.
2. Lead a class discussion about waste. Questions may include: *what are some of the kinds of waste you produce at your house? What items can you recycle? What can you compost? What can you throw away? How come you can't dispose of hazardous household products like cleaners, aerosol cans, batteries, oil and paint in the regular garbage? What about the large amounts of hazardous waste that some businesses and factories produce? Where does it go?*
3. As a class, discuss how ground water and water contamination occur. Tell students that sometimes hazardous wastes are stored in underground containers or other places and may occasionally leak into our watershed, ending up on our beaches and in the ocean. Introduce the word "contamination." An area is contaminated when dangerous or harmful substances are introduced into that environment. Sometimes those substances are liquids or in other forms that are difficult to clean up. Ask students: *How are contaminated areas cleaned up? Do you think the cleanup process is simple or difficult?*

Part 2: Cleanup Challenge

1. Present groups with the cleanup challenge. Divide the class into groups of four to five students. Pass out contaminated beaches. Give brief instructions; teams need to locate the contaminant (baking soda) on their beaches and then clean it up. Their cleanup method needs to stay within a budget and affect the environment as little as possible. They also need to safely dispose of the contaminant. Each group will receive a budget of $10,000 for methods and materials. If you are using poker chips to represent "cash," pass them out now.

Beach Contamination (cont.)

2. Show the available tools to the students. Describe how the tools can be used and how much each use will cost. Refer to the suggestions in the following table:

Available Tools	Simulated Item	Cost/unit
Bulldozers	Plastic spoons	$5000/scoop
Core samplers	Soda straws	$500/core sample
Grid markers	String	$50
Chemical tests and decontaminants	Vinegar	$250/test $5000/ml
Filtration devices	Coffee filters	$1000/filter
Extraction devices	Plastic syringes	$500/use
Absorbents	Cotton balls	$250/cotton ball
Holding containers	Plastic cups	$500/container

3. Have students develop a draft of their cleanup plan. Pass out the Cleanup Challenge student sheet. Decide whether to use Version One (more open-ended, student-driven) or Version Two (more scaffolded). Have the students first predict what they think the best materials and methods will be and then create a plan outlining how they will find, remove and safely dispose of the contaminant. Be sure they include a budget for necessary materials. Review the students' proposals before allowing them to begin excavating. Send them back to the drawing board if the proposal doesn't meet the criteria (economic, best for environment, safe disposal). Collect the appropriate fees for the materials needed for each plan.
4. Groups conduct the contamination removal and cleanup. Provide the materials the students included in their budget. Once the groups have found the baking soda, they should clean it up (place it in a cup) and then figure out how to clean the contaminated sand and water. They may choose to use the coffee filters, cotton balls, vinegar or other materials to make the water and sand clean again.

Discussion:

1. Discuss student findings. Ask questions like: *Which materials and methods worked the best? At what economic cost? At what cost to the environment? How DO you measure the cost to the environment? How important is it to carefully store hazardous waste? What kinds of difficulties and issues arose during the activity? Are there other ways to purify water and sand? What impact may hazardous waste have on plants and animals?*
2. Now that students have conducted the contamination removal and clean up, have them revisit the question: *How can hazardous waste be cleaned up with the least impact on the environment while keeping within a budget?* Students may think on their own or discuss with a partner. Then in their science notebook, you may have them draw a line of learning and under it add their original thoughts about the question.

Beach Contamination (cont.)

Ocean Literacy Principles:

Ocean literacy is an understanding of the ocean's influence on us, and our impact on the ocean. There are seven Ocean Literacy Essential Principles that all people of our blue planet should have an opportunity to learn and understand. This activity touches upon the following Essential Principles:

1. The Earth has one big ocean with many features
6. The ocean and humans are inextricably interconnected

Further Your Impact with Sailors for the Sea Powered by Oceana:

As sailors and water-lovers, you are among the first to notice changes to our seas such as fewer marine animals, more pollution and damaged marine habitat. Through our Green Boating initiative, Sailors for the Sea Powered by Oceana provides opportunities for you and your community to address pressing ocean health issues. As a Green Boater, you will be provided with the information, resources and access to combat marine plastic pollution, prevent habitat destruction, source responsible seafood and protect marine animals. From demanding plastic-free alternatives to choosing sustainable seafood, your voice and actions are an important part of restoring the abundance of our oceans and protecting marine habitats. Join our growing Green Boating Community today.

Cleanup Challenge
Version One

Name:

Find the hazardous material (baking soda) on your contaminated beach and completely remove it from the beach. Your method must:

- Be as economical as possible.
- Impact the environment as little as possible.
- Safely dispose of the contaminant once it has been removed.

1. Develop a Plan.

- How are you going to locate the contaminant? What materials and procedures might you use?
- Once you locate the contaminant, what materials and procedures are you going to use to get it out of your beach?
- Once you remove the contaminant, what materials and methods are you going to use to clean and dispose of the polluted sand and water?
- Are you under budget? Are there any ways to reduce your overall cost?

Available Tools	Simulated Item	Cost/unit
Bulldozers	Plastic spoon	$5000/scoop
Core samplers	Soda straw	$500/core sample
Grid markers	String	$50
Chemical tests and decontaminants	Vinegar	$250/test $5000/ml
Filtration devices	Coffee filters	$1000/filter
Extraction devices	Plastic syringe	$500/use
Absorbents	Cotton balls	$250/cotton ball
Holding containers	Plastic cups	$500/container

2. Submit Your Plan and Receive Approval.

- Did you stay within your budget?
- Did you allow for unexpected expenses and outcomes?

3. Monitor the Procedure

- Do you need to buy additional materials? Why or why not?
- How are your procedures working? Explain.

4. Summarize and Evaluate the Results of the Cleanup

- What worked well?
- What would you do differently next time?
- What advice would you give to people when they are disposing of hazardous waste?
- What makes cleaning up an area contaminated by hazardous materials difficult?

Cleanup Challenge
Version Two

Name:

BEFORE THE CLEANUP

1. Make a prediction: Discuss ideas for locating, removing and cleaning up the contaminated beach with your group. What materials are available? What methods can you use?

   I think the best materials to clean up our contaminated beach will be_____

   because_____.

   I think the best method to clean up our contaminated beach will be_____

   because_____.

2. Develop a plan with your group. Make sure you are within your budget and you are choosing the method and materials best for your beach environment. Submit for approval and revise as necessary.

We are going FIND the contaminant by:	We are going to use these materials:
	Materials Cost Total Cost:
We are going to REMOVE the contaminant by:	**We are going to use these materials:**
	Materials Cost Total Cost:
We are going to CLEAN the contaminated sand and water by:	**We are going to use these materials:**
	Materials Cost Total Cost:

DURING THE CLEANUP

1. Do you need to buy additional materials? Why or why not?

2. How are your procedures working? Explain.

AFTER THE CLEANUP

1. Fill out the problem and methods chart below. (If it's too small, copy it into your science notebook.)

2. Discuss with your group:
   - What worked well?
   - What would you do differently next time?
   - What advice would you give to people when they are disposing of hazardous materials?
   - What makes cleaning up an area contaminated by hazardous materials difficult?

Problem and Methods Chart

Problem

What

Why

I attempted the following methods and found these results:

Methods

Attempted Methods	Results
1.	1.
2.	2.

These results **SUPPORTED** or **DID NOT SUPPORT**
(circle one above)

my prediction because:

Reflection