Environmental Science Unit

Purdue University GK-12 2006-07

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Unit overview

This unit is an approximately 12 class period unit that enhances students’ knowledge of human impact on the environment and methods to limit this impact through proper waste management. The lessons presented in this unit teach concepts related to recycling, landfills, integrated waste management, earth’s finite resources and alternative energy strategies. This lesson consists of 4 activities: 1) How much trash do you produce?, 2) Leaky Landfills, 3) Waste Management and 4) Water: A Finite Resource.

Activity 1: How much trash do you produce?

1. Activity overview

This project is an approximately 3 class period activity designed to introduce an environmental science unit for 8th grade students. In this activity we discuss the common types of household trash and which types of trash can be recycled or composted. Students will consider the volume and type of trash produced by their household on a daily basis and will compare that to the national average for America. A classroom visit by a local waste management expert at the end of the activity will emphasize recycling and composting as methods to reduce the waste we produce.

2. Purpose

The purpose of this unit is to stimulate student awareness of how much trash their household produces on a daily basis, to compare that to an average American household, and to consider whether the amount of trash could be reduced. Students will use math skills to make pie charts of their household trash composition. We will also discuss how composting and recycling may help to reduce the amount of trash than enters a landfill.

3. Objectives

- To stimulate students to think about the volume of trash that their families produce in a day or over a weekend
- To teach students how household trash can be categorized, and what the typical American household’s trash is composed of
- To teach what materials can be recycled, as well as the advantages and disadvantages of recycling
- To teach what trash composting is, as well as what materials can be composted

4. Indiana Standards Met

8.1.7 Explain why technology issues are rarely simple and one-sided because contending groups may have different values and priorities.

8.1.8 Explain that humans help shape the future by generating knowledge, developing new technologies, and communicating ideas to others
8.2.2 Determine in what units, such as seconds, meters, grams, etc., an answer should be expressed based on the units of the inputs to the calculation.

8.2.4 Use technological devices, such as calculators and computers, to perform calculations.

8.3.6 Understand and explain that the benefits of Earth’s resources, such as fresh water, air, soil and trees, are finite and can be reduced by using them wastefully or by deliberately or accidentally destroying them.

5. Methods

5.1. Materials & Resources

The materials required for this activity are:

- Plastic trash bags (large kitchen size) – 8 per volunteer “trash collector”
- Blank adhesive labels
- Black sharpie marker
- Bathroom scale
- “Trash” items
  - Paper products, plastic jugs, old T-shirts, glass jars, food scraps, yard trimmings

5.2. Procedures

5.2.1 Preparation
- Assume that there will be three student volunteers for each class. For each volunteer, reserve 8 trash bags. Six of the bags will have adhesive labels on them, labeled “plastic”, “paper”, “food waste”, “glass”, “metal” or “miscellaneous trash”. Two bags will have blank labels, and will be used in case the trash collector needs more bags.

5.2.2 Introduction to the activity (1 period)
- Begin by showing students aerial photographs of Lafayette, IN from past (1972) and present (1999). Discuss the population growth that the city has experienced, and what that population growth might mean in the context of volume of trash produced by residents of Lafayette.
- Ask students what they consider to be trash. Show them items, such as paper products, plastic jugs, old T-shirts, glass jars, food scraps and tree branches or grass clippings and ask which of these are trash.
- Show students the handout – “What’s in America’s trash?” and discuss the EPA pie chart.
- Class assignment: Choose three student volunteers (who have a ride to school in the morning – students who ride the bus probably cannot perform this task) to collect their household’s trash over the weekend. The volunteers will be given 8 trash bags each, and six of the bags will have adhesive labels on them, labeled “plastic”, “paper”, “food waste”, “glass”, “metal” or “miscellaneous trash”. The volunteers must collect their family’s trash on Saturday and Sunday, and must categorize it as listed above. Each volunteer will also receive two extra bags with blank labels in case they produce extra trash. The volunteers will bring the collected trash back to school on Monday, and we will
weigh each trash bag. Student volunteers will be given a note to take home to their parents, which will explain the purpose of the exercise.

5.2.3 Data collection and discussion (1 period)
- Weigh the trash collected by student volunteers: Have student (or teacher) stand on scale holding each trash bag to find weight of each trash bag.
- Record for each student volunteer:
  - Total weight of all trash bags = total trash lbs
  - Weight of bag containing plastics = plastic trash lb
  - Weight of bag containing paper = paper trash lb
  - Weight of bag containing glass = glass trash lb
  - Weight of bag containing metal = metal trash lb
  - Weight of bag containing food scraps = food trash lb
  - Number of people residing in house
  - Each student records these data values in Worksheet 1
  - As a class, we calculate amount of trash generated per person per day for one volunteer trash collector. Students use calculators to answer the rest of the questions in worksheet 1 (homework?)
  - At the end of class, use data for trash collector #1 to talk about the amount of trash generated per person per day.
  - Discussion questions: How does this compare to the 4.6 lb/day average for America? Do students feel that this is a lot of trash or a minimal amount? Where does this trash go? Are there ways to minimize the amount of trash that we generate?

5.2.4 Visit and Demonstration by Waste Management Expert (1 period)
- Dawn Boston from Wildcat Creek Solid Waste District will visit the classroom and give a demonstration on recycling and composting

6. Scope
Using our timeline and three “trash collector” volunteers per class, the activity should take approximately four class sessions.

<table>
<thead>
<tr>
<th>Number of 42 minute class periods</th>
<th>Tasks and Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to the activity and assignment of trash collectors</td>
</tr>
<tr>
<td>1</td>
<td>Data collection – Begin worksheet 1 (finish as homework)</td>
</tr>
<tr>
<td>1</td>
<td>Visit from waste management expert</td>
</tr>
</tbody>
</table>
7. Activities, worksheets, and templates
The following MS Word worksheets are available for use in this lesson:

Worksheet -- How much trash do you produce?
Handout – What’s in America’s Trash?

8. Evaluation
All of the students had previously created pie charts in math class. Evaluation in this lesson was based on the “What’s in our trash?” worksheet.

9. Reflection/Lessons Learned/Alterations for future use
When we introduced the trash collection activity, many students volunteered to be trash collectors, but very few actually brought trash in on the following school day. To avoid problems, it would be wise for a teacher to also collect his/her household trash to provide “back-up data”.

10. Resources
EPA Consumer Handbook for Reducing Solid Waste: General Overview of What’s in America’s Trash:

http://www.epa.gov/epaoswer/non-hw/reduce/catbook/what.htm
How much trash do you produce?

<table>
<thead>
<tr>
<th></th>
<th>Trash Collector 1</th>
<th>Trash Collector 2</th>
<th>Trash Collector 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of plastic trash</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight of paper trash</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight of glass trash</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight of metal trash</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight of food waste</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight of miscellaneous trash</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total trash weight</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of people in household</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of days trash was collected</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pounds of trash per person</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pounds of trash per person per day</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
What is in our trash?

Directions: Using the data you collected in table 1, find out what % of total trash weight each type of trash represents. Then create a pie chart (using protractors!) to show what makes up our trash.

<table>
<thead>
<tr>
<th>Type of trash</th>
<th>% of total trash weight</th>
<th>Number of degrees (out of 360)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paper</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food Waste</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miscellaneous</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Trash Collector: _______________
Total Trash weight: ________________
General Overview of What's In America's Trash

Table of Trash Types and Percentages

<table>
<thead>
<tr>
<th>Trash Type</th>
<th>Percentage</th>
<th>Tonnage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper</td>
<td>40.4%</td>
<td>71.6 million tons</td>
</tr>
<tr>
<td>yard trimmings</td>
<td>17.6%</td>
<td>31.6 million tons</td>
</tr>
<tr>
<td>Metals</td>
<td>8.5%</td>
<td>15.3 million tons</td>
</tr>
<tr>
<td>Plastics</td>
<td>8.0%</td>
<td>14.4 million tons</td>
</tr>
<tr>
<td>food scraps</td>
<td>7.4%</td>
<td>13.2 million tons</td>
</tr>
<tr>
<td>Glass</td>
<td>7.0%</td>
<td>12.5 million tons</td>
</tr>
<tr>
<td>Other</td>
<td>11.6%</td>
<td>20.8 million tons (e.g., rubber, leather, textiles, wood, miscellaneous inorganic wastes)</td>
</tr>
</tbody>
</table>
Activity 2: Leaky Landfills

1. Activity overview
This unit is an approximately 2-3 class period project designed to teach students the importance of proper landfill construction and the importance of limiting the volume of trash that enters a landfill. Students will learn the features of a well-designed landfill, and will gain an understanding of environmental consequences associated with improper landfill construction.

2. Purpose
Modern sanitary landfills are lined holes in the ground where waste is buried in layers and covered with dirt. They are engineer-designed to divert rainfall, trap and treat all of the other liquid (leachate) that flows through the waste, and release trapped methane gases which build up from the decomposition of waste. Improperly designed and/or managed landfills can endanger public health, pollute groundwater, and reduce overall environmental quality.

In this activity, students learn how a modern landfill is properly constructed and develop an understanding of the reasons for several regulations regarding modern landfill construction. Students will design and construct working models of three different landfills. They will make observations of the effectiveness of these models to determine the elements of good landfill design and identify potential environmental impacts associated with poor landfill design.

3. Objectives
   o To compare methods of landfill construction, past and present
   o To understand how a modern landfill is properly constructed
   o To understand why regulations regarding landfill construction are necessary and what potential environmental consequences are associated with poor landfill design

4. Indiana Standards Met
   8.1.7 Explain why technology issues are rarely simple and one-sided because contending groups may have different values and priorities.
   8.1.8 Explain that humans help shape the future by generating knowledge, developing new technologies, and communicating ideas to others
   8.3.6 Understand and explain that the benefits of Earth's resources, such as fresh water, air, soil and trees, are finite and can be reduced by using them wastefully or by deliberately or accidentally destroying them
   8.3.7 The atmosphere and oceans have a limited capacity to absorb wastes and recycle materials naturally
   8.4.4 Describe how matter is transferred from one organism to another repeatedly and between organisms and their physical environment.
5. Methods

5.1. Materials & Resources

The materials required for this activity are (per group of 2-3 students):

**For teacher prep:**
- Red food coloring
- Newspaper or paper towels
- Sponges (1 sponge/group), torn into pieces

**For each group:**
- 1 clear wide-mouthed glass jar
- Measuring cup
- Soil
- 1 cup of gravel or pebbles
- 9-12 1/2-inch by 1/2-inch sponge pieces (to represent garbage), previously soaked in red food coloring (with excess squeezed out with paper towels)
- Plastic wrap
- Water
- 2 rubber bands

**For “Improperly designed landfill” groups:**
- Cheesecloth

**For “Properly designed landfill” groups:**
- Heavy-duty plastic sandwich bag

5.2. Procedures

5.2.1 Preparation
- Before class, teachers add red food coloring to sponge pieces and squeeze out excess with paper towels or newspaper

5.2.2 Introduction to the activity (Part of 1 period –April 16th)

Introduce the lesson by projecting the transparency of "A Modern Landfill" (see figure 1) and discuss the components of modern landfill design. Review the following information with students:

Modern sanitary landfills are lined holes in the ground where waste is buried and covered with a layer of soil each day. In the past, trash in landfills was burned to reduce its volume. This process produced a relatively non-toxic ash, but emitted large amounts of pollutants and toxins into the air. Now, trash in landfills is compacted or crushed before it is buried. Disposal of wastes in landfills can cause serious environmental problems if the landfill is not properly designed and constructed. When rainfall or surface water enters landfills, the waste and soil...
in the landfill initially absorb the liquid. However, with increased rainfall, the waste and surrounding soil become saturated and the water leaches through. This liquid (leachate) picks up soluble materials in the waste as it passes through the layers of the landfill. Often these soluble materials can be hazardous to humans and/or the environment. If landfill leachate is not contained in some way, it can eventually contaminate groundwater or surface water.

In order to protect groundwater from contamination, an impermeable barrier or liner is needed at the bottom of a landfill and the surface of a landfill must contain drains to allow rainfall to run off the surface of landfills. In addition to leachate collection systems and stormwater controls, modern landfills must also contain methane gas collection systems. Methane gas is produced when wastes begin to decompose in a landfill. The gas must be released, or vented, from the landfill in order to prevent too much pressure forming underground. Finally, when landfills are full, they must be closed and covered with a cap. Even closed landfills must be continuously monitored to prevent groundwater contamination and methane gas buildup.

As we learned in the previous lesson, many different types of trash are found in landfills, even trash that we consider to be easily biodegradable, such as food waste and yard trimmings. Although some of these items may degrade faster than other items such as plastic bags or metal cans, they still add to the overall weight of the landfill. As more and more trash becomes compacted in the landfill, more weight is put on the landfill liner. Once a weight limit has been reached, the landfill should be closed to reduce the potential damage to the liner. So even items like food trash that can degrade relatively quickly take up valuable landfill space.

Indiana contains 32 active landfills.

5.2.3 Landfill construction (1 period)

- Next, divide the class into groups of two or three. Explain that each group will construct one of three different landfill models to determine the elements of good landfill design. Distribute a copy of the "Leaky Landfill" data sheet to each group and review the procedure for the lab activity. Distribute the materials for the landfill model and assist groups as needed. Instruct groups to label their containers and let the landfill models sit undisturbed overnight.

5.2.3 Data collection and discussion (1 period)

- Allow each group to examine its models. Have groups record changes in the appearance (e.g., color and clarity) of the groundwater in each model on their "Leaky Landfill" data sheets.
- Remind students that this activity is a simulation. In reality, many chemical contaminants in groundwater are invisible. With the entire class, conduct a discussion of each group's results and use the following questions to lead a class discussion. Students have a copy of these questions in a study guide – encourage them to record answers for use in studying later.
- Finally, end the project by going back to the aerial photographs of Lafayette from 1972 vs 1999 (used in previous project). Ask students what impact they think that population growth will have on landfills. More people = more trash = more landfills needed. More trash and more landfills increase potential for leaky landfills. When landfills leak, groundwater is contaminated. City water treatment facilities remove many impurities, but may
not remove all contaminants. Residents who use wells derive their water directly from the (contaminated) ground.

6. Scope

Using our timeline, the activity should take approximately 2 class sessions.

<table>
<thead>
<tr>
<th>Number of 42 minute class periods</th>
<th>Tasks and Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction and construction of landfill</td>
</tr>
<tr>
<td>1</td>
<td>Evaluation of landfills and discussion</td>
</tr>
</tbody>
</table>

7. Activities, worksheets, and templates

The following lab activity sheets and worksheets are available for use in this lesson:

**Figure 1. A Modern Landfill**  
**Lab Activity Sheet: Leaky Landfills (Day 1 and Day 2)**  
**Study Guide: Leaky Landfills**

8. Evaluation

- Ask students to draw a diagram of a modern landfill or explain how modern landfills are constructed.
  - Have students explain why modern landfills are constructed the way they are.

9. Reflection/Lessons Learned/Alterations for future use

For the landfill construction activity, we used diluted red food coloring to reduce the total amount of food coloring needed. The activity worked, but the “leachate” was pale pink and not as dramatic as we hoped. It would be better to use undiluted food coloring for the landfill construction.

10. Resources


Figure 1

Landfill Diagram

- Clay cap
- Methane gas probe
- Gas collection wells
- Vegetated and graded slopes to promote run-off and minimize erosion
- Vegetated topsoil
- Daily cover
- Low permeability clay liner usually covered with impermeable plastic
- Completed waste
- Leachate collection pipe
- Leachate sump

Copyright Browning-Ferris Industries, 1995
Lab Activity: Leaky Landfills, Day 1

Day 1: Build three landfill models according to the following directions.

Model 1. Open Dumping

1. Pour two inches of clear water into a glass jar. (This represents groundwater.)
2. Add one cup of gravel or pebbles to the water.
3. Cover the pebbles with one inch of soil.
4. Place the red-colored sponge pieces on top of the gravel
5. Pour one cup of water over the sponge pieces. (This represents rainfall.)
6. Cover the jar with plastic wrap secured with a rubber band.

Model 2. Improperly Designed Landfill

1. Pour two inches of water into a glass jar.
2. Suspend a piece of cheesecloth in the jar about two inches above the water line. Secure the cheesecloth with a rubber band.
3. Place one-half cup of gravel or pebbles in the cheesecloth liner.
4. Place the red-colored sponge pieces on top of the gravel.
5. Cover the sponge pieces with one inch of soil.
6. Pour one cup of water over the soil.
7. Cover the jar with plastic wrap secured with a rubber band.

Model 3. Properly Designed Landfill

1. Pour two inches of water into a glass jar.
2. Suspend a plastic sandwich or freezer bag in the jar about two inches above the water line. Secure the bag with a rubber band.
3. Place one-half cup of gravel or pebbles in the plastic liner.
4. Place the red-colored sponge pieces on top of the gravel.
5. Cover the sponge pieces with one inch of soil.
6. Pour one cup of water over the soil.
7. Cover the jar with plastic wrap secured with a rubber band.
Lab Activity: Leaky Landfills, Day 2

1. Observe the groundwater in each model. What changes have occurred to color and clarity of the groundwater overnight?

Model 1: Open Dumping

Model 2: Improperly Designed Landfill

Model 3: Properly Designed Landfill

2. Draw a diagram of a modern (properly constructed) landfill, or describe how a modern landfill is constructed. *If you need more space, use the back of this page.*
Study Guide: Leaky Landfills

1. Based on changes in color and clarity, which model has the most groundwater contamination by leachate? [open dump]

2. Which model has the least evidence of groundwater contamination by leachate? [properly designed landfill]

3. In what ways is the "Open Dump" model different from the "Improperly Designed Landfill" model? [open dump does not bury or cover waste; open dump has no liner; waste in open dump can have direct contact with groundwater]

4. In what ways is the "Improperly Designed Landfill" different from the "Properly Designed Landfill" model? [improperly designed landfill has a permeable liner and waste is not compacted before burial]

5. In addition to concerns regarding groundwater contamination, what other problems could result from open dumping of waste on top of the ground? [dispersal of waste by wind, water, and animals; spread of disease by insects and other animals]
6. Why are new sanitary landfills required to have an impermeable rock, clay, or plastic liner? [to prevent potential groundwater contamination by landfill leachate]

7. Why do you think waste is compacted before it is placed in a landfill? [to conserve landfill space; to remove as much initial moisture as possible]

8. Can you think of any materials that should not be placed in a landfill? [wastes containing toxins that are soluble] Why? [the toxins could dissolve in the landfill leachate and eventually contaminate water supplies]

9. What effects can run-off from heavy rainfall (stormwater) have on landfills? [run-off can carry leachate near the surface of the landfill to nearby surface water sources, such as streams or rivers; the accumulation of stormwater in the landfill can exert great pressure on the liner]
Activity 3: Waste Management

1. Activity overview

This unit is an approximately 3-4 class period project designed to teach students the different methods of waste management. Students will learn the advantages and disadvantages of managing waste via source reduction, reuse/recycling, incineration, and landfill disposal, in the context of the waste hierarchy pyramid (www.epa.gov). Finally, students will be provided with a case study of a model town that needs help with its waste management and environmental practices. Students will create an Environmental Improvement Plan, which suggests solutions for improving the town’s waste management practices.

2. Purpose

The purpose of this project is to increase student awareness of the practices of waste management, and how some methods are more environmentally sound than others. Students will be assigned the task of finding real-world solutions to a town’s waste management and environmental problems.

3. Objectives

- To teach students the methods of waste management, including source reduction, reuse/recycling, composting, incineration and sanitary landfills

- To emphasize what trash materials can be handled by the specific methods of waste management, and advantages and disadvantages for each method

- To apply knowledge regarding trash, landfills and waste management to a case study of a growing town with waste management and other environmental concerns. Students will use their knowledge of waste, landfills and waste management to create reasonable solutions to help the model town.

4. Indiana Standards Met

8.1.7 Explain why technology issues are rarely simple and one-sided because contending groups may have different values and priorities.

8.1.8 Explain that humans help shape the future by generating knowledge, developing new technologies, and communicating ideas to others

8.3.6 Understand and explain that the benefits of Earth’s resources, such as fresh water, air, soil, and trees, are finite and can be reduced by using them wastefully or by deliberately or accidentally destroying them.
8.3.7 The atmosphere and oceans have a limited capacity to absorb wastes and recycle materials naturally

8.5.8 Explain how estimates can be based on data from similar conditions in the past or on the assumption that all the possibilities are known

5. Methods

5.1 Materials & Resources

Materials needed for this activity include:
- Reusable trash items, like a glass jelly jar, a water bottle (disposable and Nalgene), coffee cups (disposable and nondisposable)
- Examples of excessive and economical packaging, like for food products, CDs, etc.
- Plastic grocery bag from Target, with re-use tips printed on the side

5.2 Procedures

5.2.1 Introduction to the activity (1 period)

- Begin by reminding the students of what they have learned so far about types of trash and landfills. Review some problems associated with landfills (leaching, lack of space, methane gas emission, “not in my back yard”), and ask students to name alternative methods for managing waste. List these on the board.
  - Recycling – during recycling, we take one product and turn it into material to make another product. What is required for that transformation? Energy
  - Incineration – incineration completely destroys trash so that it doesn’t take up space, but it increases air pollution
  - Composting – back yard composting or neighborhood composting projects, but may be prevented by lack of space
  - Reducing use, reusing products
    1. buying less, give to and shop at Goodwill, Plato’s closet, sometimes even eBay
    2. Pay attention to the packaging of the products you buy – provide examples of poorly packaged and economically-packaged products.
    3. Plastic grocery bags – How environmentally sound are they? How can we reduce our use of them?
      a. Show students a cloth grocery bag
      b. Show students the Target grocery bags with reuse tips printed on side

- Ask students which they think is the “best”, “worst” and “somewhere in-between” of the methods listed, then present the Waste Hierarchy diagram
o Recycling in Lafayette: The city of Lafayette recycles newspapers (inserts accepted), glass (clear, brown and green), aluminum and tin cans, plastics #1 and #2

5.2.2 Case study: A town in trouble (2 periods)
Break students into groups of 3-4, and present use the Case Study: A Town in Trouble handout to present the town profile

5.2.3 Class presentations and discussion (1 class periods)
o Groups will present their ideas to the class. The presentations will be very casual, and will be in the form of a general class discussion. This will allow students to place focus on content of their solutions for the case study.
o Remind students to take notes during the presentation/discussion of the case study. On the exam, they will be given a brief case study where they will have to identify some potential solutions to a town’s waste management problems.

6. Scope

Using our timeline, the activity should take approximately 3-4 class sessions.

<table>
<thead>
<tr>
<th>Number of 42 minute class periods</th>
<th>Tasks and Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to waste management</td>
</tr>
<tr>
<td>1-2</td>
<td>Case study assignment and group work</td>
</tr>
<tr>
<td>1</td>
<td>Group presentations / class discussion</td>
</tr>
</tbody>
</table>

7. Activities, worksheets, and templates
The following lab activity sheets and worksheets are available for use in this lesson:

- Handout- How Can We Manage Our Waste? The Waste Hierarchy Pyramid
- Handout- Case Study: A Town in Trouble
- Environmental Improvement Plan

8. Evaluation

- Students will be evaluated on their Environmental Improvement Plan that they generate in their group.
9. Reflection/Lessons Learned/Alterations for future use

The Waste Hierarchy pyramid is a useful learning tool, but probably does not need to be provided for the students. It would be just as effective to show the pyramid on an overhead projector and allow students to write down important concepts. It seemed that providing students with a hard copy of the pyramid was unnecessary, and that a class discussion of the concept was more useful.

10. Resources

   The EPA website contains a wealth of information on waste management and the waste hierarchy (www.epa.gov)

   A few specific pages on the EPA website which are particularly useful:

   http://www.epa.gov/epaoswer/non-hw/muncpl/msw99.htm
   http://www.epa.gov/epaoswer/non-hw/reduce/catbook/berk.htm
   http://www.epa.gov/epaoswer/osw/community.htm

   Recycle Zone: An educational resource for teachers:

How Can We Manage Our Waste?
The Waste Hierarchy Pyramid

The waste hierarchy
Welcome to Dumptown, Indiana. Dumptown is a small city located on a river with plenty of parks and good schools. Because Dumptown is a nice city located next to a big university, a lot of new people have moved here in the last 20 years, and the city population has doubled. Although the population has grown, the city of Dumptown has not improved its trash management or environmental practices and now the city is experiencing many problems:

- The city uses one landfill located on the Southwest side of town, but it may only have enough space to last for another eight years (assuming Dumptown residents don’t start producing more trash).
- Water quality testing of groundwater near the landfill has shown high levels of chemical toxins. The residents on the Southwest side of town are worried that the landfill might be leaching into their groundwater, and they are complaining to the city council.
- The town offers recycling for aluminum, tin, and plastic #2.
- The landfill contains: 14% yard trimmings, 10% food scraps, 42% paper, 12% plastics, 12% glass, and 10% of other items such as old clothes and old children’s toys.
- The traffic in town has increased in recent years. The streets are still in good condition, but they are crowded with cars. There are bike lanes on 10% of streets.
- The town has a bus system that operates Monday-Friday 9am-4pm and runs in the center part of town.
Case Study: A Town in Trouble
Environmental Improvement Plan

Your assignment: Your group represents the city council for Dumptown, Indiana. You realize that if you don’t make some changes soon, your city will be in serious trouble. Use all of the information you’ve been provided about Dumptown, along with everything you’ve learned so far about waste management to create an Environmental Improvement Plan to help Dumptown manage its population growth and environmental problems. In your Environmental Improvement Plan, you should recommended changes to be made in Dumptown to improve environmental conditions. Be creative – even if you’re not sure a certain change is possible, you can include it in your plan as long as you explain why you think the change is necessary!
Activity 4: Water: A Finite Resource

1. Activity overview

This activity is an approximately 3 class period project designed to teach students

2. Purpose

In this lesson students will consider their own personal water use and will learn methods for conserving water use in daily life. Graphical data will be used to demonstrate the relative proportions of salt water and freshwater that compose the earth’s water supply. Students will learn how little useable water there is on Earth despite the fact that 75% of the Earth’s surface is covered by water. They will read news articles regarding water shortages in the United States and India, with the goal of recognizing that water is not always a renewable or easily attainable source for everyone.

3. Objectives

- Recognize many of the ways that people use water in their everyday lives
- Recognize that availability of fresh, safe water differs in different countries
- To compare current water shortages in the United States with India
- Recognize that the amount of useable freshwater on Earth is minimal and finite

4. Indiana Standards Met

8.1.7 Explain why technology issues are rarely simple and one-sided because contending groups may have different values and priorities.

8.1.8 Explain that humans help shape the future by generating knowledge, developing new technologies, and communicating ideas to others

8.2.4 Use technological devices, such as calculators and computers, to perform calculations.

8.2.7 Participate in group discussions on scientific topics by restating or summarizing accurately what others have said, asking for clarification or elaboration, and expressing alternative positions.

8.3.6 Understand and explain that the benefits of Earth’s resources, such as fresh water, air, soil, and trees, are finite and can be reduced by using them wastefully or by deliberately or accidentally destroying them.
8.3.7 The atmosphere and oceans have a limited capacity to absorb wastes and recycle materials naturally.

5. Methods

5.1 Materials & Resources

Materials need for this activity:
- Calculators

5.2 Procedures

5.2.1 Introduction to the activity (1 period)
- Post thought questions on the overhead projector or chalk board and ask students to answer them using their own paper. Suggested questions:
  - i. Make a list of all the things you use water for on a daily basis.
  - ii. Do you think people on Earth use a lot of water?
  - iii. What do you think humans use the most water for?
  - iv. Will useable water ever run out?
- Now ask students to fill out the “How much water do you use?” worksheet, and to calculate their daily and weekly water use.
- Discuss the results of thought questions and water use chart with the class. Use the following additional questions to help lead the discussion.
  - i. Have students report their water use amounts.
  - ii. Ask, were you surprised at the amount of water you use? Do you think it is excessive or necessary?

5.2.2 The Earth’s Water (1 period)
- Use an overhead of graphs 1 and 2 to facilitate a discussion with the students.

Use the following questions to facilitate a discussion:
- What is graph 1 saying about the amount of fresh and salt water? _Freshwater is only a small portion (3%) of all the water on Earth._

- In graph 2 are all the sources of freshwater available for human consumption? _No, only the surface, lake, river, and groundwater section is available to humans. The other portions are inaccessible or expensive to make available._

- What could the amount of available water mean for human water use? _Of the very small amount of freshwater on earth only a small portion of that is useable (less than 1%). Therefore, water is not as accessible to everyone as it may seem to some Americans._

- Use topographical maps of India and the US Southwest to show the Cauvery River and the Colorado River, respectively.
Discuss the Cauvery River dispute that has been occurring in India for the last 20 years. **Background:** The Cauvery River is a major river that flows in South India from Karnataka state through the state of Tamil Nadu and into the Bay of Bengal. The river irrigates thousands of acres of farmland in both states. In the 1970s, the state of Karnataka began building dams on the river that allowed them to have more water than Tamil Nadu. The people of Tamil Nadu were very unhappy about this, and they suffered from water shortages that were made more severe by droughts in 1996. The problem became violent as the states fought over the water supply. Finally, in March 2007, the Indian government reached a decision and awarded more water access rights to Tamil Nadu. The residents of Tamil Nadu feel some relief, but they still don’t think they received a large enough share of the water supply. The state of Karnataka is very unhappy that they have to share more of their water.

Discuss the shortage of water in the American Southwest. **Background:** In the American Southwest, the Colorado River is shared by seven states (Arizona, California, Nevada, Colorado, New Mexico, Wyoming and Utah) before it reaches Mexico. All along the river, water is diverted by these states for irrigation and urban water -- with Arizona and California the biggest users. Most of the water is used to irrigate agricultural crops, although population growth in Southwestern cities also increases the demand for water for personal use. Mexico also needs to use the Colorado River for irrigation, but so little water now reaches Mexico that the delta on the Sea of Cortez (which was once fertile) is now dry and polluted.

The Colorado may be completely allocated, but the Southwest continues booming. According to one estimate, five of the 10 fastest-growing U.S. states are in the river's drainage.

### 5.2.3 Newspaper assignment (1 period )
- Students are given the newspaper articles from India and the U.S. If there is time, read the articles (or at least the one from India) together as a class to make sure students understand the content.

- After reading the articles, students are assigned to complete the Water Fight Worksheet as homework.

### 6. Scope

Using our timeline, the activity should take approximately 3 class sessions. Depending on time required for class discussion, some of these activities could be combined into the same day, so the total time required may be less than 3 class periods.
<table>
<thead>
<tr>
<th>Number of 42 minute class periods</th>
<th>Tasks and Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction: thought questions, calculation of water use</td>
</tr>
<tr>
<td>1</td>
<td>The Earth’s Water</td>
</tr>
<tr>
<td>1</td>
<td>Newspaper assignment</td>
</tr>
</tbody>
</table>

6. Activities, worksheets, and templates

The following overheads, handouts and worksheets are available for use in this lesson:

**Day 1. Worksheet:** How much water do you use?

**Day 2. Overhead:** The Earth’s Water: Graph 1 and Graph 2  
**Worksheet:** The Earth’s Water

**Day 3. Overhead:** The Worldwide Water Supply  
**Handout:** News Article #1 and News Article #2  
**Worksheet:** Water Fight

7. Evaluation
   - Assessment will be based on the three worksheets: How much water do you use; The Earth’s Water; and Water Fight.

8. Reflection/Lessons Learned/Alterations for future use
   - For future use, an easy and reliable source for news articles is Google News. This source will allow you to find pertinent news articles from the U.S. and abroad.

9. Resources

**Cauvery: The War for Water.**  
http://kerala4u.in/238/cauvery_kaveri_the_war_for_water_by_kannan_balakrishnan

**Water Woes:** http://whyfiles.org/131fresh_water/2.html

Tackling the Big Three (air and water pollution, and sanitation), David J. Tenenbaum, Environmental Health Perspectives, Volume 106, Number 5, May 1998.
How Much Water Do You Use?

Directions:
1. Fill out the chart on the back of this sheet. Put in how many times you do each of the items listed. For example, if you wash your hands and face 5 times everyday, put a five in the box under each day. In the case of the shower put in how many minutes you spend in the shower each day. Remember to include if you take more than one shower.

2. Add up the times you did each activity to get your total for the week. For the hand and face washing example above the total would be 35.

3. For each activity, multiple the total number of times by the number of gallons and put this number in the total weekly use column.

4. Add up all your weekly gallons for the total number of gallons you used in a day.

5. Answer the questions below.

Questions:

1. How many gallons of water do you use in one week?__________

2. Figure out the average number of gallons used in one day. To do this, take the number in question one and divide by 7. ________________

3. What things do you do that use the most amount of water?

4. What would or could you eliminate in your water use if water was limited?
<table>
<thead>
<tr>
<th>Activity</th>
<th>Sun</th>
<th>Mon</th>
<th>Tues</th>
<th>Wed</th>
<th>Thurs</th>
<th>Fri</th>
<th>Sat</th>
<th>Sun</th>
<th># times</th>
<th>Amount of water used (gallons)</th>
<th>Total weekly water used (gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washing face or hands</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Taking a shower</td>
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<td></td>
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<td></td>
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<td></td>
<td></td>
<td>6 per minute</td>
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<tr>
<td>Taking a bath</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Brushing teeth (water running)</td>
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<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Brushing teeth (water turned off)</td>
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<td></td>
<td></td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td>Flushing the toilet</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Getting a glass of water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td>Washing dishes by hand</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Running dishwasher</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td>15</td>
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</tr>
<tr>
<td>Doing a load of laundry</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td>30</td>
<td></td>
</tr>
</tbody>
</table>

Total weekly water used for all activities (gallons)  

__________
Graph 1

Percent distribution of water on Earth

- Salt water
- Fresh water

Graph 2

Distribution of fresh water

- Ice caps and glaciers
- Soil moisture and very deep underground water
- Surface water (lakes and rivers) and shallow ground water
The Earth’s Water

Graph 1

Percent distribution of water on Earth

Graph 2

Distribution of freshwater

1. Explain in your own words what graph 1 is trying to say about fresh and salt water.

3. Using graph 2, fill in the chart indicating which portions of freshwater on Earth can be used for human consumption. Explain why it can or can’t be used for humans. If you need more space, write on the back of this page.

<table>
<thead>
<tr>
<th>Water Source</th>
<th>Can this be used for human consumption?</th>
<th>Why or Why not?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ice caps and glaciers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil moisture and deep underground water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface water (lakes and rivers) and shallow ground water</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. What do you think Graph 2 can tell you about water for human consumption?
Prime Minister: Water should not be cause of conflict

Published: Friday, 23 March, 2007, Delta Times

NEW DELHI: Prime Minister Manmohan Singh yesterday said water should not be an issue for conflict and chaos between nations or within countries and called for a people’s movement for its conservation.” We cannot allow human societies to descend into chaos due to conflict on the utilization of water resources, be it within nations or between nations,” Singh said while inaugurating World Water Day celebrations here.

“Humanity has the wisdom to avert conflicts which are sure to arise if water resources are not managed wisely. The challenge before us is to tap into that wisdom and find solutions for the benefit of all,” he said. “At home, we must view the issue of sharing of water as a national issue. Our national strategies must be based on optimizing the use of this scarce and necessary resource,” Singh said.

The prime minister’s remarks are significant as they come after a dispute between Karnataka and Tamil Nadu over the sharing of the Cauvery river waters. There were widespread protests in Karnataka after the Cauvery Water Tribunal in February ordered the sharing of waters of the river that passes through both states. It had awarded 419 thousand million cubic feet (TMC) to Tamil Nadu and 270 TMC to Karnataka.

Pointing out the need for wiser usage of water, the prime minister said: The challenge is to use less, even as we provide access to clean water to all and water for all uses.” He said there was “an urgent need to improve water use in agriculture by getting ‘more crops per drop’. This requires economic pricing of water as well as community-based cooperation in water use.”

Expressing concern over increasing water pollution, Singh said, “We worship our rivers, our civilisation has grown on the banks of these mighty rivers. Yet we treat them with shocking disregard. The fact is that almost every river in our country is getting increasingly polluted.

“This way we treat our rivers, we may well turn them into a cause of increasing loss of lives. Unclean, dirty water is a major cause of the significant amount of childhood mortality in our country. It is also beginning to hurt the quality of our farm produce. We must therefore devise more effective strategy to check the pollution of our sacred rivers,” the prime minister said. Singh called for a people’s movement for water conservation.

“We should agree to make water management our individual and combined national obsession. It is clear that unless water becomes everybody’s business, unless each one of us is engaged in thinking about how we use water and how we can save water, we will not build a water-secure movement.

“We need a massive people’s movement in support of conservation of our scarce water resources,” he said. – IANS
Our precious artery

Mar. 15, 2007, The Arizona Republic

Water experts have long believed that one day the Colorado River would not have enough water to keep up with all the communities that draw from it.

Increasing scientific evidence shows through tree-ring analysis that the river can’t keep up with water demand. And the long-running drought - 12 years and counting in Arizona – along with the region’s steady population growth (up by about 25 percent since 1995) has put an exclamation point on the inevitability of shortages.

The seven states that use the river -- Arizona, California, Nevada, Colorado, New Mexico, Wyoming and Utah -- were told a few years ago by former Interior Secretary Gale Norton to come up with their own plan for managing the river in times of shortage, or face the prospects of the federal government imposing a management plan of its own.

The states have produced a proposal for better management of the river over the next 20 years. It was released recently in a draft environmental impact statement by the Bureau of Reclamation, along with three other alternatives, two of which were submitted by the bureau and one by environmentalists. Some changes proposed by the group included an expansion of the cloud seeding program, desalting water, lining porous canals, fallowing farmland and removing water-hungry salt cedar trees.

But the best science tells us that drought, climate change and population growth will dictate flows in the Colorado River. Conservation and more efficient management operations are good as far as they go, but the scientists nevertheless warn that there’ll be increasing demands on water supplies.
Water Fight: Water Shortages in India and the United States

Directions: Read the newspaper articles from India and Arizona, and use the articles as well as what you’ve learned about the water supply to answer the following questions.

1. Write a few sentences to summarize the article titled “Water should not be cause for conflict”.

2. Write a few sentences to summarize the article titled “Our Precious Artery”.

3. Is water scarcer in the United States or in India?

4. People in India worry about not having enough water. Aside from not having enough, what other concerns might people in India have about the water that they do have?
Newspaper Assignment

Name _________________________ Due Date ________ Class Period _____

5. What states depend on the Colorado River for their water supply?

6. The water in the Cauvery River in India and the Colorado River in the U.S. is used by humans for many purposes. What is the greatest use for the water in both countries?

7. Thinking about what you learned about your water use, the water use of other cultures, and the amount of water available on Earth. Do you think there is enough water? How have your ideas changed from the journal question at the beginning of the lesson? Explain your answer.