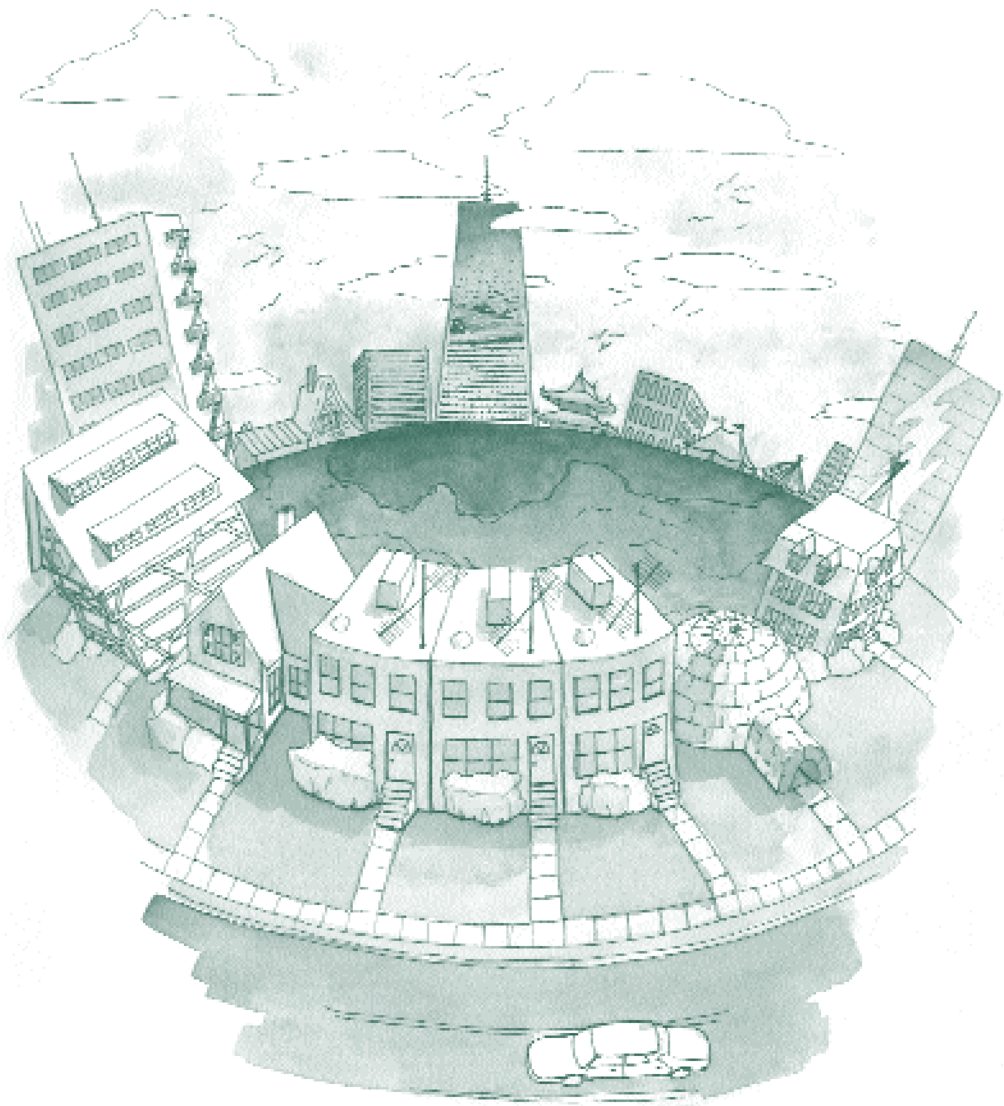
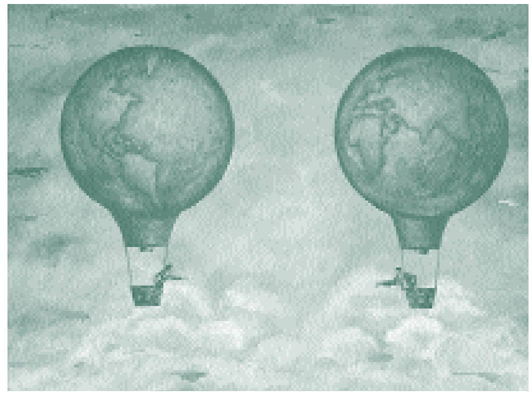


LESSON FOUR

AIR QUALITY

AIR QUALITY



Illustrations from *artville.com*. Activities from other sources are credited within the activity.

AIR QUALITY

OBJECTIVE

By the end of this lesson, students will have studied an environmental issue and its impact on personal choices. They will begin to understand what causes air pollution, how far pollution can travel, and implications for personal ethics.

ACTIVITIES

- Particulates and Gases: A Model
- Community Air Inventory
- Pollution Pathways

CLOSURE AND TRANSITION

Air quality is a shared responsibility among everyone living in a community because it has global impacts, as was demonstrated by the Chernobyl accident. In the next lesson, we'll evaluate the choice the engineers at Chernobyl made when they decided to perform that experiment. Was it right or wrong and how do we know? Then we'll look at water resources to see if there is any connection between air quality and water quality.

HOMEWORK

- Journal Entry: Personal Decisions Can Have Big Impacts
- "Right-versus-Wrong: Knowing the Difference" reading
- Personal Water Inventory (to be completed by Lesson Six)

OPENING DISCUSSION

Follow-up to Lesson Three homework:

Ask students to share the results of the "Global Barometer" activity sheet. Discuss the similarities and differences between student results.

Introduction to Lesson Four:

What is air pollution? (Write the students' definition on the board.) Let's brainstorm things that pollute the air. (For an extension, ask kids to research the U.S. Clean Air Act and find out how it defines air pollution.)

Background

Most major air pollutants are invisible, although large amounts of them concentrated in areas such as cities can be seen as smog. One often-visible air pollutant is particulate matter, especially when surfaces of buildings and other structures have been exposed to it for long periods of time, or when it is present in large amounts.

Particulate matter is made up of tiny particles in the atmosphere that can be solid or liquid (except for water or ice) and is produced by a wide variety of natural and human-made sources. Particles can be smaller than 10 microns in size (about seven times smaller than the width of a human hair). Particulate matter includes dust, dirt, soot, volcanic ash, pollen, smoke, and tiny particles of pollutants.

Major sources of particulate pollution are factories, power plants, trash incinerators, motor vehicles, construction activity, fires, and natural windblown dust. Coal and oil burned by power plants and industries, and fuel burned by most vehicles are the chief sources of human-made particulate pollutants, but not all important sources are large scale. The use of wood in fireplaces and wood-burning stoves also produces significant amounts of particulate matter in localized areas, although the total amounts are much smaller than those from vehicles, power plants, and industries. Large amounts of pollution particles in the air cause haze and can lower visibility. Particulate matter concentrations may worsen in the winter due to wood-burning and coal-burning fires, and vehicles can cause higher pollution levels in more densely populated areas. Highs or lows may also be caused by areawide weather conditions such as dust storms or rain. Some areas within a city may be worse than others, if they are located closer to major pollution sources such as industry.

One important aspect of air is that it has no boundaries. Wind can carry pollutants hundreds of miles from their origin. Sand and dust from the Sahara Desert in Africa can rise into the air and be carried across the Atlantic ocean, the Caribbean, and the Gulf of Mexico. The distance air pollutants travel depends on how high in the atmosphere they go. If the pollutants do not rise very high, they are deposited close to the source. However, pollutants that are lifted high into the atmosphere may travel thousands of miles before they drop back to earth. Air does not know local, state, national, or international boundaries.

From "The Path of Pollution." *Teaching Environmental Sciences Class*, Texas Southern University, Houston, Texas, February 24, 1997.

Lesson Assessment: Revisions for Next Time ________________

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ACTIVITY

Particulates and Gases: A Model

Purpose

The purpose of this activity is to help students understand the different behaviors of gaseous and particulate air pollution.

Preparation and Materials

You will need (for each group):

- 1 large glass jar
- 1 tablespoon of milk
- 1 teaspoon of pepper
- 1 plastic spoon
- Water

Before class:

- Pair up or break students into small groups.

Procedure

1. Give each pair or group:
   1 large glass jar
   1 tablespoon of milk
   1 teaspoon of pepper
   1 plastic spoon
   Water
2. Ask students what the water in the jar is modeling. (Answer: air.)
3. Ask students what the milk and pepper are supposed to represent. (Answer: The milk represents gaseous air pollution; the pepper represents particulate air pollution.)
4. Have each group or pair do the following:
   a. Fill the jar half full with water.
   b. Add one tablespoon of milk to water; stir to mix.
   c. Add one teaspoon of pepper to water; stir.
   d. Observe the differences between the milk and the pepper.
5. Ask students to observe how long it takes the pepper to settle to the bottom.

Discussion

- What kind of pollutant(s) did the milk act like in the water? (Answer: gases.)
- What kind of pollutant(s) did the pepper act like in the water? (Answer: particulates.)
- Would it be easier to get the milk or the pepper out of the water? (Answer: pepper.)
- Would it be easier to remove the gases or particulates out of the air? (Answer: In a controlled area, particulates can be removed by filtering the air. To remove gases from the air is more difficult. Some gases can be removed by using industrial “scrubbers.”)
- How can we measure the gases in the air when we can't see them? (Answer: A piece of equipment called a gas chromatograph can be used to test for some gases; also, air samples can be taken for lab analysis.)

Adapted from “Particulate Information Activities and Data,” Air Quality Lesson Plans and Data Web Site, Texas Office of Air Quality, Air Planning and Assessment Division, 1997. *http://www.tnrcc.state.tx.us/air/monops/lessons/partinfo.html*

Community Air Inventory

Purpose

Students will assess the air quality in their community and differentiate between particulates and gases.

Preparation and Materials

- Each pair of students will need a copy of the "Air Inventory Worksheet," a pencil, and something to write on.
- You may want to take your class to a specific location where several items on the inventory sheet can be clearly seen, or you may just use the school grounds. Also consider asking the students to do the inventory at their research site.

Procedure

- Ask the pairs to spread out so they have some space to move around.
- Ask them to fill out the worksheet as a team by looking and smelling. They will also be able to fill in some items by what they know is in their community, even though they may not be able to see or smell the effects of those sources right then.

AIR INVENTORY WORKSHEET

Names:____

Fill in the table below based on what you can See (mark with an *S*) or what you can smelL (mark with an *L*) in the air where you are. If you can't see or smell an item right now, but you Know it exists in your community, place a *K* in the box. In the box labeled "Source," write down what causes the gas or particulate in the air in your community.

Source(s)	Particulate	Gas	Both	In Our Community
Agricultural burning				
Ash				
Car exhaust				
Carbon dioxide (CO2)				
Carbon monoxide (CO)				
Cigarette smoke				
Cow burps				
Dirt				
Dust				
Fireplace smoke				
Forest fires				
Haze				
Industrial emissions				
Lead				
Lightning				
Nitrogen oxides (NOx)				
Ozone				
Perfume				
Pollen				
Power plants				
Rice fields				
Rotting leaves				
Sewers				
Soot				
Street cleaning				
Sulfur dioxide (SO2)				
Swamps				
Volcanic ash				
Other				

Adapted from "Particulate Information Activities and Data." Air Quality Lesson Plans and Data Web Site, Texas Office of Air Quality, Air Planning and Assessment Division, 1997. *http://www.tnrcc.state.tx.us/air/monops/lessons/sw.jpeg*

JOURNAL ENTRY : PERSONAL DECISIONS CAN HAVE BIG IMPACTS

- Read "Lessons from Chernobyl" essay.
- Prepare for class discussion about this article by responding to the following questions in your journal:
    1. Do you think the pollution caused by the explosion was particulate or gaseous?
    2. Why do you think the engineers decided to do this experiment?
    3. Do you think they knew what they were doing was very dangerous?
    4. Based on the reading, what do you think *ethics* means?

LESSONS FROM CHERNOBYL

by Rushworth M. Kidder

Several years ago, in 1989, I discovered myself one Monday morning in March standing a few hundred yards from the wall of Reactor Number Four at the Chernobyl nuclear power plant in Russia. Looking back later, and checking the clips to see what else had been written on that subject, I discovered that I was probably the first Western journalist ever to get that close to Chernobyl. I was taken there in the company of two members of an emergency response team who had come in right after the accident on April 26, 1986, to help clean up the mess. The fallout from that disaster was detected in every country in the world capable of sensing radioactivity in the atmosphere. The explosion and its aftermath killed thousands of people.

Why did it happen? That night in 1986 there were two electrical engineers—not nuclear but electrical engineers—in charge of the control room. Perhaps the most charitable way to put it is that they were "fiddling around" with the reactors. They wanted to see what would happen as they performed an unauthorized experiment. According to Russian accounts, they were trying to see how long the turbine would freewheel if they took the power off it. In order to take the power off, they had to shut down the reactor. To do that, they manually overrode six separate computer-driven alarm systems. Each system would come up and say, "Stop! Don't do this! Terribly dangerous!" But instead of shutting off the experiment, they shut off the alarms. When my friends got in there, they discovered there were valves padlocked in the open position so that they would not automatically shut down and turn off this experiment. That is how deliberate this whole thing was.

Now, the question this raises for me is, What was going on in the minds of those electrical engineers as they did that? Obviously, these were bright people. Jobs at Chernobyl are plum jobs, and they go to the equivalent of the Russian 4.0 grade-point average, the 800 on the SATs, the Phi Beta Kappas of Russia. These two knew what they were doing. If knowledge alone were all that mattered, they would have been doing fine.

So what went wrong? It seems to me that before they could have overridden a single computer alarm system, there must have been an ethical override. Somewhere the conscience had to shut down before the alarm systems could be turned off. They could not have been unaware of the possible consequences of what they were doing. What blew up Chernobyl was not a lack of knowledge. It was a lack of ethics.

That's a crucial point for the 21st century. There is no machine you could have put those engineers in front of in the 19th century and said, "Do the most amoral thing you can to this machine," that would have produced the damage of Chernobyl.

The point here is that the very scale of our systems, the scale of our technology itself, is leveraging our ethics in ways we never saw in the past. And that is a new phenomenon. Every managerial system, however large or small, rises in its structure to the apex of one or two decision makers. What is going on in the conscience of those individuals directly determines the use of that system. So, however large and powerful the technologies, what governs them is the ethics of those in charge.

CLASS DISCUSSION

- What went wrong at Chernobyl?
- Was what the engineers did wrong? Why?
- How serious was the impact and to whom or what?
- What did the article tell us about technology in this age?
- What does the author think is most important for those operating large-scale systems? Do you agree?

POLLUTION PATHWAYS

PURPOSE

By tracing the movement of radiation released during an accident at the Chernobyl nuclear power plant in Chernobyl, Russia, students will see how air pollution, like particulate matter, can become a global issue.

PREPARATION AND MATERIALS

You will need:

- A fairly detailed, large world map
- Two copies of the "Pollution Points" handout (one for each team).
- Reference material available for students to locate countries
- A copy of the "Explosion at Chernobyl Information Sheet" from which students can read aloud

Before class:

- Make reference materials available to locate countries.

PROCEDURE

- As a whole class, discuss how air pollution travels.
- Ask a volunteer to read the first half of the "Explosion at Chernobyl Information Sheet." Ask another volunteer to finish it.
- Then ask students to break into small groups and discuss what happened to make sure they are clear about the details.
- Using the "Pollution Points" handout, ask students to plot the course the radiation took each day. Points should be plotted numerically by day and in chronological sequence.
- Split the class into two teams. Each team will work together to map pollution points.
- Mark Chernobyl's location with a sticker.

- The mapping will start with someone from the first team reading pollution point location No. 1 out loud. He/she will have 40 seconds to find the city on the map and mark it with a sticker labeled with the correct day. (For example, when No. 22—Athens, Greece—is called out, the sticker placed on Athens will be labeled “day 8” to mark the date that radioactive pollution from Chernobyl reached Athens.)
- Team members can help the player by giving directional tips (north, south, east, west) but they cannot point to any specific location.
- If the team member finds the location point within 40 seconds, that team gets one point. If not, the other team gets a chance to find the correct location.
- Teams take turns locating the points until all twenty-nine points have been mapped.

EXPLOSION AT CHERNOBYL INFORMATION SHEET

BACKGROUND

On April 26, 1986, at 1:23 A.M., Chernobyl, Russia, became the site of the world's worst nuclear power plant accident. Two operators decided to carry out an unauthorized experiment in which they had to override six alarm systems and manually lock open many automatic shutdown valves. The result of this experiment was an explosion of one of the reactors that sent radioactive gases and particles as high as three miles into the atmosphere as it blew apart. Two plant workers were killed immediately and thousands more Russians died in the aftermath.

As fires inside the reactor burned, helicopters dumped tons of lead, sand, and other minerals on the flames. Despite these efforts, the fires burned for ten days after the blast, continuing to release radioactive pollutants into the air.

WHERE IT WENT

The explosion resulted in a huge cloud that soon split into two parts. One part of the cloud moved northwest toward Poland and Scandinavia, and then southwest across central Europe. The other cloud moved east across Asia, over Japan and the North Pacific, and eventually reached western North America. As the reactor continued to burn, it released radiation that moved south and west of the plant. But scientists believe that in most cases, the amounts of radiation deposited outside the Soviet Union were relatively low.

EFFECTS OF THE EXPLOSION

The first few weeks following the Chernobyl blast were filled with confusion. Some European countries ordered the destruction of millions of dollars worth of contaminated produce, milk, and livestock. But in other nearby European countries, people were told that there was no danger and that it was safe to consume these products. Farmers suffered huge financial losses when countries in other parts of the world refused to import produce from Europe. A significant portion of the released radioactive material has a very long half-life (i.e., it will be around for a very long time, thousands of years). Radiation, even at low levels, can cause illnesses.

The explosion also strained relations between Russia and other nations. Many countries were angered by Russia's delay in reporting the accident. It was only officially reported three days after it happened.

CHERNOBYL'S LEGACY

The damaged reactor at Chernobyl now stands entombed in thick layers of concrete and steel, while the other reactors at the same plant are again producing energy. But the disaster is still taking its toll on the surrounding environment.

POLLUTION POINTS

Day One: April 26

EXPLOSION AT CHERNOBYL

Day Two: April 27

1. Winds blow radioactive cloud northwest over Gdansk, Poland.

Day Three: April 28

2. Radioactive cloud reaches Stockholm, Sweden.
3. Radioactive cloud reaches Helsinki, Finland.
4. Radioactive cloud reaches Oslo, Norway.

Day Four: April 29

5. Radiation continues moving north through Scandinavia and reaches Trondheim, Norway.
6. Radiation detected in Copenhagen, Denmark.
7. Winds carry radioactive cloud to Prague, Czech Republic.

Day Five: April 30

8. Cloud moves over Munich, Germany.
9. High amounts of radioactive particles wash out when it rains in Vienna, Austria.
10. Radioactive cloud reaches Geneva, Switzerland.

Day Six: May 1

11. Cloud travels to Rome, Italy.
12. Radioactive cloud reaches Budapest, Hungary.
13. Winds carry radioactive cloud to Zagreb, Yugoslavia.
14. Radiation detected in Paris, France.
15. Radioactive cloud reaches Tromso, Norway.

Day Seven: May 2

16. Small amounts of radiation measured near Reykjavik, Iceland.
17. Radiation reaches Bucharest, Romania.
18. Winds carry radioactive particles into Brussels, Belgium.
19. Radioactive cloud moves over London, England. High amounts of radiation wash out when it rains north of London.
20. Radioactive cloud detected in Sofia, Bulgaria.

Day Eight: May 3

21. Radioactive cloud reaches Glasgow, Scotland.
22. Winds carry radioactive cloud to Athens, Greece.
23. Radioactive particles detected in Ankara, Turkey.

Day Nine: May 4

24. Radiation reaches Beirut, Lebanon.

Day Ten: May 5

25. Radiation detected in Damascus, Syria.

Day Eleven: May 6

26. Radioactive particles reach Kuwait, the capital of Kuwait.
27. Radioactive cloud moves over Xian, China.

Day Twelve: May 7

28. Radioactive particles reach Tokyo, Japan.

Day Eighteen: May 13

29. Slight amount of radiation detected in Richland, Washington, in the United States.

Adapted from "The Path of Pollution," Air Quality Lesson Plans and Data Web Site, Texas Office of Air Quality, Air Planning and Assessment Division, 1997. *http://www.tnrcc.state.tx.us/air/monops/lessons/pathlesson.html*

RIGHT VERSUS WRONG: KNOWING THE DIFFERENCE

The world, as we know, is full of wrongdoing. Crime, family violence, drug abuse, employee fraud—each of these problems represents a collection of individual acts of wrong. And each individual wrong begins with someone's decision to do something other than right.

So how do we know if someone has done the wrong thing? Usually, in deciding whether someone is doing right or wrong, we seek answers to two questions: How well developed is this person's sense of ethical values? and, Does this person's actions reflect those values?

What do we mean by a "well-developed sense of ethical values"? If three-year-old Colin, standing next to Grandma's special candy jar, has chocolate smeared over his hands and face but denies dipping into the sweets, we might decide that he is doing something wrong. Most of us agree that you're supposed to get permission before taking something from someone else and that you're supposed to tell the truth about what you do. However, since Colin is only three, his sense of ethical values is probably not very developed. An older child or adult would be expected to understand that the action was wrong.

Does this person's actions reflect those values? Colin's actions do not represent a sense of respect or honesty, even though some people may find his actions "cute." He is still forming a sense of values and experimenting with what is important. While we will probably draw attention to his choices and coach him about a better way to behave, we might be more understanding than if his ten-year-old brother did the same thing. We are aware that Colin's sense of right and wrong is still forming.

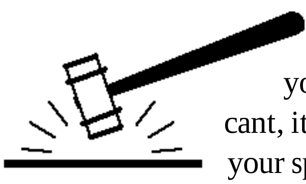
But what if Colin, as a high-school student, were to steal money from the student council treasury and pretend he had nothing to do with the theft? When asking the question, "How well developed is Colin's sense of ethical values?," we would probably have much higher expectations than we did when he was three years old. That is, we would expect the older Colin to know that it is wrong to steal from the student council. The action of taking money without permission goes against a value we all would expect him to uphold. In fact, the reaction of adults to Colin's candy jar behavior at age three may well make a big difference to his choices as a teenager. If he is never told that taking candy and lying about it are wrong, he might conclude, when older, that stealing money and pretending he didn't are acceptable choices.

FOUR WAYS TO TELL RIGHT FROM WRONG

Most of us faced with a choice between the right, the wonderful, and the good on the one hand, and the wrong, the terrible, and the bad on the other, will choose to do the right thing.

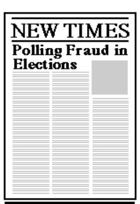
However, we're sometimes tempted to do wrong, and it often takes moral courage to make the right choice. In the case of Colin as a high-school student, for example, there was probably a reason that tempted him to steal the money. He lacked the moral vision and strength to make a good ethical decision.

Sometimes it's helpful to use the process below to determine if a choice would be right or wrong. It involves four tests that act together. While one test by itself may not leave you completely convinced, answering yes to all four of the following questions will probably leave no doubt in your mind that an action is wrong.



(1) The Legal Test: Is this choice against the law? It is wrong, we say, to pass a stopped school bus, take a candy bar without paying the shopkeeper, cut trees on your neighbor's property, or toss an empty soda bottle into the road. More significant, it is wrong to bribe public officials, refuse to pay the rent, pass bad checks, or beat your spouse. These kinds of wrongdoing involve breaking the law. You can break the law by mistake (you may not know a law exists) or on purpose (you may not agree to follow it).

(2) The Gut-Feeling Test: Does this choice go against a gut feeling? Often our intuition can determine right from wrong before our brains can think it through. Physical reactions, such as gut feelings, often indicate a need for more thought before taking action.



(3) The Front-Page Test: Would you feel good if your choice were on the front page of the local newspaper? In imagining this, you are holding up your choice to be considered by everyone you know. What would your parents think? What would your friends at school think? How would you feel if your teachers read about your decision?

(4) The Role-Model Test: Name a person you respect highly—perhaps a parent, teacher, relative, or local community figure. If this person had to make the decision you are about to make, would she or he make the same decision you're considering? Sometimes imagining how someone else would decide can help clarify your choices.

Your choice is probably wrong if it doesn't pass any of the four tests. However, these tests must be considered in combination. For example, cases of civil disobedience involve an illegal action that "passes" the other three tests. As our standards for ethical behavior shift, our definition of wrong can change, too. For example, in the early 1900s a woman might have looked to the front-page test (among others) to decide that smoking in public was wrong. Today, a woman might not be swayed by the front-page test, but the attitude of a role model might dissuade her from smoking.

PERSONAL WATER INVENTORY

Due by: ________ (beginning of Lesson Six) Name:___________________________

How much water do you use? This is a survey to find out how much water you use in your home during one full week. Place a tally mark in the "Times per Day" column every time someone in your family does the activity. Then do the math and see what you come up with for a grand total.

ACTIVITY	TIMES PER DAY *S M T W T F S*	WEEKLY TOTAL	WATER PER ACTIVITY*	TOTAL WATER USED
Toilet Flushing	+ + + + + + =	x 5 gallons =		
Short Shower (5-10 min.)	+ + + + + + =	x 25 gallons =		
Long Shower (>10 min.)	+ + + + + + =	x 35 gallons =		
Tub Bath	+ + + + + + =	x 35 gallons =		
Teeth Brushing	+ + + + + + =	x 2 gallons =		
Washing Dishes w/ Running Water	+ + + + + + =	x 30 gallons =		
Washing Dishes by Filling a Basin	+ + + + + + =	x 10 gallons =		
Using Dishwasher	+ + + + + + =	x 20 gallons =		
Washing Clothes	+ + + + + + =	x 40 gallons =		

GRAND TOTAL: ____________

* These are estimated values.

To find the average water use per person in your family, divide the "Grand Total" by the number of people in your family. The answer is: _______________.

FOLLOW-UP QUESTIONS

1. In your home, which activity happened most often?

2. Which activities use the most water each time they occur?

3. What other activities at home consume large amounts of water?

4. Why might your answer differ from those of your classmates?

Printed with permission from "How Much Water Do You Use?" *Magnificent Ground Water Connection*, New England Interstate Water Pollution Control Commission, Lowell, MA, June 24, 1999. *http://www.neiwpcc.org*