IN THE AIR

www.intheair.org

Background Information

EPA

Missouri Botanical Garden

Funding was provided by U.S. EPA, with generous support from Missouri Botanical Garden's EarthWays Center, and the 69 reviewers and partners.

Background Information

Background Information For This Module

Note: This section is written at an adult level. Reading this section is not required to present the materials. It has been included as an additional resource for those who wish to gain a more in-depth understanding of the topic. This section provides the basis for understanding problems associated with airborne toxics as follows:

- Key terms
- Airborne Toxics Chart
- Contributing Sources to Air Pollution
- Information on risk calculation
- Brief history of clean air efforts in the United States
- Conclusion and closing thought
- Sources for further reading and research

DEFINING TERMS:
The focus in this module is not on air pollution in general but on a specific type of air pollution called airborne toxics and a subset of airborne toxics called Hazardous Air Pollutants (HAPs for short). These pollutants may cause serious health problems for people, animals, and plants. They may also damage the environment. For greater clarity, we will use the diagram on the following page to distinguish airborne toxics and HAPs from other types of air pollution. (*Explanations of the terms in the boxes are based on U.S. Environmental Protection Agency (U.S. EPA) definitions, but have been modified in some cases for brevity or clarity. If you still are uncertain about the meaning of a term or an acronym, the following URL takes you directly to the glossary section on the U.S. EPA web site:* http://www.epa.gov/OCEPAterms/. *The U.S. EPA may define terms differently than a standard dictionary.*) Information on how the U.S. EPA assesses our health risk from air pollutants is included on the following pages.

Key Terms As Defined By The U.S. EPA

Note: Air toxic, airborne toxic, and hazardous air pollutant may be used interchangeably within this module. Additional words are listed and defined in the individual activities.

Air Toxics: Any air pollutant that may reasonably be anticipated to cause cancer; respiratory, cardiovascular, or developmental effects; reproductive dysfunctions, neurological disorders, heritable gene mutations; or other serious or irreversible chronic or acute health effects in humans.

Sources: http://www.epa.gov/OCEPAterms/aterms.html
http://www.sbcapcd.org/biz/toxics.htm

Key Terms (Cont.)

Criteria Pollutants: EPA has identified and set standards for six pollutants to protect human health and welfare: ozone, carbon monoxide, particulate matter, sulfur dioxide, lead, and nitrogen oxide. The term criteria pollutant is derived from the requirement that EPA must describe the characteristics and potential health and welfare effects of these pollutants. It is on the basis of these criteria that standards are set or revised.

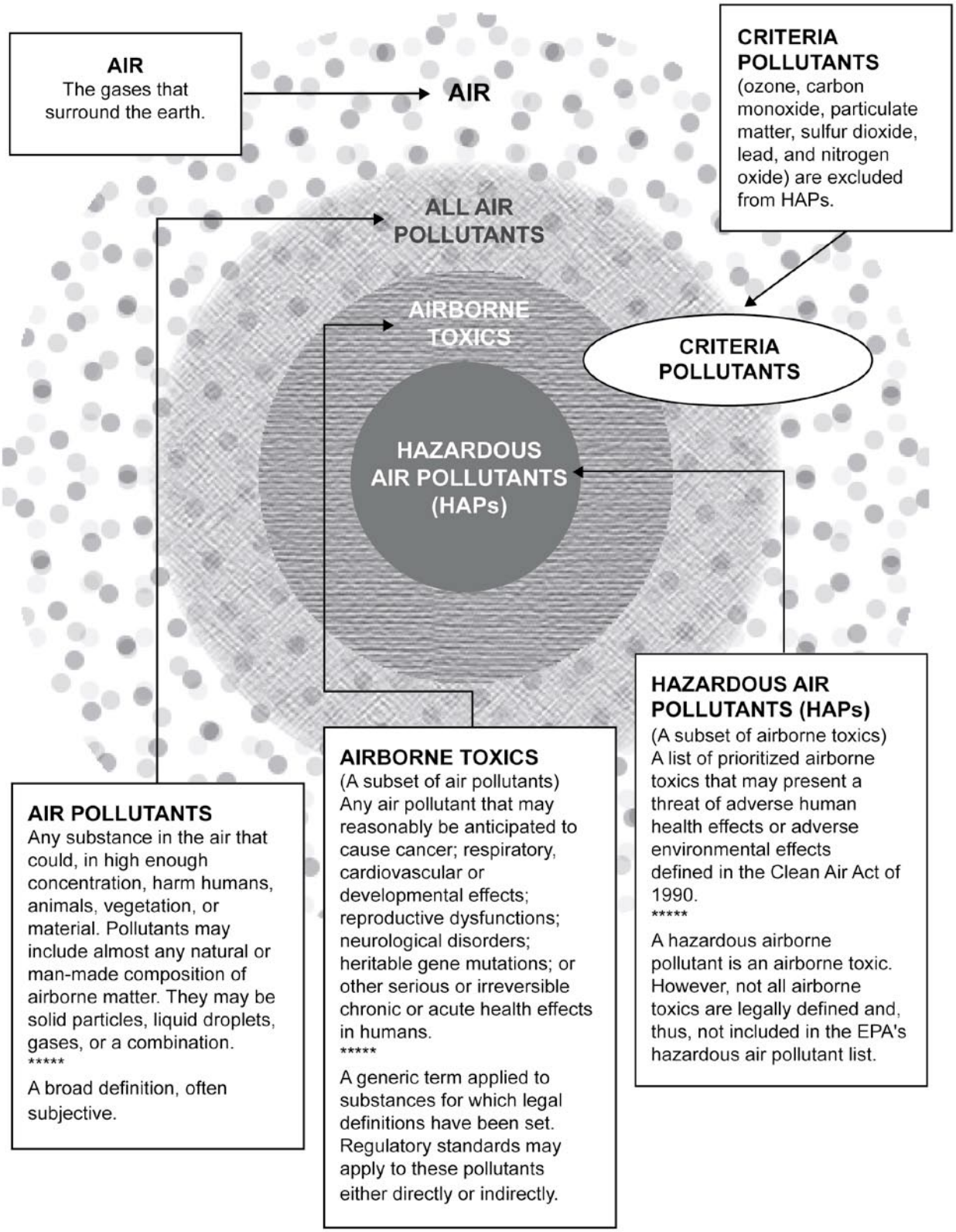
Source: http://www.epa.gov/OCEPAterms/cterms.html
Although Criteria Pollutants are placed in a separate category by the EPA and are not taken up in this module, educational materials addressing criteria pollutants are available:
http://www.epa.gov/teachers/curriculumair.htm

Hazardous Air Pollutants (HAPs): Hazardous air pollutants, known as toxic air pollutants or air toxics, are specific pollutants that cause or may cause cancer or other serious health effects, birth defects, or adverse environmental and ecological effects. EPA is required to control 188 hazardous air pollutants. Examples include benzene, which is found in gasoline; perchloroethylene, which is emitted from some dry cleaning facilities; and methylene chloride, which is used as a solvent and paint stripper by a number of industries.

Source: http://www.epa.gov/ttn/atw/pollsour.html
For descriptions, properties and potential hazards of the listed chemicals,
http://www.lakes-environmental.com/laketoxi.html.
For proposed changes or modifications to the list, see
http://www.epa.gov/ttn/atw/188polls.html

Multi-Media Approach: Joint approach to several environmental media, such as air, water, and land. *EPA uses the word media to refer to a specific type of environment. A multi-media approach is where efforts and actions are orchestrated to consider and address impacts on multiple environments.*

AIRBORNE TOXICS CHART



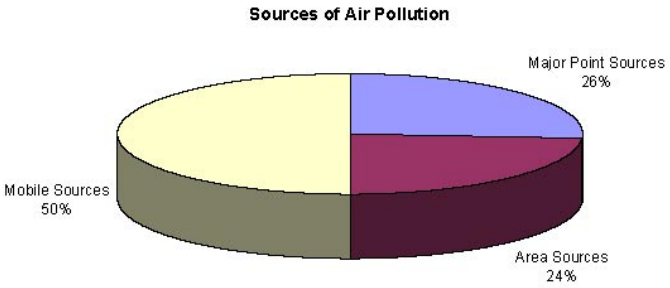
Some Contributing Sources To Air Pollution

Outdoor Air -

- mobile sources such as cars, trucks, marine vessels , trains, airplanes, construction equipment, lawn care equipment, agricultural equipment, etc.
- point sources such as large industries
- area sources (small stationary producers) of pollution such as auto repair shops, gas stations, dry cleaners and other small businesses, residences. Widespread pollutants not attributable to one specific source are also classified as area source pollutants, such as dust from roads and agriculture.
- background pollution from naturally occurring sources such as wildfires, volcanic events, legacy chemicals, etc.

Indoor Air -

- tobacco smoke
- household chemicals
- personal care products
- molds, dust, dander, and other biological substances
- pollutants from outdoor air



Learning About Risks

(The following section on risk has been adapted from EPA450/3-90-022 Air Pollution and Health Risk-March 1991)

The warnings about hazardous substances are everywhere. Everyday, people encounter hazardous chemicals in the environment that have the potential to harm human health. But risk involves several factors.

What determines the health risk from hazardous chemicals?

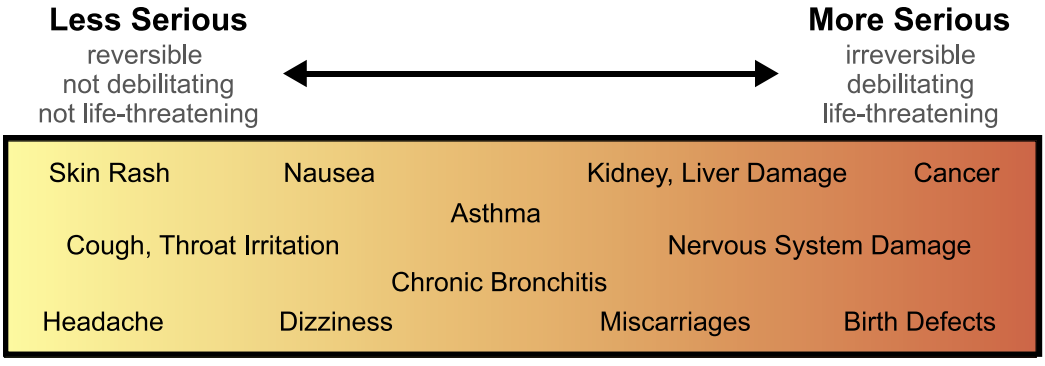
The effects of exposure to a chemical vary depending on the following:

- how toxic the chemical is
- how much of the chemical people are exposed to
- the time a person is in contact with the chemical

How a person is exposed to a chemical matters as well: Was it ingested, inhaled, or did the chemical come in contact with eyes or skin?

Which Risks Are of Greatest Concern? How Do Researchers Estimate Risk?

Adverse health effects vary in severity, ranging from reversible symptoms such as a rash or irritated eyes, to more serious effects that are irreversible such as birth defects, cancer, and damage to the central nervous system.



The elderly, the young, and those with chronic health conditions such as asthma or heart disease may be more sensitive to chemical exposures and therefore be at higher risk for adverse health effects.

What Is Health Risk?

- Health risk is the probability, or chance, that exposure to a hazardous substance will make you sick.
- Animal experiments or human studies provide information about how hazardous a substance is. Scientists use the results of such studies to estimate the likelihood of illness at different levels of exposure.
- Information on exposure comes from two places: monitors placed on factory smokestacks or at special places in the community, or from mathematical models that estimate exposure based on amounts of chemicals released.

Why Is Information Used For Health Risk Decision Making Uncertain?

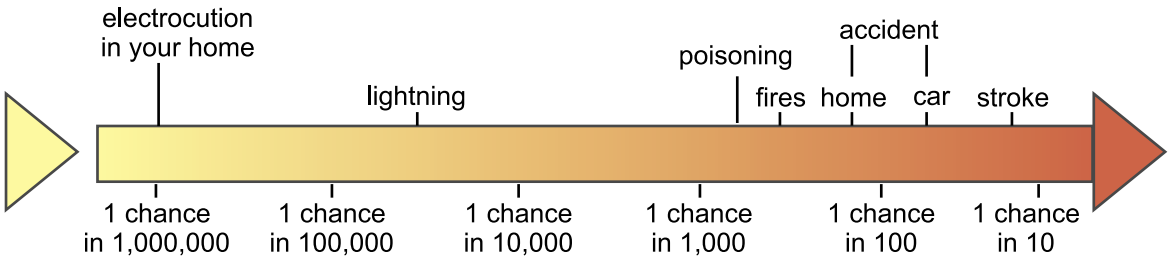
- Scientists lack a complete understanding of how a hazardous substance makes you sick and how it moves through the air, water, or ground.
- Not enough human or animal studies of the health effects of individual chemicals and mixtures of chemicals have been done.
- Many hazards are identified by testing animals. We do not know for certain if the hazard estimated using animal studies is the same for humans.
- We do not know how the variable nature of weather patterns affect exposure.
- Monitors or mathematical models may not always produce accurate exposure estimates. Accounting for the different exposures an individual person may encounter is nearly impossible.
- We are unable to know everything.

Balancing Scientific Results with Public and Economic Concerns

Ideally, all pollution and its risks would be eliminated, but this is not a realistic expectation. Regulators must address the most important health concerns and decrease them to the level at which they believe the risks are smaller than the benefits of the activity causing the pollution.

Putting Risks in Perspective

(The continuum below presents risk statistics for some familiar events.)



Public Risk Perceptions

Scientific results may show that certain hazardous substances pose a low health risk to people, but the public may still have concern because of different risk attributes. Other attributes may affect the perception of a risk:

- How serious and dreaded is the adverse health effect?
- How certain is scientific knowledge?
- Who bears the risk of the exposure?
- Is the risk voluntary?
- What activity is responsible for the hazardous substance being introduced into the environment?

What Can You Do?

People can reduce their risks from hazardous chemicals in the environment by becoming better informed and by providing input to government, industry, and consumer/environmental groups.

A Brief History Of Clean Air Efforts In The United States

Clean Air Efforts

Pollution of the air from airborne toxics is old. Since time began, Earth's air has been bombarded with airborne pollutants from natural causes such as volcanic action, forest fires begun by lightning, and dust storms. Thousands of years ago, early humans sent smoke and particulate matter into the air with their campfires and more recently with slash-and-burn agricultural practices. As the world population grew and technology advanced, succeeding generations contributed an ever-increasing number of man-made pollutants into the air.

As far back as the thirteenth century, the burning of sea-coal had already become a major environmental problem in European cities. Mechanical engineer John H. Lienhard wrote:

> "13th century millwrights had spent 200 years eating up European forests to make windmills and waterwheels. Wood was becoming too precious to use as a fuel. Wood was first replaced by surface coal—often called sea-coal because the more obvious outcroppings were found on the coast. By far the largest sea-coal deposits were English ones. . . Sea-coal was filthy stuff—loaded with bitumen and sulfur. It created environmental problems from the start."
> (Lienhard, John H. *The Engines of Our Ingenuity*. Oxford University Press, 2001.)

In London, in the early fourteenth century, smoke from burning sea-coal had become so troublesome that King Edward I banned its use. Much later, similar problems occurred in the United States as the Industrial Revolution took hold. Coal again was the main culprit as vast deposits of bituminous coal with a high sulfur content were mined and used for domestic and industrial purposes. *(A harder, less polluting type of coal called anthracite was also mined, but it was scarcer and more costly.)*

By the late nineteenth century, political and civic leaders in several American states and cities found it necessary to enact laws to abate coal-related pollution problems. Progress was slow, however, because coal production was a vital cog in the American industrial system. Moreover, with the rapid disappearance of forests, coal was essential for home heating and cooking.

As is often the case, deep-seated human practices are difficult to change until a catastrophe of some sort occurs. One such event happened in St. Louis, Missouri, in 1939. For decades,

smoke and coal dust from home fires, industries and riverboats had been dimming the skies in that city. Campaigns to clean up the air by civic leaders had met with stiff resistance from the coal industry, labor unions, and the public who depended upon inexpensive coal for domestic purposes. Finally, on Tuesday, November 28, 1939, *(henceforth to be known in St. Louis as "Black Tuesday")*, a blanket of smoke and coal dust descended upon the city. It was so thick that the light of the sun was unable to penetrate it. Pictures taken in the city that day show only the dim outlines of people on the streets and the dull glow of street lamps and automobile headlights. Not surprisingly, Black Tuesday provided the turning point for St. Louis. Stringent smoke abatement laws were passed and enforced, leading to an astonishing reduction of the city's perennially smoky air in a matter of months. *(Some bituminous coal was still used but it had to be washed and burned in ways that reduced pollution.)*

While clean air problems stemming from coal were diminishing, it was only the first step in clearing the air. As industrial development continued, other types of air pollution, gases, chemicals, and particulate matter from vehicles, mills, factories, and businesses were increasing. Under certain atmospheric conditions *(called temperature inversions)*, these residues are trapped close to the ground instead of dissipating into the atmosphere. The result is smog, a term arrived at by combining two words, smoke and fog.

A deadly smog situation occurred in Donora, Pennsylvania, in 1948. Donora, a mill town of 14,000 people, is located in a valley on the Monongahela River. When a temperature inversion trapped pollutants in the valley for five days, twenty people died of asphyxiation and hundreds more became ill. Four years later, in London, a similar event occurred but on a much more deadly scale. About four thousand people died and thousands more became ill from smog that covered the city for more than a week. In England and the United States, these tragic events led to national air control legislation.

In 1955, the United States Congress passed the Air Pollution Control Act, the first federal legislation to deal with air quality problems. The initial Act was cautious and relatively weak, but it has been revised, expanded and strengthened many times since.

Notice how the purposes of the Clean Air Act have become more comprehensive over the years.

Air Pollution Control Act of 1955	Clean Air Act of 1963	Clean Air Act of 1970	Clean Air Act of 1990
"An Act to provide research and technical assistance relating to air pollution control."	"An Act to improve, strengthen, and accelerate programs for the prevention and abatement of air pollution."	"An Act to amend the Clean Air Act to provide for a more effective program to improve the quality of the nation's air."	"An Act to amend the Clean Air Act to provide for attainment and maintenance of health protective national ambient air quality standards, and for other purposes."
For more information about all the above Clean Air Acts, go to http://www.ametsoc.org/AMS/sloan/cleanair/index.html			

Establishment of the U.S. Environmental Protection Agency

The year 1970 was a banner year for the environment in the United States. During that year, the first Earth Day was celebrated, Congress passed a more comprehensive version of the earlier Clean Air Acts and the U.S. Environmental Protection Agency (U.S. EPA) was established. The mission of the U.S. EPA was " . . . to protect human health and to safeguard the natural environment - air, water and land - upon which life depends."

History (Cont.)

By mentioning all three aspects of the environment in its mission statement—air, water, and land—the U.S. EPA indicated that it would tackle environmental problems through a multi-media approach. This means that the three environmental elements (or media) are considered as inseparable parts of a whole. For example, airborne toxics not only pollute the air but also settle on land. From the land, they are flushed into rivers, lakes, and streams. As a result, people may be exposed to chemicals that started out as an airborne toxic through: breathing air, coming in contact with contaminated soil or water and eating plants and animals that have been contaminated by certain toxics that are persistent and bio-accumulate.

Designation of Hazardous Air Pollutants (HAPs)
With 189 hazardous air pollutants designated in the 1990 version of the Clean Air Act (one chemical has been de-listed) that number is only scratching the surface. It is a prioritized list of chemicals. We breathe many potential dangers in the air. Unless you are a chemist or an engineer, you probably have never heard of most of the chemicals on the HAPs list. On the other hand, you probably have been exposed to many of them without knowing it while outdoors, at home, at school and at work. That is why you must meticulously read the labels and follow directions for the use of household cleaning fluids, insecticides, paints and varnishes, auto maintenance products, and so forth.

Know how and where to get information about commonly used chemicals. For instance, what are the properties of various widely used chemicals? How and where does one become exposed to them? What dangers to human health and the environment do they pose?

Conclusion

While all of the grim facts about airborne toxics may be unsettling, most people are only exposed to low levels of hazardous chemicals. Learning about the impact that toxics have on our environment and our health should spur us on to explore alternatives that can reduce the amount of hazardous substances entering the environment and minimize our exposure to them. Many publications about health risks from airborne toxics can be obtained from the U.S. Environmental Protection Agency and other government sources, most of them free of charge. For information on relevant publications and how to obtain them, see http://www.epa.gov/epahome/resource.htm. Check with your state and local agencies and with the University Extension office in your area for additional information.

A Closing Thought

When you are solving one or another of life's problems, it's a good idea to look back occasionally and see how far you have come. You may be pleasantly surprised. The same is true on a larger scale. For instance, the bad news about air pollution in the United States often obscures the fact that we have come a long way in a relatively short time. Of course, we have a long way to go, but time and experience have proven that having cleaner air is possible. The writer of an U.S. EPA bulletin, Air Pollution and Health Risk puts it this way:

> "Ideally, regulators would like to eliminate all pollution and its risks, but this is usually not a realistic expectation. Regulators must address the most important risks and decrease them to the level at which they believe the risks are smaller than the benefits of the activity causing the pollution. This is similar to what millions do each day when they balance the risks of an automobile accident with the convenience and necessity of driving. Just as a driver will buckle up and drive defensively to be safer, agencies take regulatory action to eliminate as much risk as is possible without losing the benefit."

For further Reading and Research

- Davis, Devra. *When Smoke Ran Like Water: Tales of Environmental Deception and the Battle Against Pollution.* Basic Books 2002.

Author Davis is a renowned environmental epidemiologist who grew up in Donora, Pennsylvania, the scene of devastating smog in 1948. In this book, she presents evidence that airborne toxics are responsible for thousands of deaths in the United States each year. She also documents how powerful vested interests in business and government resist making needed changes.

- Background information on air toxics:
  http://www.epa.gov/air/toxicair/index.html
- Information about asthma, lung disease and air pollution issues:
  http://www.lungusa.org
- Learn more about an air monitoring program in St. Louis:
  http://www.stlcap.org
- Information on air quality and the Clean Air Act. Source EPA—Office of Air and Radiation:
  http://www.epa.gov/oar/oaqps/
- Information on risk assessment, air pollution and health risk and evaluating exposures to air toxics. Source Technology Transfer Network-Air Toxics—EPA:
  http://www.epa.gov/ttn/atw
- Great for students about choices and driving:
  http//www.easybreathers.org
- Find numerous resources on the toxic chemicals and environmental health risks where you live and work. National Library of Medicine, National Institutes of Health, US Department of Health and Human Services:
  http://toxtown.nlm.nih.gov
  1-888-find-nlm
  (1-888-346-3656)

For Kids

- A great site that highlights household products that contain warnings or special instructions on how to use and dispose of them and suggests safer alternatives:
  http://www.epa.gov/kidshometour/index.htm
- Another great site:
  http://www.epa.gov/kids
- Smog City—Learn how to prevent ground level ozone and other air pollution:
  http://www.smogcity.com
- Clean up Dump Town—You are the city manager. Your job is to make your city clean again:
  http://www.epa.gov/recyclecity/gameintro.htm
- Your local public library is a good source of information.

Module Evaluation Form
In the Air: Tools for Learning About Airborne Toxics Across the Curriculum

Thank you for your responses. Please complete form, fold and mail, or go to www.intheair.org and submit your information on-line.

About You

Name (Optional)
_____

Business /School
_____

Street Address
_____

City, State, Zip Code
_____

Please check one:
☐ Teacher ☐ Non-formal educator

☐ Other _____

How did you find out about "In The Air"?

_____

How did you access these materials?

☐ Hard Copy ☐ Download from cd

☐ Download from web site

Overall Module Use

Did you have any problems downloading or reproducing the materials? If yes, what specifically?

_____

What modules did you use?
☐ K-3 ☐ 3-6 ☐ 6-8

☐ 9-12 ☐ Adult

Which activities did you use?

_____

_____

_____

For what grades/groups?
_____

Please describe how the activities were used.

_____

_____

Was the format of the materials effective?
☐ Yes ☐ No

If not, please suggest changes.

_____

Were the activity directions and descriptions clear?
☐ Yes ☐ No

Comment
_____

_____

For K-12 Modules
Did you use the Pre/Post test activity?
Yes ☐ No ☐

For Adult Presentations

What type of group did you present to?
☐ Church ☐ Community
☐ Adult education ☐ Business

☐ Other _____

Background Information
If you read the background information, did you find it valuable for your own personal education?
☐ Yes ☐ No

Did it influence your teaching of the modules?
☐ Yes ☐ No

Future Interest

If there were similar materials available on other pollution and environmental topics would you use them?

☐ Yes ☐ No

Do you have a suggestion for another topic? _____

Would you like to be informed about new materials? ☐ Yes ☐ No

How should we contact you? ☐ E-mail ☐ Phone ☐ Postcard to address already given

Contact information: _____

Additional comments you would like to share

_____

(Please fold here)

(Please fold here)

Place Stamp Here

EarthWays Center
Missouri Botanical Garden
3617 Grandel Square
St. Louis, MO. 63108

www.intheair.org