

What's the Big Question?

How Can You Improve Air Quality in Your Community?

The Air You Breathe

Once there was a peaceful land named Malaire. Malaire was a small country with mountains on three sides and a blue sea gently bathing the fourth side. The snow-capped mountains reached to the sky and cradled the land like a protective hand. The sea provided white sandy beaches for the happy children to run on and to splash in the water.



From the foothills of the mountains, one could see a lovely view of fields below. The checkered pattern of farmland was a mixture of greens and browns and yellows. Malaire was a country of farmers. Every farmhouse was surrounded by trees—shade trees, flowering trees, and fruit trees of every kind. And the flowers, such beautiful flowers you have never seen. Small wildflowers filled the shady places around the trees, and bold wildflowers captured the sunny meadows. The people of Malaire were happy, very happy, in their beautiful little country.

But one day, a young man from Malaire went on a journey over the mountains to explore the lands beyond. It was many weeks before he returned, and when he did return, it was clear from his strange clothes that he was a changed person. “What a dull, backward country we have,” he lamented to the people

of Malaire. “All we do is farm. We have nothing to buy, nothing to sell. We don’t use money. Everyone is the same, and we don’t make anything.”

“We make our own clothes and our shoes. We make butter and cheese. We make wonderful pies and cakes and soups. We even make our own houses,” his parents said.

“No, no! That’s not what I mean. We need cities and factories like in the other lands.”

“But we are happy,” the people told him. “Everyone is healthy and strong.”

“Well, I’m not happy!” retorted the young man. “And if you had seen all that I have seen—electricity and cars and cities—in the lands across the mountains, I don’t think you would be happy either.” With that, he stomped off and went back across the mountains, leaving Malaire forever.

But people were no longer as happy now. “Perhaps he is right. Perhaps we need factories and cities,” they said to each other. So they sent a delegation through the mountains to the neighboring lands to find out about cities and factories. The delegation brought back experts, who immediately started making changes.

The experts took most of the farmers from their fields and set them to work building a city along the beach. House after house was built, then factory after factory. A few men still farmed, but now they farmed much larger fields. At the bidding of the experts, they cut down trees to make bigger fields to grow more crops.

Trees were also cut down and burned in the factories and homes for heat. Smoke began to fill the sky. The factories started turning out shoes by the thousands and dumping leftover leather and chemical wastes into a river that flowed to the sea. Soon there were no fish. Other factories started making paper from trees, and thereafter, the air always had a bad smell.

Newly trained salesmen took the shoes and paper through the mountains and sold them. They brought back automobiles, and soon every family in Malaire had an automobile. Every Sunday, each family got in its car and drove, bumper to bumper, up into the mountains over a new road, to get some fresh air.



Eventually, all the large trees were gone, and there was no wood to burn. “We need coal,” said the experts, and they began looking for coal. They found it in the foothills. They brought in huge machines that tore up the earth and took out the coal. They took the coal into the city, and as coal burned in all the factories and homes, the air quality got worse and worse.

“Let’s start using electricity,” said the experts. So a power plant was built, and power lines were stretched everywhere in the city, using coal to generate electricity for the homes and businesses. The air got worse and worse.

Then, for a full week, the wind blew in from the sea. The hazy air hung over the city. People wheezed and coughed, and their eyes watered. The smelly air was thick with grimy particles from the coal and wood burning. Birds began to die. Old people and children became sick, too. No one knew why. No one tried to find out why.

Finally, the wind shifted. The wind took the bad air out to sea. Everyone breathed deeply again and smiled. More houses were built, and more factories, too. The power plant had to expand. Trains and tracks were built to cross the mountains, and an airport was built so they could start using jets. Both the trains and the jets burned fuel. They burned more and more fuel as the people of Malaire took more trips.

Again, the wind blew in from the sea, this time for ten days. The people coughed and wheezed, and their eyes watered. More birds died, and the few remaining trees began to lose their leaves. No one knew why. The air hung like a gloomy blanket, touching everything. Trees and flowers died, even weeds, and finally everyone was very sick, every single person in Malaire.

Then the wind changed, blowing the haze away. But now people were leaving Malaire. Malaire was no longer a happy place to live. No one could remember exactly when Malaire changed from being a happy place to being a sad place. No one could remember who was responsible. And so, the people packed up their children and their dogs and their cats and drove out onto the wide highways. They pointed their cars toward the hills and sped away, searching for a better place to live than Malaire.

As the last bit of exhaust from the last car disappeared into the air, the country sat there—silent. The factories had stopped. The homes were silent. Nothing moved.

Reflect

1. The story of Malaire is a parable. A parable is a short story that teaches some truth or lesson. What truth or lesson does the parable of Malaire teach?
2. How does your community compare to Malaire? Do you think the air quality in your community could get as bad as the air in Malaire?
3. How do you think you could keep the air in your community from becoming as bad as the air in Malaire?
4. How could the air in Malaire be improved? How do you think you could use what you read about Malaire to improve the air in your community?

On a moment-to-moment basis, air is the most important thing in your life. You inhale and exhale air constantly. Parts of air keep you alive. And yet, you can't see it. You can't usually smell it or taste it. What exactly is air? In this Unit, you are going to explore the composition and characteristics of air—what it is and what is in it. You will look at what air is in its very basic components. You will learn how air becomes **polluted**, or comes to contain substances that can cause harm to organisms and structures. You will explore how the quality of air can affect the plants, animals, and humans in a community. This will all help you to improve your answers to the *Reflect* questions.

Polluted air contains substances that can cause harm to organisms and structures. These substances are known as **pollutants**. A measurement that describes air in terms of the amount of pollutants it contains is **air quality**. Good air quality describes a lower amount of pollutants, whereas poor air quality describes a larger amount of pollutants.

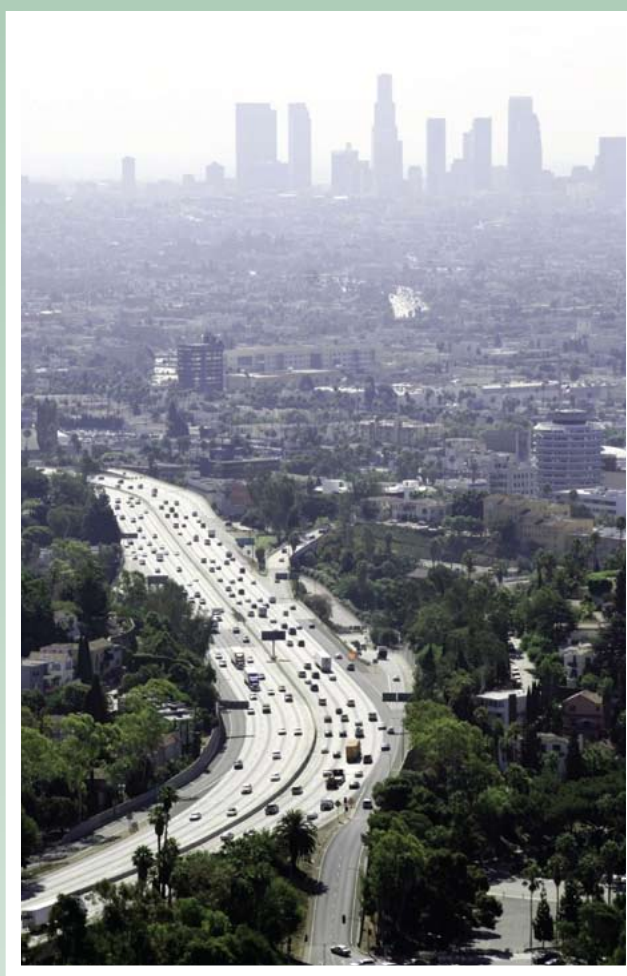
polluted:
containing substances that can cause harm to people, plants, animals, and structures; unclean or impure.

pollutant:
a substance that can make air, soil, or water harmful to organisms and structures.

air quality:
the condition of air in terms of the amount of pollutants it contains.

Air quality affects everyone. Unlike other substances you take into your body, such as food, you cannot choose the type of air you breathe. You must take in the air that surrounds you. In this Unit, you will learn that air quality is not an individual concern. Air quality is a concern for entire communities, regions, and nations. You will explore case studies involving two different regions of the United States. Each region has different issues regarding air quality. You will also learn about legislation, such as the Clean Air Act, that has been passed in an effort to improve air quality. In the end, you will discover how people affect air quality and create global climate change.

The *Big Question* for this Unit is a very important one: *How can you improve air quality in your community?* To know if the air you breathe in your own community is good, you need to know what good and poor air quality are. You also need to know where your air comes from and how air can become polluted. You will read about **air pollution** in California and in New York State, what is being done to improve the air in those places, and why it is so hard to improve the air quality in those places. You will need to learn a lot of chemistry to understand where air pollution comes from and how to manage it. You may already have some ideas about what air is and how it becomes polluted, and you may have some questions about air and air quality. You will have a chance to ask those questions and answer them in this Unit.



Poor air quality is a problem for many cities and regions.

air pollution: the introduction of chemicals, particles, or organisms to air that are harmful to living things and structures.

*Welcome to Air Quality!
Enjoy being a student scientist.*

Think About the *Big Question*

How Can You Improve Air Quality in Your Community?

In this Unit, you will investigate air quality in your community and how it can be improved. But first, you will need to identify what is meant by air quality, where pollution comes from, and how it can affect the environment. Scientists often find it useful to examine a variety of different cases to begin to understand new concepts. To begin to understand exactly what air quality is and where pollution might come from, you will begin the Unit by doing what a scientist would do. To investigate the processes occurring in some natural situations, scientists analyze case studies. A case study combines data about a variety of factors as they relate to a specific topic or issue. These results may make it possible for a scientist to identify the relationship between factors. Although you will not be able to take part in an extensive case study, you can use a similar procedure to analyze photos showing how humans impact air quality. Later in this Unit, you will read about air quality in California and New York State to help you understand more about how air becomes polluted and what can be done about it.

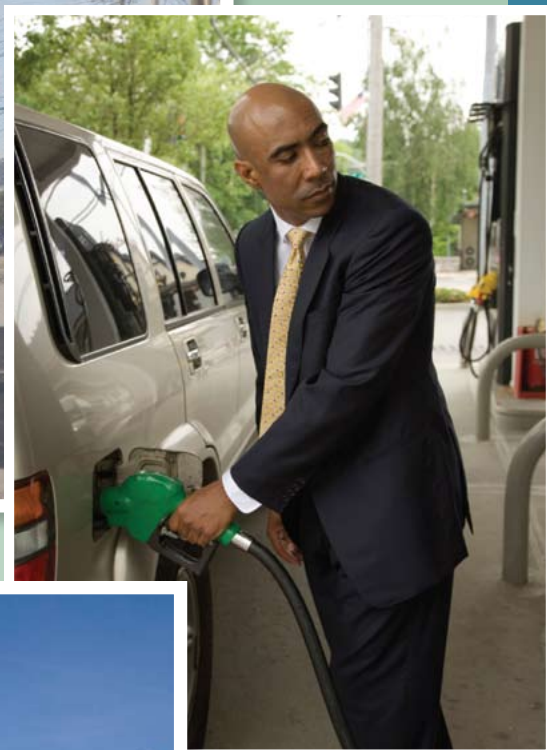
Most power plants burn fossil fuels, such as coal, to produce electricity for homes and businesses.



Vehicles clog the roads of many highways in the United States. The average American family owns 2.5 cars.



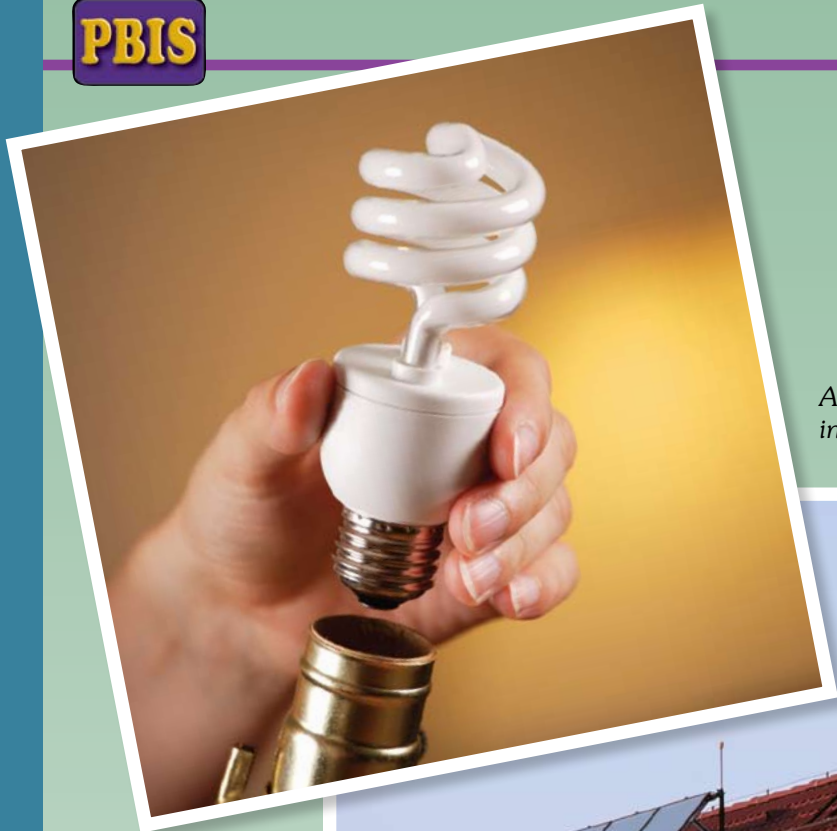
Some mass-transit trains run on electricity instead of gasoline.



At a gas station, a man pumps gasoline into his sport utility vehicle.



Wind turbines in many parts of the world stretch across open areas of land.



A compact fluorescent light bulb can be used in homes instead of a regular light bulb.



Solar panels on the roof of a house convert sunlight energy into electricity.



City workers plant a garden in a park.

Forest fires, some caused by humans, can burn for many weeks and kill many trees.



Large areas of the western United States have big herds of cattle and other livestock.



Get Started

Begin thinking about air quality by examining the pictures on this page and the previous pages. Each shows an example of a human activity or product that affects air quality. Identify the human activity or product as a *source* that has an impact on air quality. Then identify how each human activity or product might affect air quality to make it better or worse. In other words, identify its *effect*. Also, consider how the change in air quality might affect people, animals, or objects in the area. Record your ideas in the first two columns of a *Sources and Effects of Air Quality* chart like the one shown on the next page. You might think about the *Sources* column as answering the question: What activities and products make air quality good or poor? To complete the *Effects* column, think about the question: In what way does the activity improve or worsen air quality?

Sources and Effects of Air Quality		
Sources	Effects	How to improve the air

Conference

Share with your group the sources you identified and how you think those sources might affect a community. Discuss how you decided a source was good or bad for air quality and how you determined the effects of each source. It is important for every member of your group to discuss how they determined the effects of each source.

Create a group list of sources and effects. On the list, circle the ideas that some group members disagreed with. During your discussion, you may realize that there are some things you do not know about air quality. Record these as questions to share with your class.



Communicate

Share Your Ideas

As a class, make a *Sources and Effects of Air Quality* chart. When it is your group's turn to share your ideas, present the sources and effects your group discussed, why you think each is a source or effect, and the ones your group disagreed about. As you are listening, decide if you agree with the sources and effects that are presented. If you disagree, present your reasons for disagreeing. Circle the sources and effects the class disagrees about on the class *Sources and Effects of Air Quality* chart. Then, as a class, come up with a question that could be answered to help the class come to agreement about each circled item. Record the questions on the class chart. Throughout the Unit, you will investigate many sources and effects. Those investigations will help you come to agreement on ideas about which you may disagree now.

Observe

Look for Evidence of Air Quality in Your Community

The pictures gave you some ideas about what affects the quality of the air you breathe. You know enough now to begin to explore the air quality in your own community by taking an “air walk” with your class. Before you take your “air walk,” make a list of the sources and effects of air quality that you expect to see. Then, working with a partner on your walk, you will look for evidence of humans affecting air quality and the sources of these effects.



Many things you observe in nature can be an indication of good air quality or bad air quality.

As you walk around, it will help to notice small details. You may notice soot on a building or see a solar panel on a roof. You may smell wood burning in a fireplace, or you may observe butterflies on flowers. Look carefully as you walk around, and try to find examples other students have not noticed. Your *Sources and Effects of Air Quality* chart will give you some ideas about what you should be looking for.

Working with your partner, identify at least four sources that improve air quality and four sources that worsen air quality.

Recording Your Observations

Record your examples on an *Air-Walk Field Notes* pages. You will be able to fit four observations on each page, so each pair of students will have room to record eight examples.

For each example you identify,

- describe the source you identified. If you can see it, use words and a sketch to give details about your observations. If you cannot see it, describe what you think the source might be.
- record the location of the source.
- describe the effect of the source. If you can see the effect, describe what you see. If you cannot see the effect, describe what you think the effect might be.

Record enough information so that you will be able to share your observations with others. If a camera is available, someone should take pictures of the sources and effects that you identify on your walk. The sketches and photographs will help you throughout the Unit.



Stop and Think

Working with your group, use your observations to answer these questions. As your group discusses the answers to the questions, record the answers on a

new Sources and Effects of Air Quality chart. At the top of the chart, record that these sources and effects came from your air walk. Be sure to give all members of your group a chance to report their observations.

1. What sources that improve air quality did you observe on your air walk? For each, how did you decide it improved air quality? Record these sources in the *Sources* column of your air walk *Sources and Effects of Air Quality* chart. As you did earlier, circle any sources that members of your group disagree about.
2. What sources that worsen air quality did you observe? For each, how did you decide it made air quality worse? Record these sources in the *Sources* column of your air walk *Sources and Effects of Air Quality* chart. As you did earlier, circle any sources that members of your group disagree about.

Air-Walk Field Notes		0.0.1	
Name: _____		Date: _____	
<div style="border: 1px solid black; height: 100px; width: 100%;"></div>		<div style="border: 1px solid black; height: 100px; width: 100%;"></div>	
Source _____	Source _____	Source _____	Source _____
Description _____	Description _____	Description _____	Description _____
Location _____	Location _____	Location _____	Location _____
Effect _____	Effect _____	Effect _____	Effect _____
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Source _____	Source _____	Source _____	Source _____
Description _____	Description _____	Description _____	Description _____
Location _____	Location _____	Location _____	Location _____
Effect _____	Effect _____	Effect _____	Effect _____

3. For each source you observed, what effects did you observe or suggest? Record those in the *Effects* column of your air walk *Sources*

and *Effects of Air Quality* chart. For each, how did you identify it as an effect? If you did not observe effects, record any effects you think might result from the source you observed. Put parentheses around any effects that you did not directly observe. As earlier, circle any effects that members of your group disagree about.

4. How did what you actually observed differ from what you expected to see?
5. What evidence did you observe to show that people in your community are working to improve air quality? Record these efforts in the *How to improve the air* column of your air walk *Sources and Effects of Air Quality* chart.

Communicate

Share Your Ideas

You are now ready to share your observations with the class. As you did earlier, create a class *Sources and Effects of Air Quality* chart. Each time you share an idea with the class, be sure to tell the class why you think what you observed was related to air quality. Others may have different ideas about what they observed. They may have observed different things, or they may have interpreted what they saw differently than you did. Listen carefully as others present their ideas. Ask questions if you do not understand how others came to their conclusions. Be sure to ask your questions respectfully.



Reflect

The *Big Question* for this Unit is *How can you improve air quality in your community?* To answer this question, you will have to identify how good the quality of the air is in your community, what might be causing poor air quality in your community, and what can be done to improve air quality. Then you will make recommendations for improvement. Working with your group and using the ideas on the *Sources and Effects of Air Quality* charts, identify what you already know about sources and their effects on air quality and what you need to learn more about. Use the following questions as a guide.

1. What are the three most important things your class has identified about the quality of air in your community?
2. What are the three most important things your class has identified about sources that affect air quality in your community?
3. What are the three most important things your class has identified about the effects of human activities and products on air quality in your community?
4. What else do you need to know about sources and their effects on air quality to decide if your community has good or poor air quality?
5. What else do you need to know to decide how the air quality in your community can be improved?

As you work with your group, share ideas about what you need to do to answer the *Big Question*. Look back at the parable you read and the observations from your *Sources and Effects of Air Quality* charts. What does your community have in common with Malaire? How is it different? Refer back to the parable for examples of how the air quality can become bad. Discuss how what you do every day affects air quality. If you lived in Malaire, what could you do to improve air quality? Would you be willing to give up some things for better air? What would you give up? What would happen if you did that? What would happen if everybody did that? How can you have the things you want and still have good air quality? These are all questions you should be thinking about as you consider the *Big Question*, *How can you improve air quality in your community?*

Create a Project Board

When you are trying to answer a difficult question or solve a hard problem, it is helpful to organize your work. You will be using a *Project Board* throughout this Unit to keep track of your progress and the things you still need to do. Your class will keep a class *Project Board*, and you will use your own copy of the *Project Board* for reference.

Remember that the *Project Board* has space for answers to five guiding questions:

- What do we think we know?
- What do we need to investigate?
- What are we learning?
- What is our evidence?
- What does it mean for the challenge or question?

How can you improve air quality in your community?				
What do we think we know?	What do we need to investigate?	What are we learning?	What is our evidence?	What does it mean for the challenge or question?

To begin this *Project Board*, identify the *Big Question* for this Unit: *How can you improve air quality in your community?* Record it across the top of the class *Project Board*.

What do we think we know?

In the first column of the *Project Board*, record what you think you know about air and air quality. You will want to think about what is meant by good-quality air and poor-quality air, and what are the sources that impact air quality. How does poor-quality air make you sick, and how can it change the quality of your life? How does it affect animals and objects? Think about the air-quality problems facing your community. What kinds of air pollution would you expect to find in your community? What are the people of your community doing now to improve air quality? What do you think they can do in the future?



How does poor-quality air make you sick?

What do we need to investigate?

Perhaps not all students in your class agree on the main problems your community faces in trying to improve air quality. Or, maybe you and other members of your class have different opinions about how scientists and engineers can solve the air-quality problems in your community. Use this column to keep track of what you need to investigate to answer the *Big Question*. Make sure you also record what you need to find out about air and air quality. Record things you are not sure about and need to find out more about.

You will return to the rest of the *Project Board* throughout the Unit. For now, work with your class to fill in the first two columns.