# CLEANER AIR TREE BY TREE

## *TEACHER'S GUIDE*

EARTH + HUMAN ACTIVITY

# WELCOME

***Cleaner Air, Tree by Tree*** is a set of lessons examining human impact on Earth systems and the role we can all play as stewards of environmental restoration. The overall objective is for students to learn how to identify trees and discover the wealth of benefits that trees provide, including, but not limited to, air quality improvements, stormwater interception, and greenhouse gas mitigation. The lessons address Washington, D.C., Public School 5th Grade, Advisory 4 "Human vs. Earth: Conservation."

***Cleaner Air, Tree by Tree*** uses 2004 Nobel Prize winner Wangari Maathai as an example of an agent of change and a model of commitment, leadership and vision. After observing the environmental degradation caused by deforestation, Maathai founded the Green Belt Movement to restore the land while empowering women. Maathai overcame many obstacles in her journey to promote the rights of her people, especially women, to a healthy environment. Maathai believed that "a tree is worth much more than its wood."



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# WANGARI MAATHAI

Students explore the inspiring legacy of Nobel Peace Prize winner Wangari Maathai. Through her activism, Maathai created a blueprint for environmental stewardship. Through a guided reading and discussion of the book Wangari Maathai: The Woman Who Planted Millions of Trees, students reflect on the meaning of the phrase, "A tree is worth more than its wood." Students consider ways that humans, past and present, have impacted the environment and discuss how they might play a role as environmental stewards in restoring the environment around them.

### OBJECTIVES

Students will provide textual evidence that supports Wangari Maathai's claim that "A tree is worth more than its wood."

### ASSIGNMENTS

Students consider the phrase, "A tree is worth more than its wood" and in their Cleaner Air, Tree by Tree workbook they write a paragraph on why planting trees was so important to Maathai and what benefits planting trees might provide to their community. Students draw and label a tree and identify what it needs to survive.

## REFER TO APPENDIX PAGE 66 | STUDENT WORKBOOK PAGE 2

WELCOME TO CLEANER AIR, TREE BY TREE

Cleaner Air, Tree by Tree is a set of investigations that examine human impact on earth systems. Specifically looking at the role of urban trees in air quality improvements, stormwater interception and greenhouse gas mitigation.

OVERALL OBJECTIVE OF CLEANER AIR, TREE BY TREE | The overall objective is for students to be able to describe the benefits trees provide and their role in restoring humans' impact on the environment.

WANGARI MAATHAI

*The Woman Who Planted Millions Of Trees*

Wangari says "A tree is worth more than its wood."
Why was the act of planting trees so important to Wangari?
Why is the act of planting tree(s) important in your neighborhood and our city?

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# EARTH SYSTEMS — THE FOUR SPHERES

Students study the four spheres that make up the Earth systems. Students watch a video that provides local examples of the four spheres and how they interact and are interdependent. Students learn to differentiate between impervious versus permeable surfaces and planned versus naturalized green spaces. Students learn how to draw a bird's-eye landscape of their neighborhood or school-grounds.

### OBJECTIVES

Students identify and define the four spheres that make up Earth systems: the atmosphere, geosphere, biosphere, and hydrosphere. Students can describe the interactions and interdependence of the Earth's four spheres. Students can differentiate between impervious versus permeable surfaces and planned versus naturalized green spaces.

### ASSIGNMENTS

Students identify and label the four spheres that make up Earth systems and describe how the spheres interact and are interdependent. Students draw a bird's-eye view streetscape model of their neighborhood, incorporating impervious versus permeable surfaces and naturalized versus planned green spaces.

## REFER TO APPENDIX PAGES 67-68 | STUDENT WORKBOOK PAGES 3-4

HUMAN IMPACT AT YOUR SCHOOL

OBJECTIVE | Students learn characteristics that help them differentiate between naturalized forest and planned green spaces to understand human impact in their neighborhood.

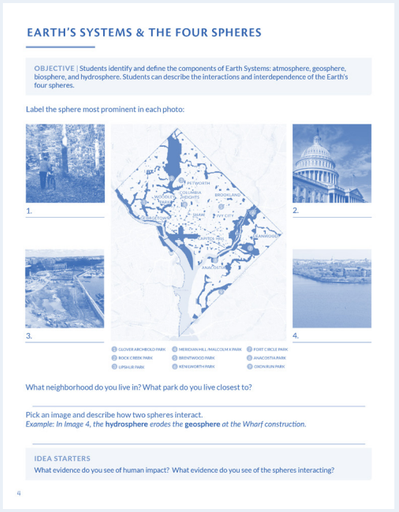
*Naturalized Forest*

*Planned Green Space*

Draw your immediate neighborhood.

IDEA STARTERS
Does your neighborhood have naturalized forests or planned green spaces?
What evidence do you have to support your claim? (e.g., school gardens as a planned green space)

3



EARTH'S SYSTEMS & THE FOUR SPHERES

OBJECTIVE | Students identify and define the components of Earth Systems: atmosphere, geosphere, biosphere, and hydrosphere. Students can describe the interactions and interdependence of the Earth's four spheres.

Label the sphere most prominent in each photo:

1.

2.

3.

4.

What neighborhood do you live in? What park do you live closest to?

Pick an image and describe how two spheres interact.
*Example: In image 4, the* **hydrosphere** *erodes the* **geosphere** *at the Wharf construction.*

IDEA STARTERS
What evidence do you see of human impact? What evidence do you see of the spheres interacting?

4

# AIR QUALITY MATTERS

Students focus on the atmosphere and the role it plays in making planet Earth livable. They learn the composition of the air and recognize that oxygen is essential to life. Students study the lungs as part of the respiratory system and learn about respiration as the exchange of oxygen and carbon dioxide from the trillions of cells in the body. They study natural and anthropogenic air pollutants and their sources. They learn how poor air quality impacts human health and exacerbates respiratory issues, including asthma symptoms and cardiac problems. They study the Air Quality Index (AQI), a color index used for reporting daily air quality.

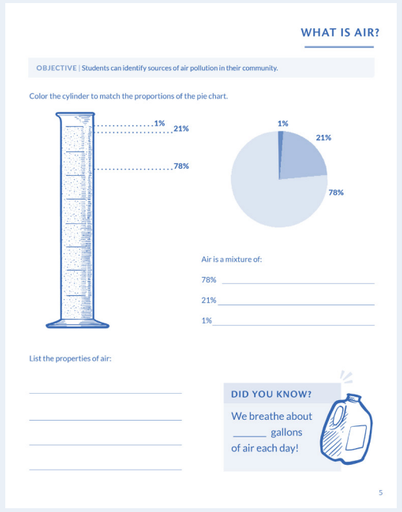
## OBJECTIVES

Students describe the composition and properties of air and identify sources of air pollution in their community. Students will know the structures and functions of parts of the respiratory system and circulatory system. Students will know that oxygen is the gas in the air that we inhale, which is needed to sustain human life. Students will know that we exhale carbon dioxide. Students recognize the AQI as a color index that identifies the level of air pollution and the associated health risks. Students understand that the AQI is used to help make decisions about outdoor activities.

## ASSIGNMENTS

Students make a model of the respiratory system. The model can be abstract (it does not have to be realistic), but it should include the nose, lungs, bronchi, trachea, alveoli, air/oxygen, and carbon dioxide. Students should describe how air pollutants can impact the human body. Students identify sources of air pollution (mobile or stationary) on their bird's-eye view streetscape model. Students incorporate the atmosphere and gas exchange on the leaves of the tree they drew.

## REFER TO APPENDIX PAGES 69-73 | STUDENT WORKBOOK PAGES 5-9



WHAT IS AIR?

OBJECTIVE | Students can identify sources of air pollution in their community.

Color the cylinder to match the proportions of the pie chart.

1%
21%
78%

Air is a mixture of:

78% _____
21% _____
1% _____

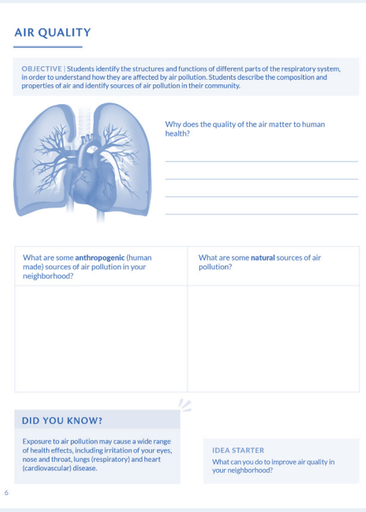
List the properties of air:

_____
_____
_____
_____

DID YOU KNOW?

We breathe about _____ gallons of air each day!

5



AIR QUALITY

OBJECTIVE | Students identify the structures and functions of different parts of the respiratory system, in order to understand how they are affected by air pollution. Students describe the composition and properties of air and identify sources of air pollution in their community.

Why does the quality of the air matter to human health?

_____
_____
_____
_____

| What are some **anthropogenic** (human made) sources of air pollution in your neighborhood? | What are some **natural** sources of air pollution? |
|---|---|
| | |

DID YOU KNOW?

Exposure to air pollution may cause a wide range of health effects, including irritation of your eyes, nose and throat, lungs (respiratory) and heart (cardiovascular) disease.

IDEA STARTER

What can you do to improve air quality in your neighborhood?

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READING AIR QUALITY

SITE 1

| AirBeam | Last Second |
|---|---|
| AirBeam-PM1 | 20 |
| AirBeam-PM2.5 | 63 |
| AirBeam-PM10 | 75 |
| AirBeam-RH | 41% |
| AirBeam-Temp | 66° |
| AirBeam-Ozone | 100 |



Compare the data from the Airbeam with the images of the playground below. Why do you think children are playing outside at one site, and not the other?

Record the data in the table.
Note what color "code" each day is.

SITE 2

| AirBeam | Last Second |
|---|---|
| AirBeam-PM1 | 2 |
| AirBeam-PM2.5 | 5 |
| AirBeam-PM10 | 4 |
| AirBeam-RH | 36% |
| AirBeam-Temp | 68° |
| AirBeam-Ozone | 33 |



SITE 1



SITE 2

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# TREE DETECTIVE

Students study the characteristics of leaves, bark, and seeds, and learn how these characteristics enable the identification of tree species. Students learn how urban foresters measure the size of trees and learn about other indicators of tree health.

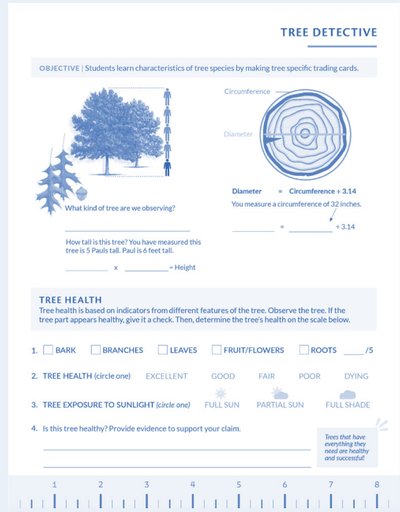
## OBJECTIVES

Students will use characteristics of leaves, bark, flowers, fruits, nuts, and seeds to differentiate tree species. Students learn the unique characteristics that help them identify tree species in Washington, D.C. and what functions these serve. Students will also consider good indicators of tree health.

## ASSIGNMENTS

Students observe and select a tree in their neighborhood or schoolyard, or with samples brought into class by the teacher. Students will record their observations. They will review the steps to determine tree age and good indicators of health through prompts in the workbook.

## REFER TO APPENDIX PAGE 75 | STUDENT WORKBOOK PAGE 11



TREE DETECTIVE

OBJECTIVE | Students learn characteristics of tree species by making tree specific trading cards.

What kind of tree are we observing?

_____

How tall is this tree? You have measured this tree is 5 Pauls tall. Paul is 6 feet tall.

_____ x _____ = Height

Circumference
Diameter

**Diameter = Circumference ÷ 3.14**

You measure a circumference of 32 inches.

_____ = _____ ÷ 3.14

TREE HEALTH

Tree health is based on indicators from different features of the tree. Observe the tree. If the tree part appears healthy, give it a check. Then, determine the tree's health on the scale below.

1. ☐ BARK ☐ BRANCHES ☐ LEAVES ☐ FRUIT/FLOWERS ☐ ROOTS _____/5
2. TREE HEALTH (circle one) EXCELLENT GOOD FAIR POOR DYING
3. TREE EXPOSURE TO SUNLIGHT (circle one) FULL SUN PARTIAL SUN FULL SHADE
4. Is this tree healthy? Provide evidence to support your claim.

_____
_____

*Trees that have everything they need are healthy and successful!*

1 2 3 4 5 6 7 8

# OUTDOOR LESSON (OPTIONAL)

*Contact Clean Air Partners or Casey Trees to determine if an educator can assist with this lesson.*

Students will be divided into two groups and will spend the class period outside rotating through two separate 20-minute lessons. In one lesson, students will apply the characteristics of trees they learned to enable them to differentiate tree species and use indicators of tree health to assess the health of trees on their campus. In another lesson, they will use Airbeams to collect and record measurements of particulate matter pollution in the air.

## OBJECTIVES

Students learn unique characteristics of leaves, bark, flowers, fruits, nuts, and seeds that are used to differentiate tree species. Students learn the indicators used to detect a tree's health. Students will be able to determine if the trees on their campus are "healthy." Students will be able to measure and record particulate matter using technology. Students will be able to record and use the data they collected on their campus to make claims supported by evidence (data) as to the state of the air on their school campus (specifically regarding particulate matter).

## ASSIGNMENTS

Students share and organize the data that they collected during the outdoor lesson. Students reflect on the outdoor lesson by answering the following prompts:
Today I learned .... Today I discovered.... Today I was surprised by....

## REFER TO APPENDIX PAGE 74 | STUDENT WORKBOOK PAGE 10

### THINK LIKE AN URBAN FORESTER

OBJECTIVE | Students learn that trees species can be identified using different characteristics: leaves, bark, flowers, fruits and seeds. Students learn that each seed dispersal structure has a specific function.

**LEAVES**

Scavenge fallen leaves on the ground. Leaves are a common way of identifying trees.

Describe the leaves:

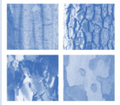
Are the edges lobbed? Smooth? Toothed?
Is the leaf texture dull, fuzzy or waxy? Observe the patterns of the veins.

**BARK**

A diversity of patterns, textures and other characteristics of bark can help you identify a tree. Come in close and gently touch the tree's bark.

Is the bark scaly, smooth, is it peeling, does it have ridges?

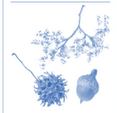
Describe what is unique about the tree's bark.



**FLOWERS, FRUITS AND SEEDS**

Look up, look down! Depending on the time of the year you may see flowers, fruits and/or seeds. Flowers can be showy or small, they're about reproduction. Fruits and seeds are all about dispersal.

How are seeds being dispersed? How does the structure of the seed help with its dispersal (function)?



Can you identify a tree in your neighborhood? Consider the characteristics (leaves, bark, flowers, fruits and seeds). Visit **caseytrees.org** to find common tree species in DC.

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# ARE TREES WORTH MORE THAN THEIR WOOD?

Students learn about the ecosystem services, or benefits, that trees provide. Using i-Tree Design, an online tool, students use collected data to see how arborists quantify the benefits of the urban forest. Students study how trees contribute to the restoration of air quality, the interception of stormwater, and the sequestration of carbon.

## OBJECTIVES

Students learn the multitude of benefits that trees provide. Students learn the role that trees play in intercepting water, improving air quality, and sequestering carbon. Students quantify the benefits (ecosystem services) that trees provide.

## ASSIGNMENTS

Students explore and quantify the ecosystem services of a tree using i-Tree Design and/or other models. Students calculate the benefits (air pollutant absorption, stormwater interception, and carbon sequestration) that trees provide in a designated space. Students reflect on how Wangari Maathai's actions successfully addressed the problems she identified in Kenya and how planting and taking care of trees may benefit their neighborhood and city.

## REFER TO APPENDIX PAGES 76-78 | STUDENT WORKBOOK PAGES 12-14

### THINK LIKE AN ARBORIST

OBJECTIVE | Students select an appropriate tree species for their schoolyard or backyard. Students assess their space for the needs of a tree-soil space, sunlight and access to water. They consider the benefits of different species of tree.

| Yoshino Cherry<br>*Prunus × yedoensis* | Red Maple<br>*Acer Rubrum* | Tuliptree<br>*Liriodendron tulipifera* |
|---|---|---|
| **HEIGHT**: 35-45 ft. | **HEIGHT**: 40-60 ft. | **HEIGHT**: 70-90 ft. |
| **STRENGTHS**: Beautiful flowers in spring, fits in small spaces. | **STRENGTHS**: Loves water! Plant me in areas that flood | **STRENGTHS**: I grow tall and straight. I absorb hundreds of pounds of carbon every year. |
| **WEAKNESS**: I am difficult to prune and susceptible to fungus. | **WEAKNESS**: My shallow roots may disrupt your sidewalks, or be in the way of your lawnmower. | **WEAKNESS**: Oops! I dropped something. My 10 ft branch. |
|  |  |  |

Look at the drawing of your neighborhood on page 3. Which of these tree species would you plant in your neighborhood?

Why would you plant this tree? *Consider: how much sunlight does this space get? Is there water nearby? How much soil is available, and do people walk there?*

Draw your tree here. What benefits will it provide?

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### TREE BENEFITS WITH iTREE

OBJECTIVE | S tudents quantify the benefits- ecosystem services- that trees provide. Students understand the role of trees in improving air quality, sequestering carbon and intercepting water.

| TREE MEASUREMENTS | |
|---|---|
| Tree Species | |
| DBH | |
| Tree Health | |

| BREAKDOWN | ENVIRONMENTAL BENEFIT |
|---|---|
| Storm Water Interception | _____ gallons |
| $CO_2$ Capture | _____ pounds |
| Air Pollutant Absorption | $ _____ saved |

1. This year, these trees will remove _____ $PM_{10}$
2. In ten years, these trees will remove _____ $PM_{10}$
3. In DC we currently have _____ trees.
4. _____ (# of trees in DC) x _____ (lbs of PM absorbed) = _____

**DID YOU KNOW?**

Trees provide ecosystem services for humans and the environment. An ecosystem is a community of living and nonliving things, think all 4 spheres working together! Ecosystem services are the important benefits that come from healthy ecosystems.

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### WANGARI MAATHAI

**Wangari stated, "A tree is worth more than its wood."**
What other benefits or ecosystem services does a tree provide?
What are some concrete actions that you can take to restore the human impact in your neighborhood?

**Wangari Maathai** won a Nobel Peace Prize in 2004.

Photo source: *The New York Times*

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# WHEN TO TEACH *CLEANER AIR, TREE BY TREE*

The best fit for **Cleaner Air, Tree by Tree**'s investigation within the District of Columbia Public Schools Science Scope and Sequence (SAS) is the 5th grade, Unit 4 advisory "Human vs Earth: Conservation."

### ▸ Connection to DCPS- SAS Unit 4 Human vs Earth: Conservation:

**Cleaner Air, Tree by Tree** is best taught in 5th grade, Unit 4 advisory as a culminating set of lessons. The investigations are considered culminating in that they touch on issues raised in Units 1, 2, 3, and 4 of the 5th grade Scope and Sequence (SAS). In **Lesson 2: Earth Systems—The Four Spheres**, we define Earth systems as made up of four interacting and interdependent spheres, which relates to **SAS Unit 1: Our Sky: Earth and Space Systems**. In **Lesson 3: Air Quality Matters**, we focus on the atmosphere, specifically the troposphere, examining the composition of air and the sources of pollutants. Students learn that air and many pollutants are made up of matter, gases, and particles too small to be seen but that can be accounted for using observable phenomena—all points that connect back to **SASUnit 2: Matter Matters**. In **Lessons 4, 5, and 6**, we touch on **SASUnit 3: Ecosystems, Energy, and Webs** when we discuss the cycling of matter (the carbon, nitrogen, water, and phosphorus cycles), and when students learn that plants find what they need for growth in air, carbon dioxide, water, and sunlight.

In **Lesson 6: Are Trees Worth More Than Their Wood?**, students use i-Tree Design to identify some of the benefits that trees provide, including air quality improvement, stormwater interception, and greenhouse gas mitigation. We advocate for planting and caring for trees as one strategy "to protect and restore communities" and reestablish the vitality of our urban habitat by reducing our negative impact on Earth systems.



**Cleaner Air, Tree by Tree** uses Nobel Peace Prize winner Wangari Maathai and the Green Belt movement in Kenya as inspiration and a through-line throughout the set of investigations. Maathai observed environmental degradation in the form of deforestation, first by British colonialists and later by Kenyans during economic development after independence in 1963. Maathai demonstrated to the world that the simple act of engaging women and youth in planting trees could slowly restore the ecosystem by reducing soil erosion, restoring watersheds, and providing countless other benefits.

| Grade 5 Evidence Statements<br>Unit 4: Humans vs. Earth: Conservation | |
|---|---|
| Performance Expectation | 5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment. |
| Evidence of Student Performance | **1. Obtaining information**<br>**a.** Students gather information from books and other reliable media about:<br>**i.** How a given human activity (e.g., in agriculture, industry, everyday life) affects the Earth's resources and environments.<br>**ii.** How a given community uses scientific ideas to protect a given natural resource and the environment in which the resource is found.<br><br>**2. Evaluating information**<br>**a.** Students combine information from two or more sources to provide and describe the evidence about:<br>**i.** The positive and negative effects on the environment as a result of human activities.<br>**ii.** How individual communities can use scientific ideas and a scientific understanding of interactions between components of environmental systems to protect a natural resource and the environment in which the resource is found.<br><br>*Unless otherwise specified, "descriptions" referenced in the evidence statements could include but are not limited to written, oral, pictoral, and kinesthetic descriptions. |

**Cleaner Air, Tree by Tree** can also be taught during the District of Columbia Public Schools science 1st advisory **SAS Unit 1: Our Sky: Space and Earth**

## ▸ Connection To DCPS- SAS Unit 1: Our Sky: Space and Earth Systems

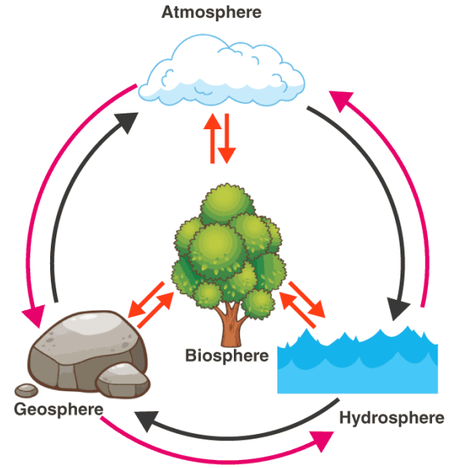
| Grade 5 Evidence Statements<br>Unit 1: Our Sky: Space and Earth Systems | |
|---|---|
| Performance Expectation | **5-ESS2-1.** Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere interact.<br><br>*Clarification Statement* \| Examples could include the influence of the ocean on ecosystems, landform shape, and climate; the influence of the atmosphere on landforms and ecosystems through weather and climate; and the influence of mountain ranges on winds and clouds in the atmosphere. The geosphere, hydrosphere, atmosphere, and biosphere are each a system.<br><br>*Assessment Boundary* \| Assessment is limited to the interactions of two systems at a time. |
| Evidence of Student Performance | **1. Components of the model**<br>**a.** Students develop a model using a specific given example of a phenomenon, to describe* ways that the geosphere, biosphere, hydrosphere, and/or atmosphere interact. In their model, students identify the relevant components of their example, including features of two of the following systems that are relevant said to given example:<br>**i.** Geosphere (i.e., solid and molten rock, soil, sediment, continents, mountains)<br>**ii.** Hydrosphere (i.e., water and ice in the form of rivers, lakes, glaciers)<br>**iii.** Atmosphere (i.e., wind, oxygen)<br>**iv.** Biosphere (i.e., plants, animals [including humans])<br><br>**2. Relationships**<br>**a.** Students identify and describe* a variant of ways in which the parts of two major Earth systems in the specific given example interact to affect the Earth's surface materials and processes in that context. Students use the model to describe* how parts of an individual Earth system:<br><br>**3. Connections**<br>**a.** Students identify and describe* a variant of ways in which the parts of two major Earth systems in the specific given example interact to affect the Earth's surface materials and processes in that context. Students use the model to describe* how parts of an individual Earth system:<br>**i.** Work together to affect the functioning of that Earth system<br>**ii.** Contribute to the functioning of the other relevant Earth system<br><br>*Unless otherwise specified, "descriptions" referenced in the evidence statements could include but are not limited to written, oral, pectoral, and kinesthetic descriptions.include but are not limited to written, oral, pictoral, and kinesthetic descriptions. |



WHEN TO TEACH CLEANER AIR, TREE BY TREE

A model of a tree (biosphere) interacting and being interdependent with the:

- hydrosphere (it absorbs water through the roots and leaves),
- atmosphere (it absorbs $CO_2$ from the air and releases $O_2$ into the air),
- geosphere (it absorbs nutrients and nitrogen through the roots and prevents erosion), and
- biosphere (it is part of the biosphere but also provides habitat and food for other members of the biosphere)



# FRAMING THE LESSONS

## IN CLEANER AIR, TREE BY TREE

Disclose to students that they are embarking on a set of four investigations that will enable them to learn about human impact on the Earth's systems. Humans impact all four spheres: the geosphere (agricultural causes of soil degradation, the extraction of mining resources), the hydrosphere (water pollution, increasing population, additional stress on the fresh water supply), the atmosphere (air pollution, increase in greenhouse gases), and the biosphere (deforestation, overfishing).

Students will learn about trees as part of the biosphere (living things) and how trees affect the land (geosphere), air (atmosphere), water (hydrosphere), and other living things (biosphere). The overall objective is for students to discover the wealth of benefits that trees provide, including, but not limited to, air quality improvement, stormwater interception, and greenhouse gas mitigation, and to understand how deforestation affects the four spheres. They will conclude that trees can play a role in improving human impact on the environment.

Students start with a close reading of a book about Wangari Maathai, a Kenyan Nobel Peace Prize winner who founded the Green Belt Movement. Maathai observed the environmental degradation in Kenya caused by deforestation, first by British colonialists and later during economic development by Kenyans after independence in 1963. Maathai believed that "a tree is worth much more than its wood," and demonstrated that the simple act of engaging women and youth in planting trees would help restore the environment by reducing soil erosion, restoring watersheds, and providing countless other benefits. In sum, as Maathai said, "a tree is a little piece of the future."

We will use Maathai's quote, "a tree is worth much more than its wood," as a thread running throughout investigations into the many benefits that trees provide. We can reflect on human impacts on the ecosystem by studying the historical transformation of Washington, D.C., from the 1790s to the urban center that it is today.

We will study Earth systems and the interconnectedness and interdependence of the four spheres. We will turn our attention to the troposphere, the layer of the atmosphere that is the closest and in contact with the earth. We will learn about the composition of air and the anthropogenic and natural sources of air pollution. We will learn that lungs, as part of the respiratory system, enable us





to breathe and supply oxygen and remove carbon dioxide from the trillions of cells that make up our body. Lastly, we will learn the impact that air pollutants have on the respiratory system.

Outside, on the school campus or out in our surrounding community, we'll collect, record, and analyze data on particulate matter. Particulate matter is one of six criteria pollutants—harmful pollutants that are constantly monitored because of their impact on human health, as required by the EPA. We will observe trees as part of the biosphere and learn to identify the characteristics of leaves, flowers, andbark that help us identify a tree and differentiate one tree from another. We will review what trees need to survive (soil, sun, water, and air) and identify observable indicators of tree health.

Using the i-Tree Design online tool, we will research the benefits that specific tree species on the school campus provide, including the improvement of air quality, stormwater interception, and greenhouse gas mitigation. Lastly, we will plant and learn how to take care of a tree or trees, and we will brainstorm ways we can become better environmental stewards and restore the health of our communities.

# NEXT GENERATION SCIENCE STANDARDS OVERVIEW

**Performance Expectation-PE** is a set of learning goals for students. They are expectations for what students should be able to do by the end of instruction.

**Focus PE: 5-ESS2-1:** Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. *[Clarification Statement: Examples could include the influence of the ocean on ecosystems, landform shape, and climate; the influence of the atmosphere on landforms and ecosystems through weather and climate; and the influence of mountain ranges on winds and clouds in the atmosphere. The geosphere, hydrosphere, atmosphere, and biosphere are each a system.] [Assessment Boundary: Assessment is limited to the interactions of two systems at a time.]*

LESSON 1 | LESSON 2 | LESSON 3 | LESSON 4 | LESSON 5 | LESSON 6

**Focus PE: 4-ESS2-2:** Analyze and interpret data from maps to describe patterns of Earth's features.

LESSON 2 | LESSON 3

**Background PE: ESS2-2:** Describe and graph the amounts of saltwater and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.

LESSON 2

**Focus PE: 5-ESS3-1:** Obtain and combine information about ways individual communities use science ideas to protect Earth's resources and environment.

LESSON 1 | LESSON 2 | LESSON 5 | LESSON 6

**Focus PE 5-LS1-1:** Support an argument that plants get the materials they need for growth chiefly from air and water.

LESSON 4 | LESSON 5

**Focus PS1-1:** Develop a model to describe that matter is made of particles too small to be seen. i.e Observe using air to expand a balloon, bicycle tire, a basketball.

LESSON 3 | LESSON 5



## SCIENCE AND ENGINEERING PRACTICES

**Science and Engineering Practices-SEP** are skills and knowledge to develop students' understanding of the nature of science and engineering. Science is the study of how the universe works and starts with asking questions. Engineering starts with defining the problem and designing with the goal of human need.

Asking questions (science) and defining problems (engineering): in science questions guide inquiry and leads to students engaging in other scientific practices.

LESSON 2 | LESSON 3 | LESSON 4 | LESSON 5

Developing and using models: In science we use (conceptual) models to explain phenomena or to share an understanding of how the world works.

LESSON 2 | LESSON 3 | LESSON 6

Planning and Carrying out Lessons: to make observation and/or produce data to serve as a basis for evidence for an explanation of a phenomenon.

LESSON 3 | LESSON 4 | LESSON 5 | LESSON 6

Analyzing and interpreting data: Data collected, and observations made must be analyzed and interpreted to derive meaning. Data and observations must be represented to reveal patterns.

LESSON 4 | LESSON 5 | LESSON 6

Using mathematics and computational thinking: mathematics and computation are fundamental tools for representing physical variables and their relationships.

LESSON 4 | LESSON 5

Constructing explanations and designing solutions: students use evidence measurements, observations and patterns to construct or support an explanation.

LESSON 6

Engaging in argument from evidence: students engage in argument from evidence of data collected, observations or model developed.

LESSON 2 | LESSON 4 | LESSON 6

Obtaining, evaluating, and communicating information: students communicate clearly and persuasively the idea they generate.

LESSON 3 | LESSON 5 | LESSON 6

## DISCIPLINARY CORE IDEAS

**Disciplinary Core Ideas-DCI** are the fundamental core ideas that are necessary for understanding a given science discipline forming the basis of the following four domains Physical Science, Life Science, Earth and Space science and Engineering, Technology, and Applications of Science.

**Focus ESS2.A:** Earth Materials and Systems Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather.

LESSON 2 | LESSON 3 | LESSON 4 | LESSON 5 | LESSON 6

**Focus ESS3.C:** Human Impacts on Earth SystemsHuman activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments.

LESSON 1 | LESSON 2 | LESSON 3 | LESSON 4 | LESSON 5 | LESSON 6

**Focus LS1.A:** Structure and Function Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.

LESSON 3 | LESSON 4 | LESSON 5

**Focus PS1A:** Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means.

LESSON 2 | LESSON 3 | LESSON 5 | LESSON 6





## CROSS CUTTING CONCEPTS

**Cross Cutting Concepts-CCC** are ideas that apply across all domains of science and have explanatory value throughout much of science and engineering. They help organize teaching and learning in science

**Patterns:** Patterns are everywhere and as scientist and engineers we can recognize, classify, organize patterns bringing a certain order out of chaos and then evaluate patterns.

LESSON 4 | LESSON 5 | LESSON 6

**Cause and Effect:** Explain causal relationship, why does something occur? If A causes B we need to have a chain of interactions. Chains of interactions are not always visible ( virus). Sometime causes are complex (Climate Change).

LESSON 2 | LESSON 3 | LESSON 4 | LESSON 5 | LESSON 6

**Scale and Proportion, and Quantity:** Size, timescale and energy. Quantity and Proportion.

LESSON 2 | LESSON 3 | LESSON 6

**Systems and System Models:** a system can be described in terms of its components and their interaction.

LESSON 2 | LESSON 3 | LESSON 4 | LESSON 6

**Energy and Matter in Systems:** Looking how energy and matter, flows, cycles and is conserved overtime through a system

LESSON 2 | LESSON 3 | LESSON 4 | LESSON 5 | LESSON 6

**Structure and Function:** How does the structure of an objects fits its function (its job)

LESSON 3 | LESSON 4 | LESSON 5

**Stability and Change of Systems:** students measure change in terms of difference over time and observe that change may occur at different rates. Students learn that some system may seem stable, but over long periods of time (time lapse) they will change.

LESSON 2 | LESSON 3

LESSON 1

# WANGARI MAATHAI

REFER TO APPENDIX PAGE 66 | STUDENT WORKBOOK PAGE 2

## OBJECTIVE

✓ Students will provide textual evidence that supports Wangari Maathai's claim that "Atree is worth more than its wood."

## ACTIVITY SUMMARY

Students explore the inspiring legacy of Nobel Peace Prize winner Wangari Maathai. Through her activism, Maathai created a blueprint for environmental stewardship. Through a guided reading and discussion of the book Wangari Maathai: The Woman Who Planted Millions of Trees, students reflect on the meaning of the phrase, "A tree is worth more than its wood." Students consider ways that humans, past and present, have impacted the environment and discuss how they might play a role as environmental stewards in restoring the environment around them.

## BEFORE CLASS

Ahead of class, hand out a class set of *Wangari Maathai: The Woman Who Planted Millions of Trees*, written by Franck Prévot and illustrated by Aurélia Fronty. Have students read the book. Use the close reading guided questions. Distribute a ***Cleaner Air, Tree by Tree*** workbook to each student.



## WARMUP

Students consider the phrase, "A tree is worth more than its wood," and reflect on why planting trees was so important to Wangari Maathai. Students identify three benefits that planting a tree or trees might provide to their community and share these benefits with the class.

## FRAME THE ACTIVITY

We are going to read *Wangari Maathai: The Woman Who Planted Millions of Trees*, written by Franck Prévot and illustrated by Aurélia Fronty. Maathai overcame both political and personal obstacles to become anagent of change for Kenyans and for women worldwide. In 1977, Maathai founded the Green Belt Movement in Kenya to address the challenges of deforestation, soil erosion, and lack of water through the simple act of planting trees. She was the first African woman to win a Nobel Peace Prize. As we read, let's keep in mind what problems Maathai identifies in her community and how she knows they are important. What problems do you identify in your community and how do you know they are important?

### COMMON CORE STANDARDS

**RI.5.1.** Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.

**RI.5.2.** Determine two or more main ideas of a text and explain how they are supported by key details; summarize the text.

**RI.5.3.** Explain the relationships or interactions between two or more individuals, events, ideas, or concepts in a historical, scientific, or technical text based on specific information in the text.

## ASSIGNMENT

Students consider the phrase, "A tree is worth more than its wood" and in their ***Cleaner Air, Tree by Tree*** workbook they write a paragraph on why planting trees was so important to Maathai and what benefits planting trees might provide to their community. Students draw and label a tree and identify what it needs to survive.

# GUIDED READING QUESTIONS

*Wangari Maathai: The Woman Who Planted a Million Trees*

By Franck Prévot | Illustrated by Aurélia Fronty

## OBJECTIVE

Students will be able to evaluate the quote "A Tree is With More Than Its Wood" by providing text evidence that supports the claim.

## VOCABULARY

colonist, authoritarian, liberate, cultivate, democracy, inhabitants, forest described as generous and precious treasure

## INTRODUCTION

Today we are going to be reading about a very inspiring woman who saw a problem in her community and decided to do something about it. As we read, let's try to figure out what problems Wangari identifies in her community and how she knows they are important.

## RELATED COMMON CORE STANDARDS

**RI.5.1.** Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.

**RI.5.2.** Determine two or more main ideas of a text and explain how they are supported by key details; summarize the text.

**RI.5.3.** Explain the relationships or interactions between two or more individuals, events, ideas, or concepts in a historical, scientific, or technical text based on specific information in the text.

| PAGE # | QUESTIONS | ANTICIPATED RESPONSES |
|---|---|---|
| Title page | • On this page we see a beautiful illustration of Wangari.<br>• What is happening in the illustration?<br>• What can we predict about Wangari before we begin to read her story? | • She likes animals because she is holding a bird.<br>• She likes nature because she is sitting in the forest.<br>• She cares about the environment. |
| Page 9 | • On page 9 we read, "Wangari feels as though she is part of the entire forest." How does this confirm our prediction about the illustration? | • Yes, she says she feels as though she is part of the forest, so she cares about nature and likes animals.<br>• Her name means "she who belongs to the leopard." |
| Page 11 | • Model inference think-aloud: Hmm… I wonder why Wangari will never forget this expression. What do you think Wangari's mom means by "a tree is worth more than its wood"?<br>• We know that Wangari never forgets this statement, so let's look for evidence that supports this claim. | • The tree gives shade.<br>• I don't know. (It's ok if students are still unsure.)<br>• Nature is important. |





| PAGE # | QUESTIONS | ANTICIPATED RESPONSES |
|---|---|---|
| Page 19 | • What effects does Wangari see after the British and then the Kenyans cut down the trees?<br>• How does this support what Wangari's mom said "a tree is worth more than its wood"? | • Rare to see animals.<br>• People can't feed their children.<br>• The rivers are muddy.<br>• No soil.<br>• While it may be worth money to sell, it also endangers animals and hurts the environment in many ways. |
| Page 20 | • What is the evidence on this page that "a tree is worth more than its wood"? | • Fruit, air, habitats, inspiration, etc. |
| Page 31 | • What are some of the battles that Wangari must fight in order to see that her dreams are achieved? | • Political battles, authoritarian power, getting the president out of power, real estate projects, people trying to make money off the trees, women's rights. |
| Page 33 | • What does Wangari do to stop President Moi from making tribes fight one another?<br>• Can you think of an example where two teams that are against each other make a gesture of peace? Maybe in sports? | • She has them give trees as gifts.<br>• Symbols of peace.<br>• In the NFL the captains always do a handshake at the beginning of the game, and teams shake hands at the end of the game. |
| Page 35 | • Why do you think "mother of trees" is a good name for Wangari? | • She loved nature.<br>• She planted a lot of trees.<br>• She helped the trees.<br>• She helped people make peace. |
| Page 37 | • What is one thing that Wangari did that really impresses you? Why? | • Varied |
| End of Book | • What do you think Wangari might say about our playground outside? | • She would say we should clean it up.<br>• We should plant more trees.<br>• We should take care of our trees. |

## CONCLUSION

With Clean Air Partners and Casey Trees, we are going to learn how we can show Wangari that we know a tree is worth more than its wood. What is one thing each of us can do to show Wangari that we know a tree is worth more than its wood? (Possible response: pick up litter, plant more trees, learn more about what our community is doing to help trees, talk to our parents about our trees.) Thanks to DCPS 5th Grade Teacher Whitney Bartell for drafting these self-guided reading questions.

# EARTH SYSTEMS

**REFER TO APPENDIX PAGES 67-68 | STUDENT WORKBOOK PAGES 3-4**

## OBJECTIVES

- ✓ Students identify and define the four spheres that make up Earth systems: the atmosphere, geosphere, biosphere, and hydrosphere.
- ✓ Students can describe the interactions and interdependence of the Earth's four spheres.
- ✓ Students can differentiate between impervious versus permeable surfaces and planned versus naturalized green spaces.

## ACTIVITY SUMMARY

Students study the four spheres that make up the Earth systems. Students watch a video that provides local examples of the four spheres and how they interact and are interdependent. Students learn to differentiate between impervious versus permeable surfaces and planned versus naturalized green spaces. Students learn how to draw a bird's-eye landscape of their neighborhood or school-grounds.

## BEFORE CLASS

Teachers will need to source and project the following satellite images:

- Slide 1: a Google map satellite view of the Earth
- Slide 2: a Google map satellite view of the Eastern Atlantic of North America
- Slide 3: a Google map satellite view of Washington, D.C.-Virginia-Maryland with landscapes impacted by humans
- Slide 4: a Google map of the school/community 1) street view and 2) satellite view

Teacher will hand out the students' ***Cleaner Air, Tree by Tree*** workbook (Appendix, page 65).



## WARMUP

In the ***Cleaner Air, Tree by Tree*** workbook (Appendix page 79; student workbook page 15) ,have students draw a tree and all it needs to survive (sunlight, air, water, and soil) and instruct them to label the roots, trunk, branches, and leaves. The type of tree is not important. Students will add to this drawing as their understanding advances.

## FRAME THE ACTIVITY

We will be looking at satellite images of Earth and learning about Earth systems and how to identify and define the four spheres. We will learn how the four spheres interact and are interdependent. As we zoom in closer to Washington, D.C., let's ask ourselves how humans have impacted the four spheres here over time.

## ASSIGNMENT

Students identify and label the four spheres that make up Earth Systems and describe how the spheres interact and are interdependent. Students draw a bird's-eye view streetscape model of their neighborhood, incorporating impervious versus permeable surfaces and naturalized versus planned green spaces. (Appendix page 67; student workbook page 3)

**EXTENSION: VOCABULARY**

atmosphere, geosphere, hydrosphere, biosphere, satellite, satellite image, interdependent, lithosphere

**Students who demonstrate understanding can:**

**Focus 5-ESS2-1:** Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

**Background 5-ESS2-2:** Describe and graph the amounts of saltwater and fresh water in the various reservoirs to provide evidence about the distribution of water on Earth. Assessment Boundary | Assessment is limited to oceans, lakes, rivers, glaciers, ground water, and polar ice caps, and does not include the atmosphere.

**Focus 4-ESS2-2:** Analyze and interpret data from maps to describe patterns of Earth's features.

### SCIENCE AND ENGINEERING PRACTICES- SEP

**Asking Questions and Defining Problem:** Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships

**Developing and Using Models:** In science we use (conceptual) models to explain phenomena or to share an understanding of how the world works.

**Engaging in Argument from Evidence:** students engage in argument from evidence of data collected, observations or model developed.

### DISCIPLINARY CORE IDEA- DCI

**5-ESS2-1:** Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes.

**5-ESS3-1:** Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments.

### CROSSCUTTING CONCEPTS- CCC

**Systems and System Models:** A system can be described in terms of its components and their interactions.

**Patterns:** Patterns can be used as evidence to support an explanation.

**Cause and Effect:** Relationships are routinely identified, tested, and used to explain change.

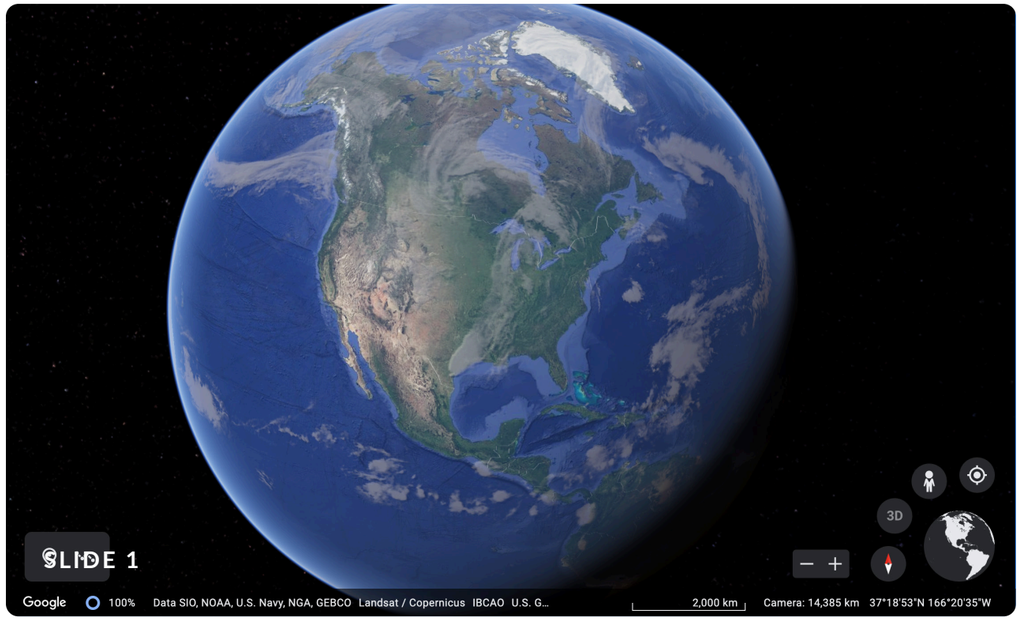
**Energy and Matter in Systems:** Looking how energy and matter, flows, cycles and is conserved overtime through a system.

**Stability and Change of System:** Students measure change in terms of difference over time and observe that change may occur at different rates

**6.RP.A.1:** Understand the concept of ratio and use ratio language to describe ratio relationship between two quantities.








**Slide 1: Satellite Image of the Earth focusing on North America**

**Instructional Sequence:**

Project the satellite view of the Earth - **Slide 1**

As a class, ask students the following questions:

What are the four prominent colors that you see when you see a satellite image of Earth?
*Blue, white, green, and light brown*

What do each of these colors represent?
*White ⇨ clouds, weather, air, wind ⇨* ***the Atmosphere***
*Green ⇨ green trees, plants, humans, animals ⇨* ***the Biosphere***
*Brown ⇨ earth core/mantle, mountains, soil, metals, sand ⇨* ***the Geosphere***
*Blue ⇨ oceans, lakes, rivers, glaciers ⇨* ***the Hydrosphere***

### EXTENSION: GEOGRAPHY

Some may look at white border lines that delineate Canada and US or US and Mexico.
What makes up the North American Continent?
*Canada, United States, and Mexico. The Caribbean region and its 13 independent countries are considered part of North America.*

Tell the students that we have just identified the four spheres that are within the boundary of the Earth. These four interdependent parts of planet Earth are part of an integrated system called the Earth system. A system is a collection of interdependent parts enclosed within a defined boundary.

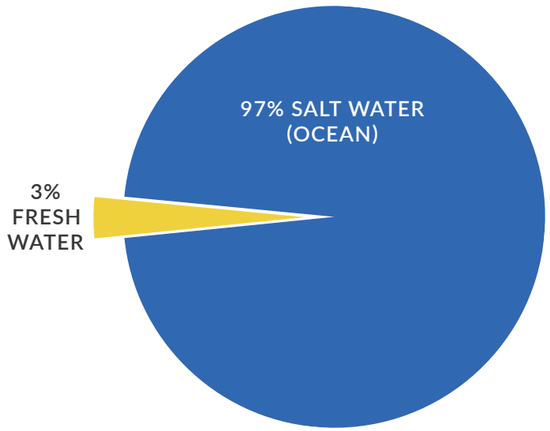
Ask the students whether they believe that the spheres are closely connected (interact with each other) or independent (separate) from each other. Have them provide supporting evidence (examples).

*Rain (Hydrosphere) falls from the clouds (Atmosphere)*
*Birds (Biosphere) fly through the air (Atmosphere)*
*Trees (Biosphere) release oxygen (Atmosphere)*

**EXTENSION: VOCABULARY**

A system is a group of related objects or components that make up a whole and can carry out functions its individual parts cannot.

A system model is a way to understand (describe or predict) how a system works.




**EXTENSION: NGSS 5-ESS2-2**

**70%** of the Earth is water.
**97%** of the water on Earth is saltwater.
**3%** is fresh water.
**2.5%** of the fresh water is unavailable, locked in glaciers, polar ice caps, and the atmosphere.
**0.5%** of water on Earth is available as fresh water.





Tell the students that we call the Earth the "Blue Planet" because it is **70%** water. **97%** of the water on Earth is ocean water (saltwater) and only **3%** is fresh water. Of the **3%** fresh water, **2.5%** is unavailable to us, locked inglaciers, polar ice caps, and the atmosphere. Only **0.5%** is available as fresh water.

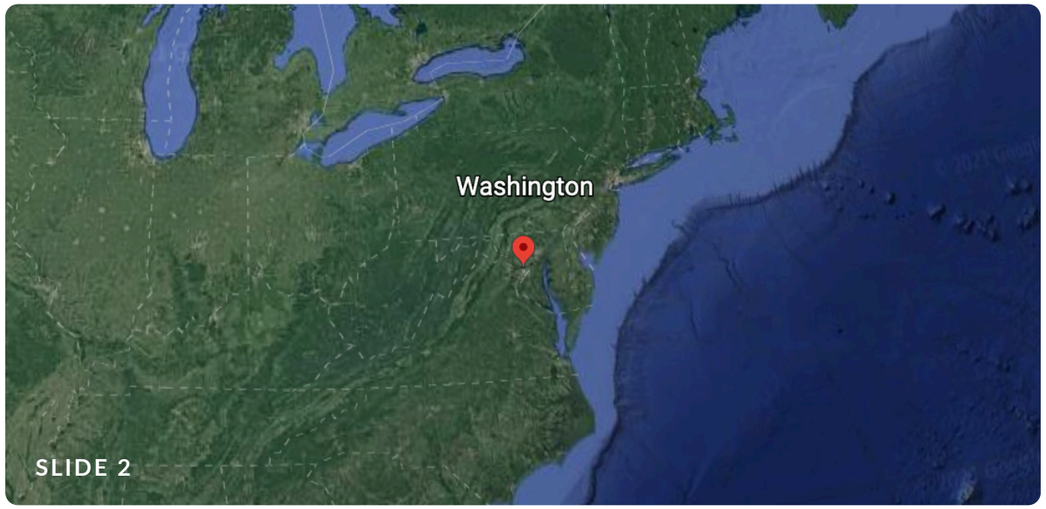
Project a satellite image of Eastern North America - **Slide 2**

As a class, ask students the following questions:

What spheres can you identify?
***Hydrosphere**: the oceans, inland water bodies (Great Lakes), groundwater, and ice sheets (cryosphere).*
***Geosphere**: solid earth, the core, mantle, crust, and soil layers (pedosphere).*
***Biosphere**: all the places on Earth (land and water) where organisms (plants and animals) live.*

The spheres are interdependent and connected to each other through complex physical, chemical, and biological processes with the energy from the Sun ultimately driving almost all of these processes. Examples of these processes are the carbon, nitrogen, oxygen, phosphorus, and sulfur cycles, as well as the water, rock, and nutrient cycles.

**Slide 2: Satellite Image of U.S. Eastern Seaboard**



Ask the students the following questions:

Can you see evidence of human activity in a satellite image of Earth?
*There is no "visible" human impact, but some students may bring up desertification, deforestation.*

If we cannot see a sphere does it mean it doesn't exist?
If we can't see human impact does that mean that there is no human impact?
*We cannot see the atmosphere but that does not mean that it is not there. The image is too far up to see human impact, but we know it is there as well.*

**EXTENSION: GEOGRAPHY**

**Earth's Energy Budget**

- **23%** of incoming solar energy is absorbed in the atmosphere by water vapor, dust, and ozone.
- **48%** passes through the atmosphere and is absorbed by the surface (ocean & land).
- **29%** of the solar energy that arrives at the top of the atmosphere is reflected back into space by clouds, atmospheric particles, or bright ground surfaces like the sea, ice, and snow.
- **100%** Sun Energy

**4 Biogeochemical Cycles of Matter**

- carbon cycle
- water cycle
- nitrogen cycle
- phosphorus cycle

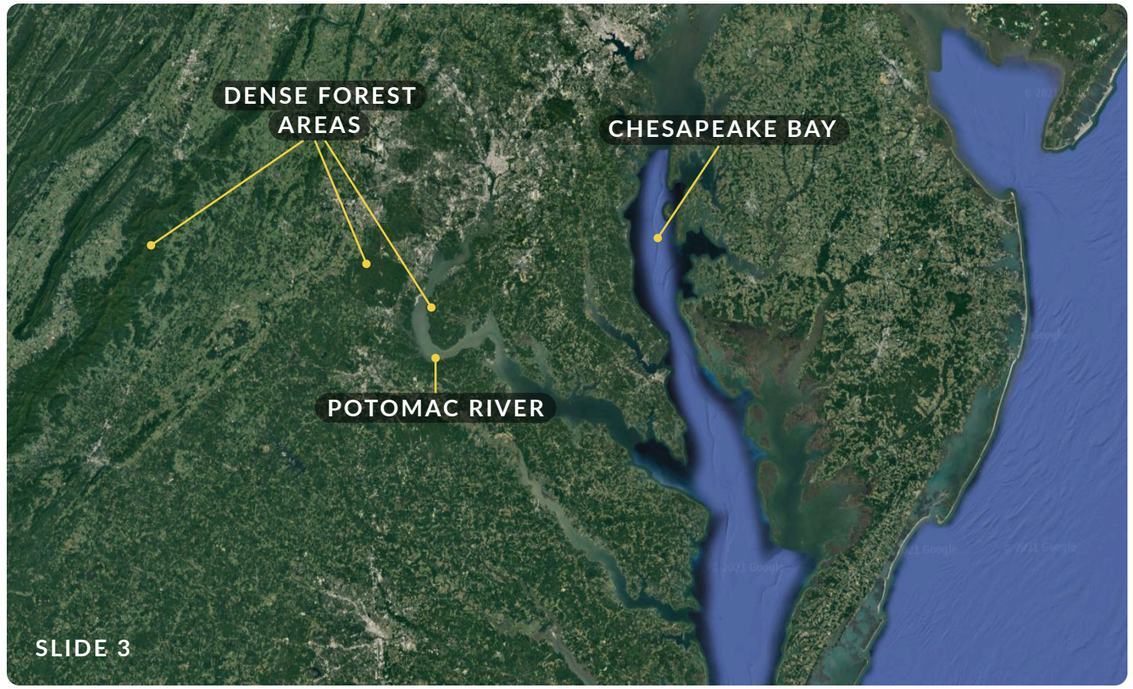
Project **Slide 3**, which zooms in to Virginia, Washington, D.C., and Maryland so that students can point out human impact.

Point out features that will help students recognize Washington, D.C. For example, point out the Potomac River to the left and the Anacostia River to the right of Washington, D.C. You can also point out the Interstate 95 corridor (straightish white line), as well as Baltimore and its Inner Harbor. Other features that can be seen from Slide 3 are bridges.

What spheres can you identify in **Slide 3**?








Have students identify the following:

- ***Hydrosphere**: the Potomac, Anacostia, Chesapeake Bay.*
- ***Biosphere**: trees (areas of tree density point to various forests both in VA and MD)*
- ***Geosphere**: land*
- ***Human Impact**: all of the whitish areas are cities made-up of concrete, buildings, roads -> transportation corridors, bridges, airports, etc.. You can also discuss the erosion of topsoil in the Anacostia and Potomac rivers.*

Students watch a video (approximately 5 minutes long) produced by Casey Trees that summarizes the Earth's systems while providing local examples of the four spheres and how they interact and are interdependent.

Part one: ***caseytrees.org/elagvideopart1***
Part two: ***caseytrees.org/elagvideopart2***


**Assignment or in Class:** Tell the students to turn to page 4 of their workbook and label the sphere most prominent (noticeable) in each photo taken around Washington, D.C.

*Answers: 1. Biosphere 2. Atmosphere 3. Geosphere 4. Hydrosphere*

Tell students that Washington, D.C., was divided into four quadrants: North Capitol and South Capitol, East Capitol Street and the National Mall. These divide the city into Northeast, Northwest, Southwest and Southeast, with the center being the U.S. Capitol. Quadrants were established by Pierre Charles L'Enfant when he designed the layout of Washington, D.C.

Ask the students to identify which of the quadrants they live in or where their school is located. Have them notice where the green, park areas are located.

**EXTENSION: SOCIAL STUDIES**

French Engineer and Architect Pierre Charles L'Enfant designed the urban plan of Washington, DC in 1871 for the first president George Washington.



LESSON 2 | EARTH SYSTEMS

## PLANNED VS. NATURALIZED SPACES

Have students identify the **Impervious** and **Permeable** surfaces and the **Planned** spaces and **Naturalized** spaces in their quadrant. Examples of "Naturalized Spaces" in Washington, DC are Rock Creek, Fort Dupont, and Roosevelt and Kingman islands. Examples of "Planned Spaces" are the National Mall, Anacostia Park, and Meridian Hill Park.

Show students these two images (Appendix page 67; student workbook page 3) and differentiate between "naturalized" and "planned" green spaces.



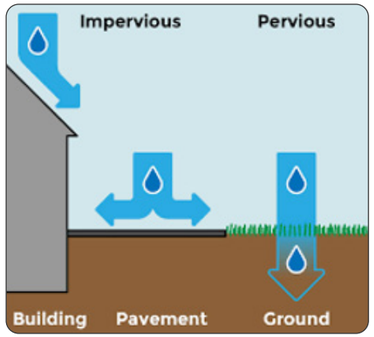
**Planned spaces** are intentionally designed urban green spaces which can fulfill many roles, depending on their planning and management. Green planned spaces, such as community gardens, parks, and roadside hedges, can reduce the **urban heat island effect**. A water retention pond that absorbs greater volumes of water during heavy rainfall can contribute to disaster risk reduction. Planned spaces contribute to aesthetics, improve the livability of a city, and contribute to biodiversity.

**Naturalized spaces** refer to native plantings, namely trees, shrubs, ground cover, and perennial plants drawn from the local geographic area. These spaces are inherently low maintenance and drought-tolerant, mostly subsisting just fine on natural rainwater. The plants are indigenous to the local area and so tend to be less expensive. These naturalized spaces can also contribute to improved air quality and increased biodiversity, attracting insects, butterflies, birds, and small animals.

**EXTENSION: SCIENCE**

Urban heat island occurs when a city experiences much warmer temperatures than nearby rural areas. The difference in temperature between urban and less-developed rural areas has to do with how well the surfaces in each environment absorb and hold heat. For example: black asphalt vs. green grass.

## IMPERVIOUS VS. PERMEABLE SURFACES



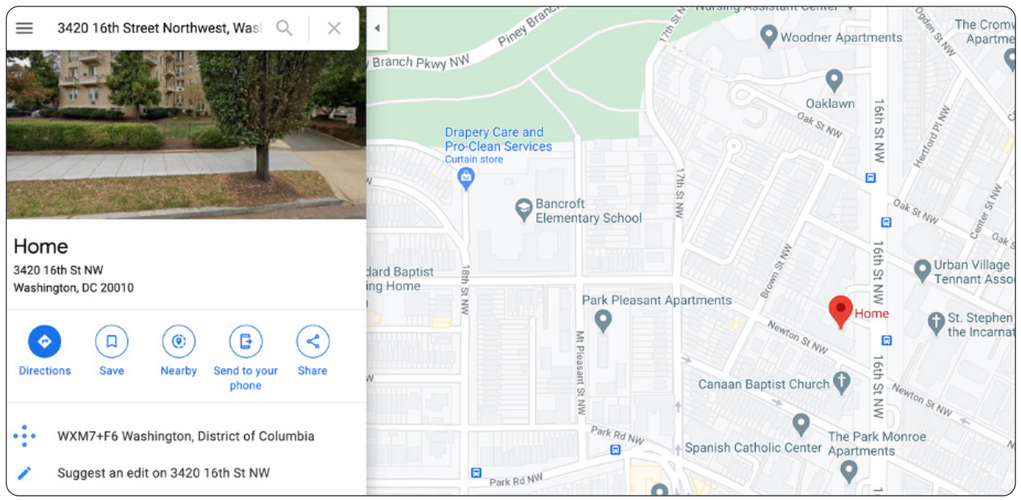

**Impervious** is any surface that does not allow liquid to pass through.
Examples: concrete, asphalt, roofs.

**Permeable** or **pervious** is any material or membrane that allows a liquid to pass through.
Examples: soil, grass.

## ASSIGNMENT

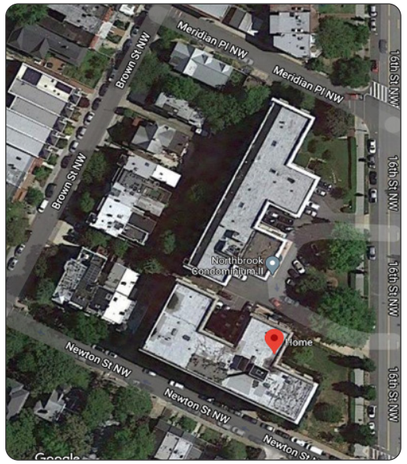
Tell students that they are going to draw a bird's-eye view streetscape model of their neighborhood or school block. They will incorporate impervious and permeable surfaces, as well as naturalized and planned green spaces. Have students turn to their workbook or use a blank piece of paper.

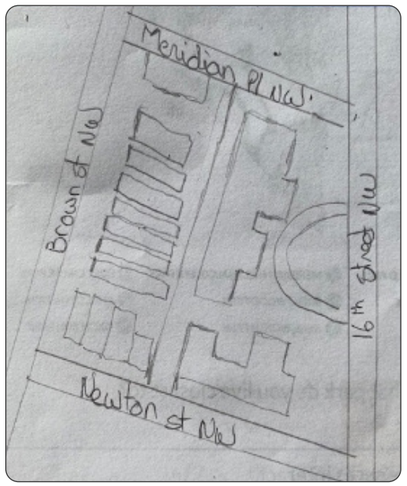
Project a Google Maps image of the school or have students visit Google Maps and enter their home address and use the +/- sign on the right of the map to zoom in or out until they get to their block.

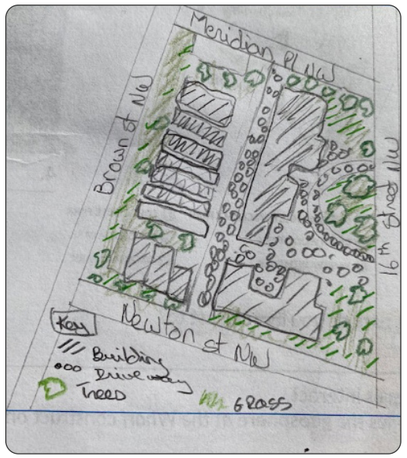







Tell students to take a straight edge and draw the streets (lines) that form the shape of their block. The example provided is a sort of diamond shape. Some may be more rectangular or circular.

Tell students to draw the houses, apartments, other buildings, and alleys on their block. These are **impervious surfaces** which do not allow any rain to pass through into the earth. Tell students to switch to satellite view (left on Google Maps). Now students can also see green surfaces, bare earth, and trees, all of which can be drawn too. Tell students to draw in the "trees" or green spaces and to make a key explaining the symbols or colors they use in their drawing. Finally, if possible, have students "ground proof" their drawings by walking the block they have drawn with teachers, parents, or guardians.

LESSON 3

# AIR QUALITY MATTERS

**REFER TO APPENDIX PAGES 69-73 | STUDENT WORKBOOK PAGES 5-9**

## OBJECTIVES

- ✓ Students describe the composition and properties of air and identify sources of air pollution in their community.
- ✓ Students will know the structures and functions of parts of the respiratory system and circulatory system.
- ✓ Students will know that oxygen is the gas in the air that we inhale, which is needed to sustain human life.
- ✓ Students will know that we exhale carbon dioxide.
- ✓ Students recognize the AQI as a color index that identifies the level of air pollution and the associated health risks. Students understand that the AQI is used to help make decisions about outdoor activities.

## ACTIVITY SUMMARY

Students focus on the atmosphere and the role it plays in making planet Earth livable. They learn the composition of the air and recognize that oxygen is essential to life. Students study the lungs as part of the respiratory system and learn about respiration as the exchange of oxygen and carbon dioxide from the trillions of cells in the body. They study natural and anthropogenic air pollutants and their sources. They learn how poor air quality impacts human health and exacerbates respiratory issues, including asthma symptoms and cardiac problems. They study the Air Quality Index (AQI), a color index used for reporting daily air quality.

## BEFORE CLASS

Teachers will need to project the following images in this Lesson, including the Google Maps bird's-eye view of their school campus.

## WARMUP

Students write and share thoughts on how eating and drinking are different from breathing. Why do we need to breathe?





## ASSIGNMENT

Students make a model of the respiratory system. The model can be abstract (it does not have to be realistic), but it should include the nose, lungs, bronchi, trachea, alveoli, air/oxygen, and carbon dioxide. Students should describe how air pollutants can impact the human body. Students identify sources of air pollution (mobile or stationary) on their bird's-eye view streetscape model (Appendix page 67; student workbook page 3). Students incorporate the atmosphere and gas exchange on the leaves of the tree they drew (Appendix page 79; student workbook page 15).

## FRAME THE ACTIVITY

We will learn about how the Earth's atmosphere (one of the four spheres) is special because it can sustain life. The atmosphere refers to the gases surrounding a planetary body (such as the Earth) or star, held in place by gravity. The blanket of gases on Earth not only contains the air that we breathe but also protects us from the blasts of heat and radiation coming from the Sun. The atmosphere warms the planet by day and cools it at night. The Earth's atmosphere is made up of several layers and the layer closest to the Earth is the troposphere. We will learn the composition, or chemistry, of air and the anthropogenic and natural sources of air pollution, as well as the effects pollutants have on our health. We will learn the essential elements of the respiratory and circulatory systems, focusing on the gas exchange of oxygen and carbon dioxide.

We will also look at a map of our school grounds or neighborhood and identify potential sources of air pollution (mobile or stationary) and decide where we will conduct our outdoor walkabout.

**VOCABULARY**

atmosphere, troposphere, pollutants, particulate matter, PM2.5, anthropogenic, mobile, stationary, regulated, exacerbate, secondary pollutants

**STUDENTS WHO DEMONSTRATE UNDERSTANDING CAN:**

**Focus 5-PS1-1. Matter and its interactions.** Develop a model to describe that matter is made of particles too small to be seen. *[Clarification Statement: Examples of evidence supporting a model could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating saltwater.] [Assessment Boundary: Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.]*

**Background 5-ESS2-1:** Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

### SCIENCE AND ENGINEERING PRACTICES- SEP

**Asking Questions and Defining Problem:** Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.

**Planning and Carrying Out Investigations:** Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. Explore more: *caseytrees.org/elag-lesson3-sep*

**Obtaining, Evaluating, and Communicating Information:** Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem.

### DISCIPLINARY CORE IDEA- DCI

**PS1.A:** Structure and Properties of Matter. Matter of any type can be subdivided into particles that are too small to see, but even then, the matter still exists and can be detected by other means.

**PS1.B:** Chemical Reactions. When two or more different substances are mixed, a new substance with different properties may be formed.

### CROSSCUTTING CONCEPTS- CCC

**Systems and System Models:** A system can be described in terms of its components and their interactions.

**Cause and Effect:** Relationships are routinely identified, tested, and used to explain change.

**Scale, Proportion, and Quantity:** Natural objects exist from the very small to the immensely large. Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.

**Structure and Function:** How does the structure of an objects fits its function (its job).

**5.NBT.A.1** Explain patterns in the number of zeros of the product when multiplying a number by powers of 10 & explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10. (5-PS1-1)
**5.NF.B.7** Apply and extend previous understandings of division to divide unit fractions by whole numbers and whole numbers by unit fractions. (5-PS1-1)
**5.MD.C.3** Recognize volume as an attribute of solid figures and understand concepts of volume measurement. (5-PS1-1)
**5.MD.C.4** Measure volumes by counting unit cubes, using cubic cm, cubic in, cubic ft, and improvised units. (5-PS1-1)



LESSON 3 | AIR QUALITY MATTERS

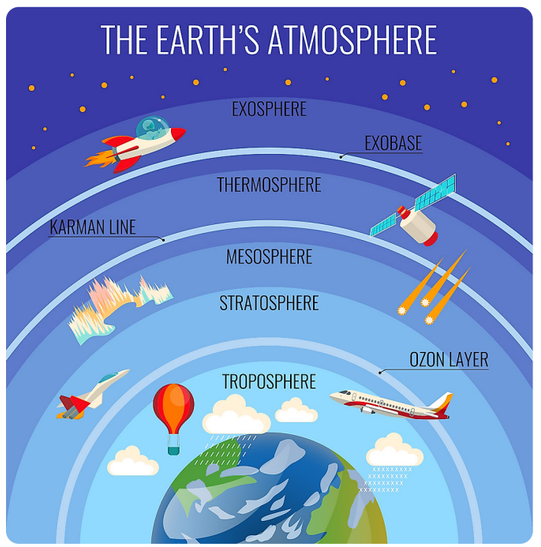
## INSTRUCTIONAL SEQUENCE

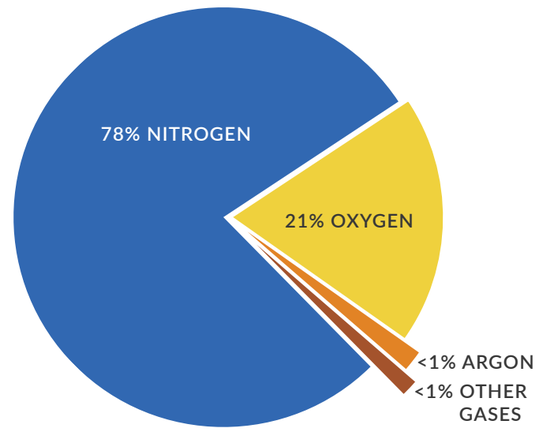
Discussion questions:

**Of the four spheres, which sphere contains air?**
***Answer**: The atmosphere. The layer of the atmosphere that contains air is the one closest to the Earth and is called the troposphere. The chemical composition of the troposphere determines the quality of the air. The stratosphere, mesosphere, thermosphere, and exosphere are the other layers of the atmosphere. The water or hydrologic cycle (the formation of clouds, rain, and water vapor) is driven by the energy of the Sun and has a great influence on the weather and the climate. Greenhouse gases (GHGs) residing in the upper part of the troposphere trap heat in the atmosphere and are essential to life on Earth. Too high of a concentration of GHGs, however, alters the climate.*

**Is air really matter? If you cannot see it, how do you know it is there?**
***Answer**: Air is classified as matter. We prove that air is matter by defining its properties (characteristics) and its existence from the following indirect evidence: It has mass, it takes up space, it can move, it exerts pressure, and it can do work.*

**What is air made of?**
***Answer**: Air is made up of gases which are made from particles of matter that are too small to see. These particles are moving freely around in space and can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) Air is a mixture of gases and contains Nitrogen (78.09%), Oxygen (20.95%), Argon (0.93%), Carbon dioxide (0.03%), and several trace gases. Water vapor (humidity) varies between zero and 4% volume.*



**EXTENSION: SCIENCE, WATER CYCLE**

The Water or Hydrologic Cycle is the movement of water between the Earth and the atmosphere.

Water circulates through condensation, evaporation, precipitation, convection, and runoff.

The Troposphere contains 99% of the water vapor in the atmosphere.

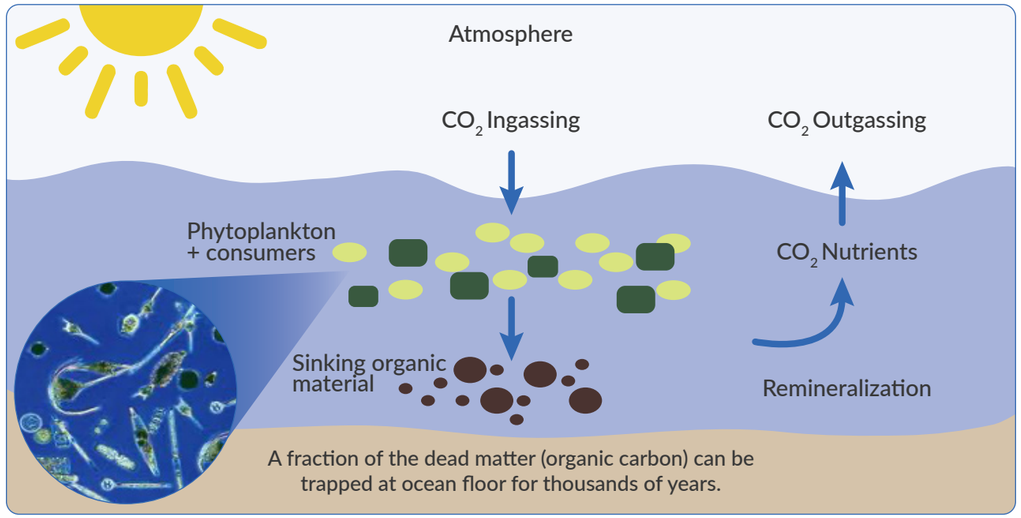
The exchange and movement of water between the Earth and its atmosphere is called the water cycle. This cycle, which occurs in the troposphere, begins as the Sun evaporates large amounts of water from the Earth's surface and the moisture is transported to other regions by the wind.

As air rises, expands, and cools, water vapor condenses, and clouds develop. Clouds cover large portions of the Earth at any given time and vary from fair weather cirrus to towering cumulus clouds. When liquid or solid water particles grow large enough in size, they fall toward the Earth as precipitation. The type of precipitation that reaches the ground, be it rain, snow, sleet, or freezing rain, depends upon the temperature of the airthrough which it falls.

*Discussion questions continued:*

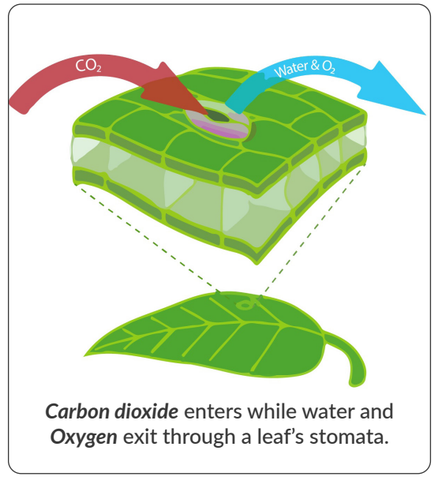
**What is the source of oxygen on planet Earth?**

***Answer**: The majority (at least 50% and maybe as much as 70%) of the oxygen on Earth is produced by phytoplankton in the ocean. Trees, plants, and phytoplankton photosynthesize, using carbon dioxide, water, and sunlight to grow. Photosynthesis is the process by which phytoplankton and plants use sunlight to synthesize foods from carbon dioxide and water and release oxygen. Phytoplankton and plants get all the material they need to grow chiefly from the air and water in their surroundings.*

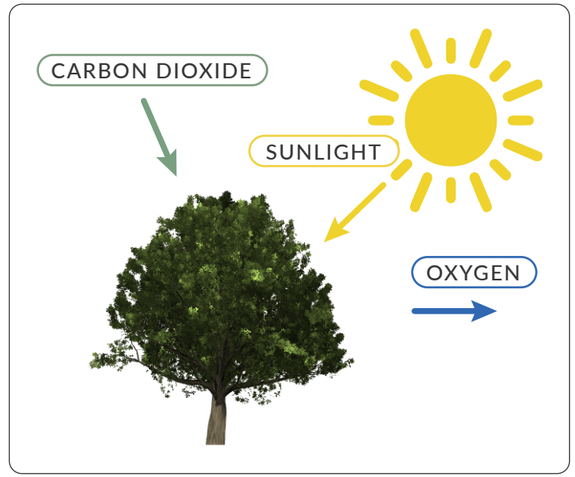







***Carbon dioxide*** enters while water and ***Oxygen*** exit through a leaf's stomata.




*Discussion questions continued:*

**How does the oxygen get to all the cells?**

***Answer**: The respiratory system is the part of the human body that consists of specific tissues, organs, and structures used for gas exchange (breathe in, inhale air with oxygen and breathe out, exhale carbon dioxide). The trillions of cells in the human body depend on oxygen to do their jobs and need the carbon dioxide to be removed. The air (78% nitrogen, 21% oxygen) that you inhale (breathe in) enters your lungs and is carried through the bronchioles to your approximately 6 million alveoli. It is at the level of the alveolus that gas exchange takes place. The oxygen that is in the air diffuses through each alveolus into the blood.*

*The air (78% nitrogen, 21% oxygen) that you inhale (breathe in) enters your lungs and is carried through the bronchioles to your approximately 6 million alveoli. It is at the level of the alveolus that gas exchange takes place. The oxygen that is in the air diffuses through each alveolus into the blood.*

*The blood (circulatory system) flowing through the 6 million alveoli picks up the oxygen and carries it to the trillions of cells in your body.*

*Concurrently (at the same time), the blood picks up carbon dioxide from the trillions of cells and brings it to the alveoli and through diffusion releases the carbon dioxide into the bronchioles. The carbon dioxide is then exhaled. All of this is done thanks to the autonomic nervous system. This process works automatically, without a person's conscious effort.*

*PS: Alveoli (plural-many) Alveolus (singular-one)*

**EXTENSION: SCIENCE**

The respiratory system is one of eleven body systems. It is responsible for gas exchange.

It contains an upper tract, which includes the nose, nasal cavities, sinuses, pharynx, and the part of the pharynx above the vocal folds.

It also contains a lower tract, which includes the lower part of the larynx, the trachea, bronchi, bronchioles and millions of alveoli (air sacs) where gas exchange of oxygen ⇔ carbon dioxide occurs.

**EXTENSION: MATH**

A power of 10 is any of the integer powers of the number ten; in other words, ten multiplied by itself a certain number of times.

Millions = $1x\ 10^{6}$

Billions= $1x\ 10^{9}$

Trillions= $1x\ 10^{12}$

*Discussion questions continued:*

**What is air pollution? How does the air get polluted? What are sources of air pollution?**

***Answers**: Air pollution refers to the release of pollutants into the air that are detrimental to human health and the Earth as a whole. Pollutants can be anthropogenic (man-made) or natural.*

*Pollutants can be gases or particles discharged from industry, power generation (electricity), motor vehicles, or agriculture, and they can also be discharged from natural sources such as volcanoes or forest fires.*

Can we see all air pollution?
***Answer**: Not all pollutants that are harmful are visible. An example is carbon monoxide (the "silent killer"). We cannot see or smell it, but if there is too much of it in an enclosed space, it can kill us (which is why we use carbon monoxide detectors).*

*Most pollutants are measured in parts-per-million (ppm) .000001 or $1x10^{-6}$*
*Thanks to a Federal Law called the Clean Air Act (1970), air emissions from stationary and mobile sources are regulated. One of the goals of the Clean Air Act was to address the public health and welfare risks posed by certain widespread air pollutants.*

*To protect human health, the EPA requires that the following **criteria pollutants** are monitored: 1) ozone, 2) particulate matter, 3) carbon monoxide, 4) sulfur dioxide, 5) nitrogen dioxide, 6) lead.*

*Government agencies communicate the level of these pollutants to the public each day using a color index called the Air Quality Index (AQI).*



LESSON 3 | AIR QUALITY MATTERS

**EXTENSION: SOCIAL STUDIES**

The Clean Air Act is the United States' primary federal air quality law, intended to reduce and control air pollution nationwide. Initially enacted in 1963 and amended many times since, it is one of the United States' first and most influential modern environmental laws

*Discussion questions continued:*

**What is the U.S. Air Quality Index (AQI)?**
***Answer**: The U.S. AQI is the EPA's index for reporting air quality.*

**How does the AQI work?**
***Answer**: Think of the AQI as a yardstick that runs from 0 to 500. The higher the AQI value, the greater the level of air pollution and the greater the health concern. For example, an AQI value of 50 or below represents good air quality, while an AQI value over 300 represents hazardous air quality. The AQI is divided into six categories. Each category corresponds to a different level of health concern. Each category also has a specific color. The color makes it easy for people to quickly determine whether air quality is reaching unhealthy levels in their communities.*

**AQI BASICS FOR OZONE AND PARTICLE POLLUTION** ***www.airnow.gov/aqi/aqi-basics***

| DAILY AQI COLOR | LEVEL OF CONCERN | VALUES OF INDEX | DESCRIPTION OF AIR QUALITY |
|---|---|---|---|
| Green | Good | 0-50 | Air quality is satisfactory, and air pollution poses little or no risk. |
| Yellow | Moderate | 51-100 | Air quality is acceptable, but there may be a risk for some people, particularly those who are unusally sensitive to air pollution. |
| Orange | Unhealthy for sensitive groups | 101-150 | Members of sensitive groups may experience health effects. The general public is less likely to be affected. |
| Red | Unhealthy | 151-200 | Some members of the general public may experience health effects. Members of sensitive groups may experience more serious effects. |
| Purple | Very unhealthy | 201-300 | Health alert: the risk of health effects is increased for everyone. |
| Maroon | Hazardous | 301+ | Health warning of emergency conditions: everyone is more likely to be affected. |

**EXTENSION: CHEMISTRY**

Ground level **Ozone** is considered a secondary pollutant. It is the product of a photochemical reaction that takes place when $NO_2$, $SO_2$ and VOC are in contact with sunlight.

**Five Major Pollutants**

The EPA established an AQI for five major air pollutants regulated by the Clean Air Act. Each of these pollutants has a national air quality standard, which is set by the EPA to protect public health:

- ground-level ozone
- particle pollution (also known as **particulate matter**, including PM2.5 and PM10)
- carbon monoxide
- sulfur dioxide
- nitrogen dioxide

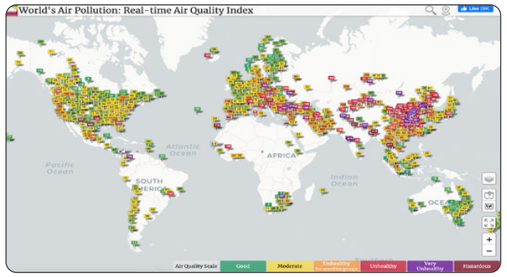
Lead is the sixth **criteria pollutant**.

- Historically, a major sources of lead air emissions were motor vehicles (from leaded gasoline, which was outlawed in the US on January 1st, 1996). Currently, lead is emitted largely from industrial sources.

The following links are engaging websites that show real-time readings of AQI around the world:

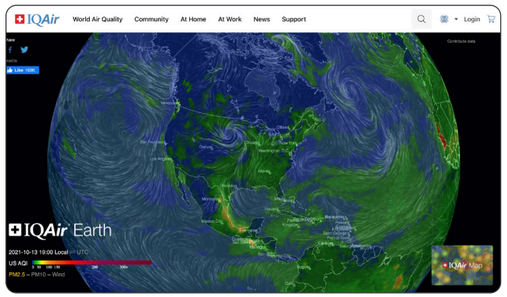
World Map with Air Quality Index

▶ *www.waqi.info*



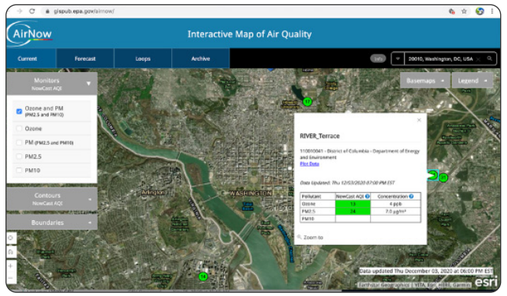

Real Time AQI around the Earth with wind currents

▶ *www.iqair.com/earth*




Looking for AQI in the United States

▶ *www.gispub.epa.gov/airnow*








## DEMONSTRATION

Students can observe soot-particle pollution (particulate matter), an example of **incomplete combustion**, by watching a simple classroom demonstration. The teacher (wearing an oven mitt for protection) holds the bottom of a can about two inches over the flame of a candle. The wick (usually cotton) burns in the presence of oxygen, while the wax slows the burning process and melts. Carbon monoxide and soot are released into the environment and soot will collect on the bottom of the can.

**What is Particulate Matter?**

***Answer**: Particulate Matter is one of the six criteria pollutants—harmful pollutants that are constantly monitored because of their impact on human health, as required by the EPA. Particulate matter consists of small microscopic particles (1ppm, 2.5 ppm, or 10 ppm) that are suspended, floating in the air. It can be made up of dust, dirt, smoke, and/or liquid droplets (diesel particles). Some particle pollutants are not visible to the naked eye and can be 30 times smaller than the width of a hair on your head.*

**How is Particulate Matter measured?**

***Answer**: An **AirBeam** is one of numerous instruments used to monitor and measure the level of particulate matter in the air. The AirBeam measures units of 1.0 µm/m³, 2.5 µm/m³, and 10.0 µm/m³ every second at a specific location.*

*(µm/m³ or microns per cubic meter is a measurement of size over volume, referring to the size of the particle in microns per cubic meter. A micron, or micrometer, is $1\times10^{-6}$ meters or one millionth of a meter.)*

*The AirBeam sends the data to an Android phone (using the AirCasting application) as a number and a color code (AQI).*

### EXTENSION: VOCABULARY

**Incomplete combustion** is any fuel, including fossil fuels like coal, which burns incompletely will release waste products into the environment.

**Combustion** is a chemical process in which a substance reacts rapidly with oxygen and gives off heat.


**AirCasting** is an open-source, end-to-end solution for collecting, displaying, and sharing air quality data (Particulate Matter 2.5), available on Android phones.On AirCasting day (outdoor lesson), the class is divided into teams: 1) Air Monitor Transporter, 2) Timekeeper, 3)Tablet carrier, 4) Observer/ cartographer

When we meet for the optional outside lesson, you will be using the AirBeam on the school campus to collect data on the amount of particulate matter in the air. Let's review the usage of the AirBeam. In preparation for the AirCasting session, each team looks at a bird's-eye view of their campus in their workbook. The same map is projected in front of the class. Ask students to identify different elements on the map until all students are able to orient themselves. Each team at their desk will ponder the following questions:

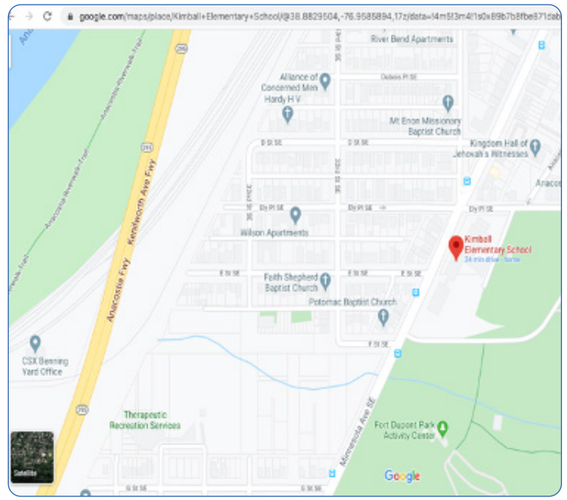
> **Where on our school campus might there be particulate matter pollution? Why?**
> **Where should we walk on the school ground with the AirBeam to collect data about the level of particulate matter pollution?**

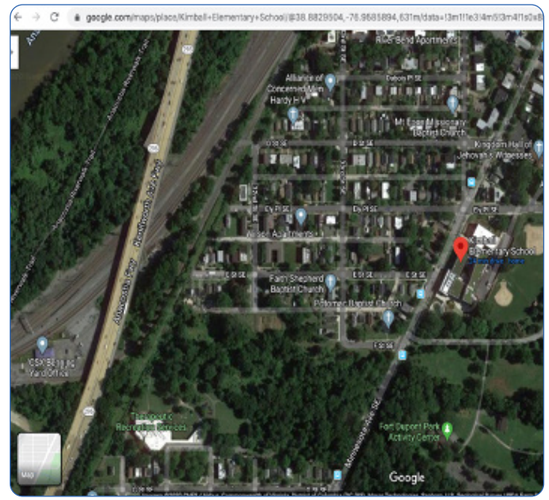
## INSTRUCTIONAL SEQUENCE

Project a Google Maps satellite image of the school grounds or the students' neighborhoods for discussion. Help students orient themselves by having them point out landforms, streets, transportation corridors, and parks from these maps. Toggle between street map view and satellite view. The example illustrates Kimball ES.








Ask the students to construct an argument, with evidence, to support a claim as to why it would be worthwhile to test for particulate matter pollution in a specific area on the school campus or their neighborhood. (Example: There is a bus route passing nearby.)

**Option: Outside Investigation**

Once the students agree as to what part of the campus should be tested, use colored pencils to map out their walking route to monitor, collect, and record air quality data.

Let students know that in the optional outside lesson, we will divide into two groups and collect and record the air quality data and tree observations. The school grounds can be divided into two sections for the two different groups. We will then go back to the classroom for **Lesson 6: Are Trees Worth More Than Their Wood?** to process and interpret the data.

## ASSIGNMENT

Students make a model of the respiratory system. The model can be abstract (it does not have to be realistic), but it should include the nose, lungs, bronchi, trachea, alveoli, air/oxygen, and carbon dioxide. Students should describe how air pollutants can impact the human body. Students identify sources of air pollution (mobile or stationary) on their bird's-eye view streetscape model (Appendix page 67; student workbook page 3). Students incorporate the atmosphere and gas exchange on the leaves of the tree they drew (Appendix page 79; student workbook page 15).

LESSON 4

# TREE DETECTIVE

*Be an Air Quality Investigator and a Tree Detective*

REFER TO APPENDIX PAGE 75 | STUDENT WORKBOOK PAGE 11

## OBJECTIVES

- ✓ Students will use characteristics of leaves, bark, flowers, fruits, nuts, and seeds to differentiate tree species.
- ✓ Students learn the unique characteristics that help them identify tree species in Washington, D.C.
- ✓ Students learn the indicators of tree health.

## ACTIVITY SUMMARY

Students study the characteristics of leaves, bark, and seeds, and learn how these characteristics enable the identification of tree species. Students learn to think like urban foresters by identifying the right tree for the right place by deciding what tree species they might plant where in their community and why.

## BEFORE CLASS

Teachers ask students to bring in examples of leaves, seeds and flowers or other fruiting bodies to class to observe diversity in form and function.

## WARMUP

We will learn that tree species can be identified using characteristics of leaves, bark, flowers, fruits, and seeds. We will learn the role of tree bark and that each seed dispersal structure has a specific function.

## ASSIGNMENT

Students observe and select a tree in their neighborhood or schoolyard. Students identify the tree they selected by using the Casey Trees Species Guide as a reference and by considering the characteristics of trees that they learned. They then can assess the health status of the tree.

### STUDENTS WHO DEMONSTRATE UNDERSTANDING CAN:

**Focus 5-LS1-1:** Support and argument that plants get the materials they need for growth chiefly from air and water

**Background 5-ESS2-1:** Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.



### SCIENCE AND ENGINEERING PRACTICES- SEP

**Engaging in Argument from Evidence.** Student engage in argument from evidence of data collected, observations or model developed.

**Asking Questions and Defining Problems.** In science questions guide inquiry and leads to students engaging in other scientific practices.

### DISCIPLINARY CORE IDEA- DCI

**5-LS1-1:** Structure and FunctionPlants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.

### CROSSCUTTING CONCEPTS- CCC

**Structure and Function:** How does the structure of an objects fits its function (its job).

**Energy and Matter:** Matter is transported into, out of, and within systems.

**Patterns:** Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

**Scale, Proportion, and Quantity:** Natural objects exist from the very small to the immensely large.

## INSTRUCTIONAL SEQUENCE

Students are introduced to the major parts of a tree and the functions of each part. Remind students that each tree species has different characteristics of leaves, bark, and fruiting bodies, which are adapted to the particular environment they live in. We have included some examples of different characteristics below. (Appendix page 74; student workbook page 10)

**Leaves**

Different plants have leaves with different shapes and textures to cope with different environmental conditions. Leaves are the primary organs for photosynthesis and transpiration. They absorb carbon dioxide from the air (atmosphere) and energy from the sun's rays. The chloroplasts (green cells) in the leaves enable the leaf to photosynthesize, making food for the tree and releasing oxygen.

**Flowers**

Flowers are important parts of trees that contain the reproductive structures and, when pollinated, turn into fruits. They come in many colors, shapes, sizes, and smells. These can be an easy identifying character of many trees.

**Fruits**
Fruits are the product of reproduction, and it is how seeds are formed in order for more trees to grow.

**Bark**
Bark is the outermost layer of the stems and roots of woody plants. It helps with the transportation of the products of photosynthesis, defends and protects the tree from the outside world, and prevents the tree from losing too much moisture.




**Trunk**
The tree trunk provides shape and support for the tree. It connects the leafy crown to the roots. The greater the measurement or the distance around the trunk of a tree, the older it is. Each year, a tree forms new cells arranged in concentric circles called annual growth rings. **Dendrochronology** is the scientific method of dating a tree by its rings.

**Roots**
Roots absorb and transfer moisture and minerals from the soil to the rest of the tree. Roots also anchor and provide support for the above ground portion of the tree.

Now that we know the different parts of a tree and each part's function, let us think about what might be indicators (signs) of the age of a tree and its health?

## ACTIVITY

**How old is that tree? |** There are two ways to learn how old a tree is. The first way, counting tree rings, can only be done when the tree has been cut down. Using the tree ring method, also called dendrochronology, a scientist (you!) can count the number of tree rings from the very center of the tree to the outer bark. Each ring represents a growth cycle - or year - the tree has been alive. Think of the tree ring like a target - you would start counting at the bullseye and move out to the outer layer of bark. But that would mean cutting the tree down. See Outdoor Lesson 5 for another way to calculate a tree's age.





The other method is measuring the circumference of the tree (the distance around the tree) to calculate the diameter.

1. Take a tape measure and find the tree you'd like to measure.

2. Measure the **circumference** or the distance around the tree at about 4 ft from the ground Have your helper write down the measurement.

3. Using your calculator. Take the circumference in inches and divide it by **3.14 (pi)** and you will have the tree's diameter.

**Circumference / 3.14 = Diameter**

Arborist have a special tape called a Diameter at Breast Height (DBH) tape which Instantly converts tree circumference to diameter inches. The diameter in inches gives you an indication of the age of the tree. The rate of growth for a tree is influenced by variables such as soil, drainage, water, fertility, light, exposure, as well as environmental disturbances such as pests, fire, weather and much more.

**How do you think you can tell if a tree is healthy?**

- Looking at the Leaves, Trunk Bark, Roots are good indicators
- Is the tree getting the sun that is needs?
- Is it getting the water that it needs?
- Are pests or fungus attacking the tree?
- What might be some other indicators of the health of a tree?

## ASSIGNMENT

A healthy tree begins with careful planning for "the right tree in the right place." Students assess their schoolyard to determine which species of tree they would plant if they were an arborist. Using a selection from their workbook, students consider the characteristics of three tree profiles. They then measure the space and sun exposure and select a tree species to draw on their map. (Appendix page 76; student workbook page 12.)

LESSON 5

# OUTDOOR LESSON

*Optional*

**REFER TO APPENDIX PAGE 74 | STUDENT WORKBOOK PAGE 10**

**OBJECTIVES**

- ✓ Students learn unique characteristics of leaves, bark, flowers, fruits, nuts, and seeds that are used to differentiate tree species.
- ✓ Students learn the indicators used to detect a tree's health.
- ✓ Students will be able to determine if the trees on their campus are "healthy."
- ✓ Students will be able to measure and record particulate matter using technology.
- ✓ Students will be able to record and use the data they collected on their campus to make claims supported by evidence (data) as to the state of the air on their school campus (specifically regarding particulate matter).

**ACTIVITY SUMMARY**

Students will be divided into two groups and will spend the class period outside rotating through two separate 20-minute lessons. In one lesson, students will apply the characteristics of trees they learned to enable them to differentiate tree species and use indicators of tree health to assess the health of trees on their campus. In another lesson, they will use Airbeams* to collect and record measurements of particulate matter pollution in the air.

**BEFORE CLASS**

Students will meet outside in teams with their ***Cleaner Air, Tree by Tree*** workbooks and a pencil. Casey Trees and Clean Air Partners will provide clipboards. Teachers should separate the class into two groups and within each group create teams of 3-5 students. Teachers should remind the students of the expectations for outdoor class behavior.

**FRAME THE ACTIVITY**

Today we will divide into two supervised groups and spend the class period outside. The time outside will be divided into two activities.

**ACTIVITIES**

**Activity 1**

Collecting Air Quality Data with the AirBeam For this activity, one group will walk the school grounds investigating the atmosphere and collecting and recording air quality data with the supervision of an instructor. We will use AirBeams* and tablets to collect temperature (°F), relative humidity (RH%), and particulate matter data in the following sizes: 1.0, 2.5 and 10micrograms per cubic meter (μg/$m^3$).





**AirBeam is a low-cost, palm-sized air quality instrument that measures hyperlocal concentrations of harmful microscopic particles in the air known as particulate matter, as well as humidity and temperature.*

**Activity 2**

Tree Observation and Collection of Data Meanwhile, our second group will work on tree observation by comparing and contrasting characteristics, such as bark, leaves, and flowers/fruits, which will help you identify the tree species.You will record measurements such as diameter at breast height (DBH) and approximate the height of a tree. You will learn that factors such as exposure to sunlight, access to water, access to clean air, and soil are all indicators of a tree's health.

**VOCABULARY**

Data, combustion, incomplete combustion, particulate matter, monitor, detrimental, exposure, alveoli(us)

**STUDENTS WHO DEMONSTRATE UNDERSTANDING CAN:**

**Focus ESS3.C:** Human Impacts on Earth Systems identify how human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments.

**Background 5-ESS2-1:** Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

**Background 5-LS1-1:** Support and argument that plants get the materials they need for growth chiefly from air and water.

**Background 5-PS1-1:** Matter and its interactions Develop a model to describe that matter is made of particles too small to be seen.

**SCIENCE AND ENGINEERING PRACTICES- SEP**

**Asking Questions and Defining Problems:** In science questions guide inquiry and leads to students engaging in other scientific practices.

**Planning and Carrying out Investigations:** To make observation and/or produce data to serve as a basis for evidence for an explanation of a phenomenon

**Analyzing and interpreting data:** Data Collected, and observations made must be analyzed and interpreted to derive meaning.

### DISCIPLINARY CORE IDEA- DCI

**5-LS1-1:** Structure and FunctionPlants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.

**5-LS1.A:** Support an argument that plants get the materials they need for growth chiefly from air and water.

**LS1.B:** Cycles of matter and Energy Transfer in Ecosystems.

### CROSSCUTTING CONCEPTS- CCC

**Cause and Effect:** Cause and effect relationships may be used to predict phenomena in natural or designed systems

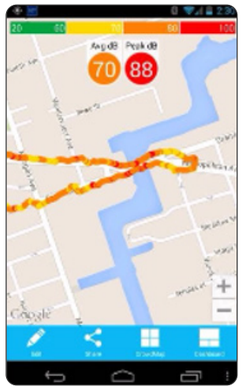
**Patterns:** Graphs, charts, and images can be used to identify patterns in data.

**Energy and Matter:** Matter is transported into, out of, and within systems.

**Structure and Function:** How does the structure of an objects fits its function (its job)

**Scale, Proportion, and Quantity:** Natural objects exist from the very small to the immensely large.

### COLLECTING AIR QUALITY DATA: Outside (20min)




**Preparation:** Teams will be given the following items:

1. AirBeam
2. Tablet with AirCast (AirBeam App)
3. Clipboard (pencils attached)
4. ***Cleaner Air, Tree by Tree*** workbook (pg. 8) with a map of the school grounds and agreed upon route.

### INSTRUCTIONAL SEQUENCE

- Teams will be given a quick review of the usage of the AirBeam.
- Depending on their "roles," students within the team will do the following:
    1. The Air Monitor Transporter (with AirBeam) makes sure the AirBeam is recording
    2. The Tablet carrier (with tablet) keeps track of data
    3. The Recorder/Cartographer/Timekeeper (with clipboard and pencil, map, and timekeeping device) records data on the table below, makes sure the group is following the agreed upon route, and keeps track of time.
- Teams will walk on their assigned route and will use the AirBeam to collect particulate matter data to serve as a basis for evidence to be used in **Lesson 6: Are Trees Worth More Than Their Wood?**





- As the students walk the school grounds, engage the students with the concept of **cause and effect:**
    A. What is/are the causes or sources of air pollutants close to the school? (examples: highways or major transportation corridors)
    B. What might be the effect of air pollution on human health? (examples: aggravates asthma, exacerbates heart disease)
- Once they have completed their designated campus route, students will regroup to receive instruction and material for Activity 2 Tree Observation and Collection of Data.


### TREE OBSERVATION AND COLLECTION OF DATA: Outside (20min)

Prior to the outdoor investigation, Casey Trees staff will select two different tree species on the school property with different visual characteristics. These characteristics can include variations in leaf size and shape, height, bark texture, or whether it has flowers and/or fruit. Students will make observations comparing and contrasting characteristics and take notes in their workbooks.

Students will turn to pg. 10 in their workbooks to the section **Think Like an Urban Forester.**

### INSTRUCTIONAL SEQUENCE

Introduce the major parts of a tree and each part's function. Remind students that each tree species has different characteristics of leaves, bark, and fruiting bodies, all adapted to the particular environment they live in.

**Leaves**

Different plants have leaves with different shapes and textures to cope with different environmental conditions. Leaves are the primary organs for photosynthesis and transpiration. They absorb carbon dioxide from the air (atmosphere) and energy from the sun's rays. The chloroplasts (green cells) in the leaves enable the leaf to photosynthesize, making food for the tree and releasing oxygen. Flowers  Flowers are important parts of trees that contain the reproductive structures and, when  pollinated, turn into fruits. They come in many colors, shapes, sizes, and smells. These can be an easy identifying character of many trees.

**Fruits**

Fruits are the product of reproduction, and it is how seeds are formed in order for more trees to grow.

**Bark**

Bark is the outermost layer of the stems and roots of woody plants. It helps with the transportation of the products of photosynthesis, defends and protects the tree from the outside world, and prevents the tree from losing too much moisture.

**Trunk**
The tree trunk provides shape and support for the tree. It connects the leafy crown to the roots. The greater the measurement or the distance around the trunk of a tree, the older it is. Each year, a tree forms new cells arranged in concentric circles called annual growth rings. Dendrochronology is the scientific method of dating a tree by its rings.

**Roots**
Roots absorb and transfer moisture and minerals from the soil to the rest of the tree. Roots also anchor and provide support for the above ground portion of the tree.

At each of the selected trees, students make observations and record in their workbook. Collect a leaf from each tree to pass around and feel. Please refer to the Casey Trees Species Guide, and How-To Guide to learn what species of trees grow on your school's campus. Save the leaves to use during the review and for potential tree identification. Guided observation answers are provided below:

Moving through the school grounds, the students should keep in mind the following questions:

A. How are the leaves, bark, flowers, fruits, nuts, and seeds similar across different species? How are they different?
B. What does the **circumference** of a tree mean, and why does it matter?

Measuring Tools Options

A. Height estimation
B. Trunk diameter at breast height (DBH)

For certain species, tree height and diameter can be indicators of age. Trees produce new growth rings, adjacent to the bark, every year.

**Tree health:** Let's look for indicators (signs) of the tree's health.

### DISCUSSION QUESTIONS

Is the tree in excellent, good, fair or poor condition?
Is the tree dying/dead? What are indicators (signs) to look for?

i. Leaves: Discoloration (Browning? Sun scorch?), Defoliation (holes/missing portions of leaves or canopy)
ii. Branches: Major branch mortality? Large broken branches? Pruning?
iii. Roots: Visible? Circling around base? Mulch volcano?
iv. Bark: Straight? Gashes? Oozing? Cracks? Fissures? Exit Holes? Epicormic Sprouts?



## LESSON 6
# ARE TREES WORTH MORE THAN THEIR WOOD?

REFER TO APPENDIX PAGES 76-78 | STUDENT WORKBOOK PAGES 12-14

### OBJECTIVES

✓ Students learn the multitude of benefits that trees provide.
✓ Students learn the role that trees play in intercepting water, improving air quality, and sequestering carbon.
✓ Students quantify the benefits (ecosystem services) that trees provide.

### ACTIVITY SUMMARY

Students learn about the ecosystem services, or benefits, that trees provide. Using i-Tree Design, an online tool, students use collected data to see how arborists quantify the benefits of the urban forest. Students study how trees contribute to the restoration of air quality, the interception of stormwater, and the sequestration of carbon.

### BEFORE CLASS

Become familiar with the i-Tree Design website (see below). Make sure the technology (laptop/tablets) are charged. Project the website to the front of the class. Write the street address of the school on the board. Provide workbooks to the students.

### WARMUP - PART 1

Remind students of the Wangari Maathai quote: ''A tree is worth more than its wood." Have students brainstorm the aesthetic, experiential, and utilitarian benefits that trees provide. Possible responses could include:

- Combat climate change
- Clean the air (ozone, particulate matter, VOC)
- Provide oxygen
- Cool the streets, the streams, the city
- Prevent soil erosion
- Prevent water pollution
- Provide shade and shield people from ultra-violet rays
- Create economic opportunities
- Create habitats for wildlife (birds, insects, fungi)
- Save water
- Conserve energy
- Provide food
- Landmarks
- Reduce violence
- Increase property values
- Slow traffic
- Provide wood
- Fun (swings, climbing trees)

Trees provide environmental benefits like improved air quality (by absorbing air pollution) and reduced urban storm runoff. We are often focused on soil and the roots of plants, but the aboveground surfaces of trees—their leaves, stems, and trunks—also intercept rainwater and store it as a thin film until it evaporates or drips through to the ground.

Trees provide economic returns in the form of higher property values, increased retail activity, and reduced energy costs of heating and cooling by reducing the heat island effect in urban environments.

Researchers have found evidence that trees and other vegetation may reduce stress (Ulrich et al., 1991), reduce crime, speed recovery from surgery (Ulrich, 1984), and enhance cognitive functioning by promoting recovery from mental fatigue (Kaplan, 1995). 1All of these benefits that trees provide are defined as **ecosystem services**.

**Ecosystem Services** are the many and varied benefits to humans gifted by the natural environment (such as a tree) and from healthy ecosystems.

### WARMUP - PART 2

Have students consider the following question: As members of a community, what could be the purpose of identifying the benefits or value of trees? Possible answers could include:

1. Convince local officials and decision makers of the importance of planting and maintaining trees and other green infrastructure, so that urban forestry will be given a higher priority in budgeting, planning, and decision-making.
2. Provide community planners and urban foresters with information they can use to improve planting and maintenance programs so as to maximize the benefits that urban trees provide to the community.

**Suggested reading:** Does beauty still matter? Experiential and utilitarian values of urban trees: *www.nrs.fs.fed.us/pubs/jrnl/2011/nrs_2011_schroeder_002.pdf*

### FRAME THE ACTIVITY

Today we will be using i-Tree Design, an online application, to estimate the benefits provided by individual trees. By inputting a tree's location, species, size, health, and sun exposure, students will be able to see the stormwater interception, carbon sequestration, and air quality improvements that specific tree will provide.

### VOCABULARY

Carbon dioxide sequestration, stormwater runoff interception, ecosystem services



LESSON 6 | ARE TREES WORTH MORE THAN THEIR WOOD?

### STUDENTS WHO DEMONSTRATE UNDERSTANDING CAN:

**5-ESS3-1.** Obtain and combine information about ways individual communities use science ideas to protect Earth's resources and environment.

### SCIENCE AND ENGINEERING PRACTICES- SEP

**Analyzing & Interpreting Data:** Data collected, and observations made must be analyzed and interpreted to derive meaning.

**Developing and Using Models:** In science we use (conceptual) models to explain phenomena or to share an understanding of how the world works.

**Constructing Explanations and Designing Solutions:** Students use evidence measurements, observations and patterns to construct or support an explanation.

**Engaging in Argument from Evidence:** Students engage in argument from evidence of data collected, observations or model developed.

### DISCIPLINARY CORE IDEA- DCI

**LS1.C:** Organization for Matter and Energy Flow in OrganismsPlants acquire their material for growth chiefly from air and water. (5-LS1-1)

### CROSSCUTTING CONCEPTS- CCC

**Patterns:** Graphs, charts, and images can be used to identify patterns in data.

**Systems and System Models:** A system can be described in terms of its components and their interactions.

**Cause and Effect:** Cause and effect relationships may be used to predict phenomena in natural or designed systems.

## INSTRUCTIONAL SEQUENCE

Project the i-Tree Design website on the white board. Invite a student to the front of the class to demonstrate entering the information. You will guide the student through the steps as the class watches. Next, the students will do it on their own.

Go to ***Design.itreetools.org***
Choose **"Laptop user"**
Enter the school address ⇨ Write the address of the school on the board or, if working from home, have students enter their home address.
Skip the "1. Draw Structures" field.


Select "2. Place Trees"

Enter the name of your tree ⇨ **oak**
Enter the tree diameter ⇨ **14 inches**
Enter the tree condition ⇨ **Excellent**
Enter the tree exposure to sunlight ⇨ **full sun**

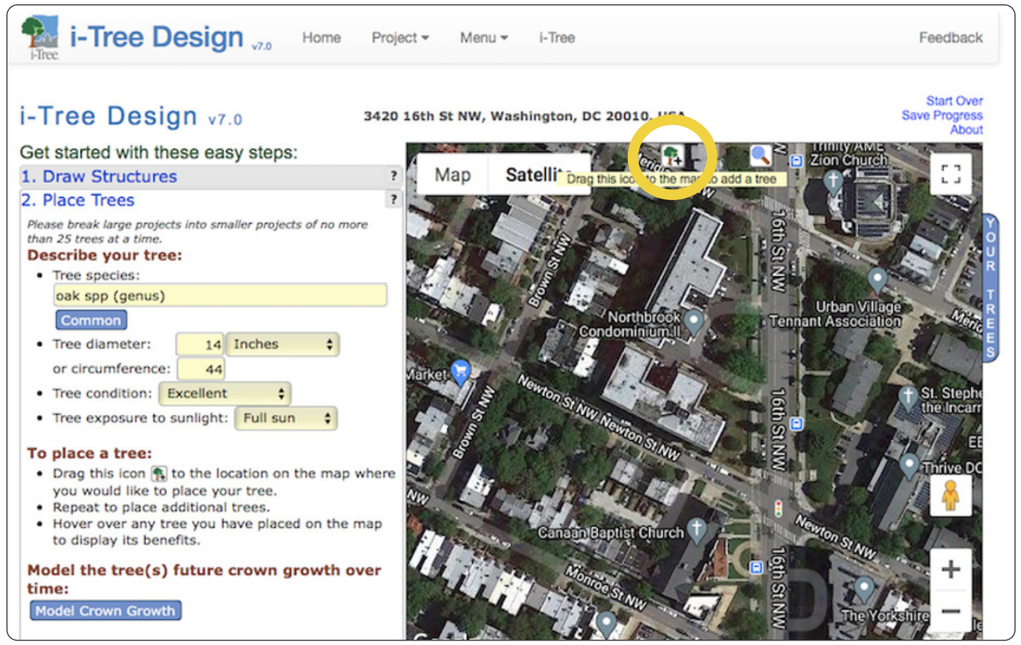
*Be aware that the Google map moves independently from the white frame. When left to their own devices, students will often get "lost" moving around the Google map.*



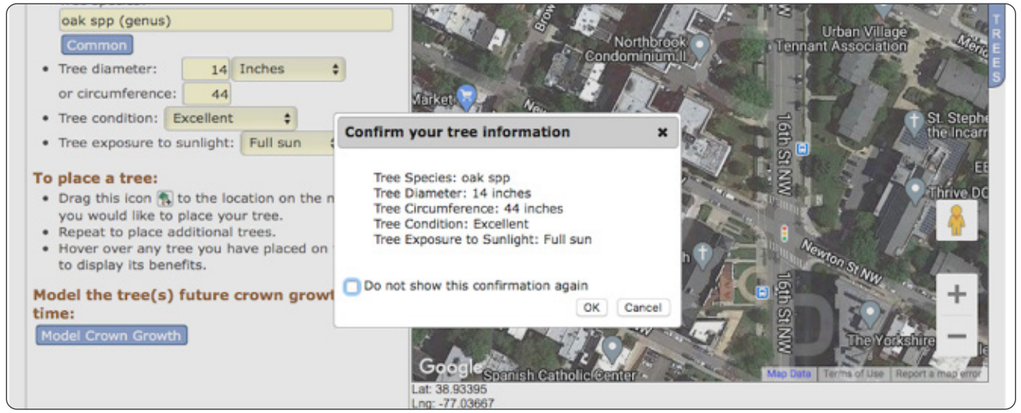


Notice the small **Tree+ icon** that is at the top of the map. This will be the oak tree that you will be planting.

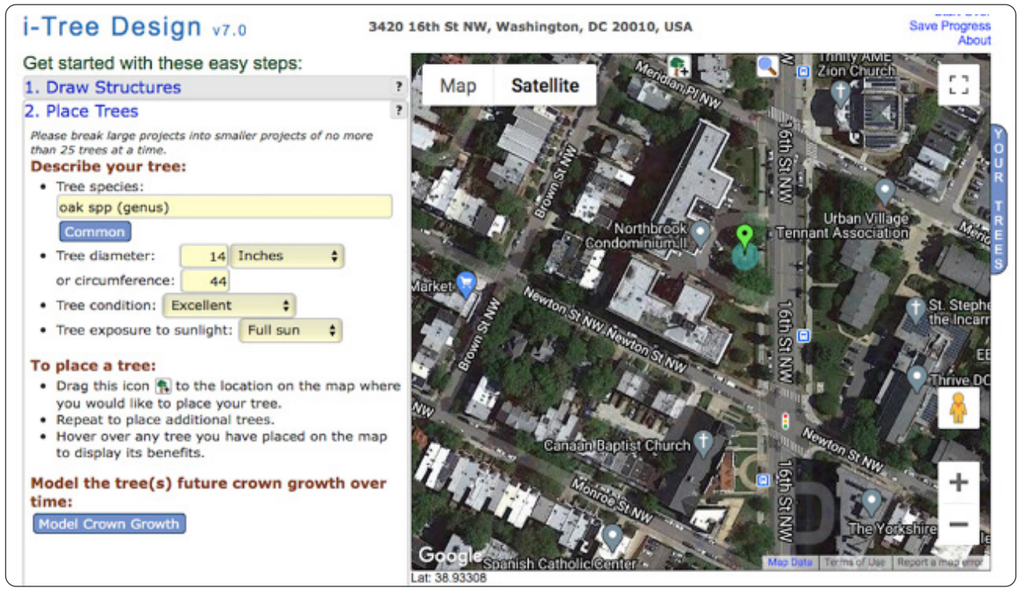
**Click and drag** the tree and plant it where you would like on the map.




Once you have planted your tree, you will get the following dialog box asking you whether this is the tree you intended to plant.



Click on **Model Growth** to see how your tree canopy will grow over a period of 60 years. This will enable you to see the shade that the tree will provide.




Click on **Estimate Benefits** ⇨ Enter **10 years** ⇨ Click on **Calculate**

This will bring you to the page where we are calculating the benefits for the oak tree with a 14-inch diameter.

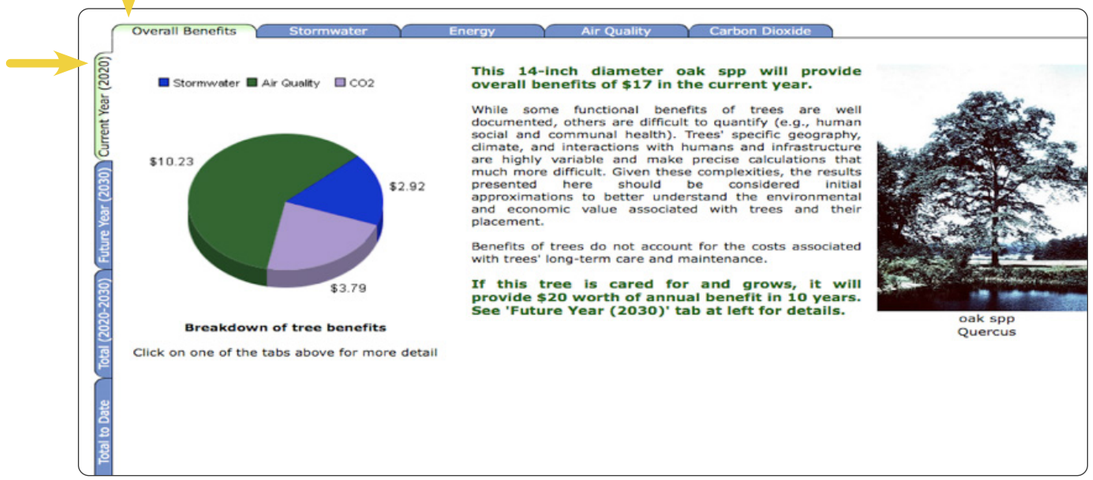
The horizontal tabs show **Overall Benefits, Stormwater, Energy, Air Quality, and Carbon Dioxide**.

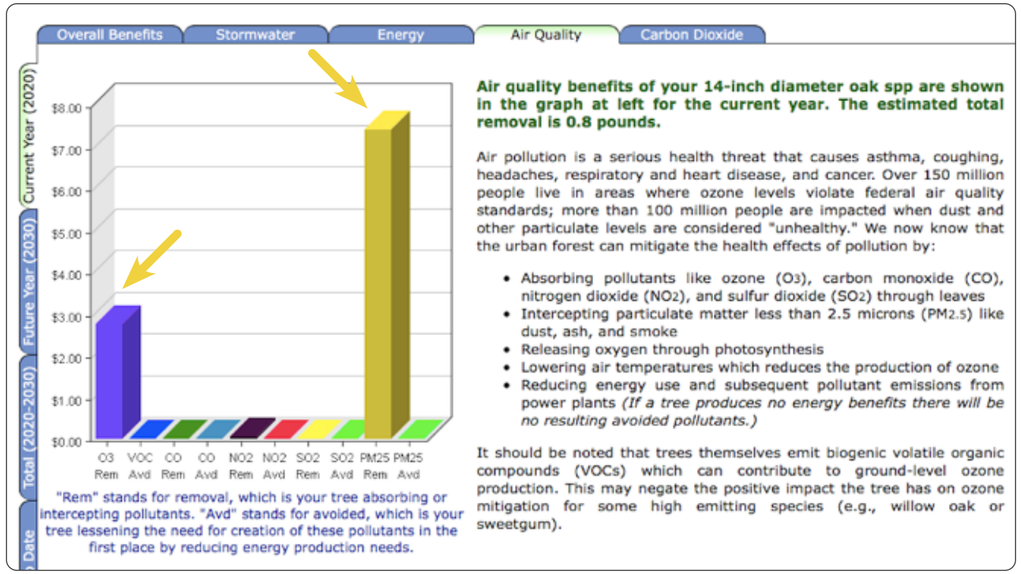
The vertical tabs show **Current Year, Future Year, Total,** and **Total to Date.**

Looking at the **Current Year** tab and the **Air Quality** tab below, students may not be impressed by the amount of air pollutants the tree removes, water it intercepts, or carbon dioxide it sequesters. But remind students that in D.C., we have more than 2,500,000 trees.








In one year, this oak tree will remove about $3 worth of ozone - $0_3$ and $7.50 of particulate matter 2.5 ug/$m^3$.

## INSTRUCTIONAL SEQUENCE

Utilizing their computer and/or the tablet, have students go to the Design.itreetools.org website. Students should use the data they collected during the outdoor lesson and calculate the benefit of the tree on their school campus or neighborhood.

Students should:

- Enter the **school address** or their home address
- Enter the **species**
- Enter the **diameter**
- Enter the **tree health**
- Enter the **tree sun exposure**
- Enter a **10-year projection**

Using the tabs for Stormwater, Air Quality and Carbon Dioxide, have the students fill out the information in their workbook, pg. 13.

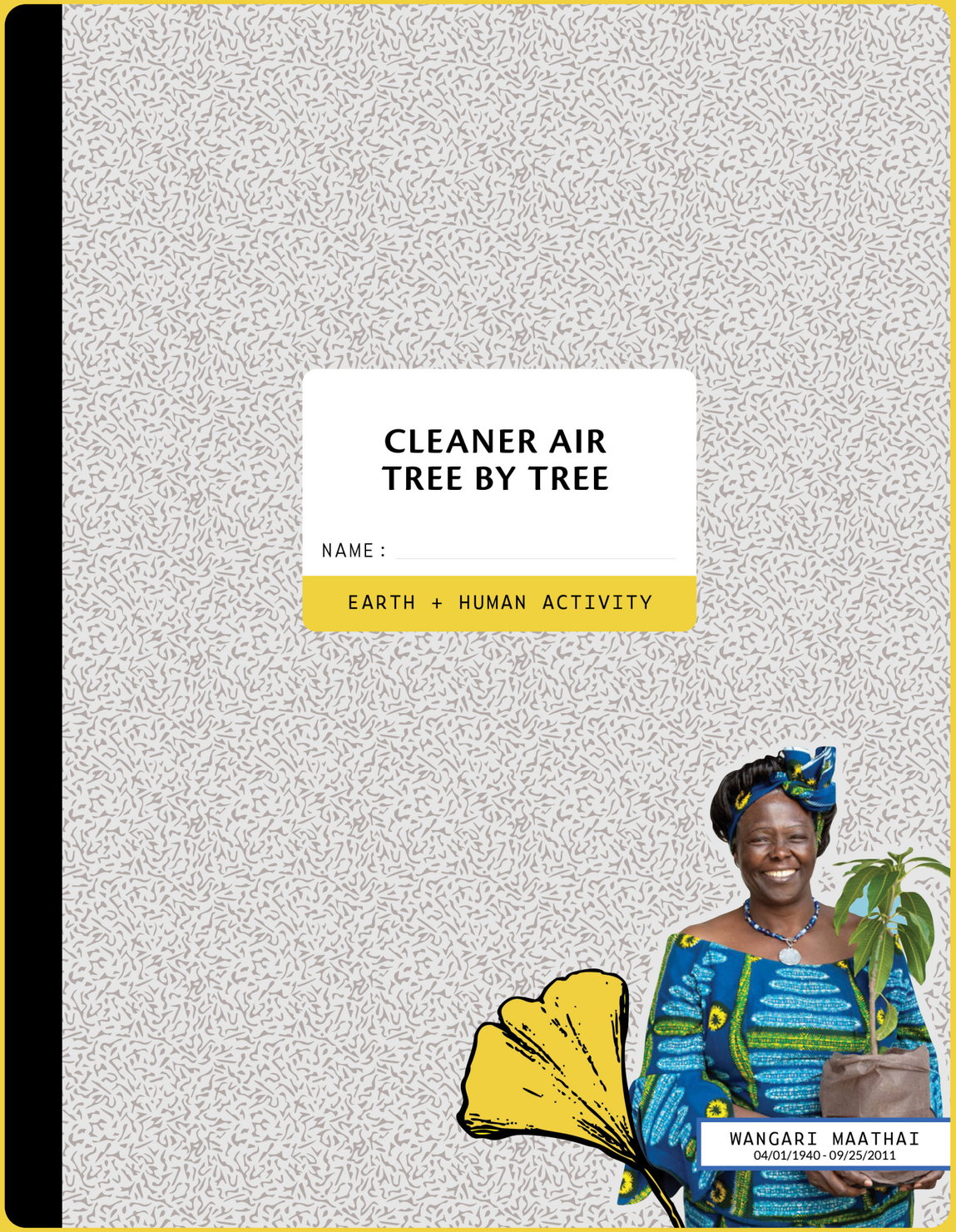
Remind the students that there are **more than 2.5 million trees** in Washington, D.C.

If we can measure or quantify the benefits or ecosystem services of one tree, would it be possible to calculate the benefits or ecosystem services that all the trees in Washington, D.C., provide? What steps would you take to accomplish this task?

In August 2006, the USDA Forest Service released the i-Tree software program. i-Tree calculates the "leaf surface area" of a city and assigns the canopy an economic value. The value comes from the environmental services trees provide, such as air quality improvements by removing ozone, particulates and nitrogen pollutants; carbon sequestration; the effect of trees on building heating and cooling costs; and trees' effect on hydrology by intercepting water.







# WELCOME TO CLEANER AIR, TREE BY TREE

Cleaner Air, Tree by Tree is a set of investigations that examine human impact on earth systems. Specifically looking at the role of urban trees in air quality improvements, stormwater interception and greenhouse gas mitigation.

**OVERALL OBJECTIVE OF CLEANER AIR, TREE BY TREE |** The overall objective is for students to be able to describe the benefits trees provide and their role in restoring humans' impact on the environment.

## WANGARI MAATHAI

*The Woman Who Planted Millions Of Trees*

Wangari says "A tree is worth more than its wood."
Why was the act of planting trees so important to Wangari?
Why is the act of planting tree(s) important in your neighborhood and our city?





# HUMAN IMPACT AT YOUR SCHOOL

**OBJECTIVE |** Students learn characteristics that help them differentiate between naturalized forest and planned green spaces to understand human impact in their neighborhood.

*Naturalized Forest*

*Planned Green Space*

Draw your immediate neighborhood.

**IDEA STARTERS**

Does your neighborhood have naturalized forests or planned green spaces?
What evidence do you have to support your claim? (e.g., school gardens as a planned green space)

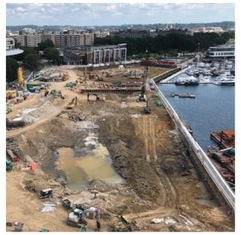
# EARTH'S SYSTEMS & THE FOUR SPHERES

**OBJECTIVE** | Students identify and define the components of Earth Systems: atmosphere, geosphere, biosphere, and hydrosphere. Students can describe the interactions and interdependence of the Earth's four spheres.

Label the sphere most prominent in each photo:

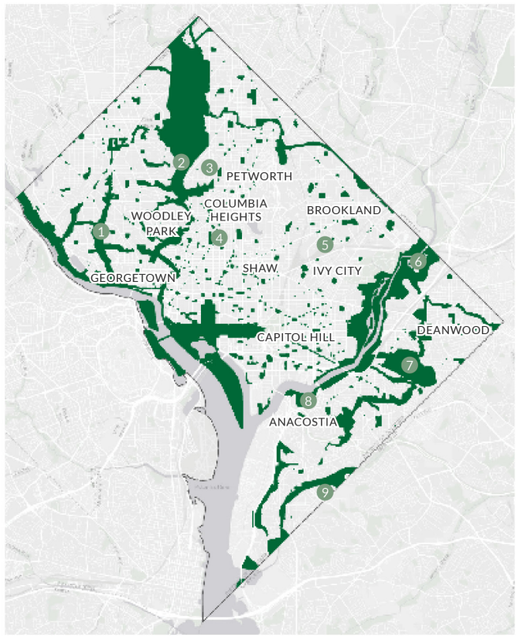
1. _____

2. _____



3. _____

4. _____




What neighborhood do you live in? What park do you live closest to?

_____

Pick an image and describe how two spheres interact.
*Example: In Image 4, the* **hydrosphere** *erodes the* **geosphere** *at the Wharf construction.*

_____

**IDEA STARTERS**

What evidence do you see of human impact? What evidence do you see of the spheres interacting?



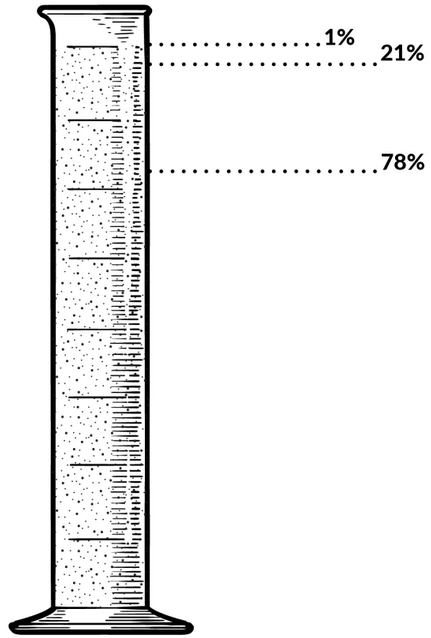


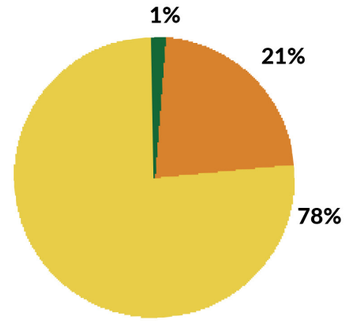


# WHAT IS AIR?

**OBJECTIVE** | Students can identify sources of air pollution in their community.

Color the cylinder to match the proportions of the pie chart.




Air is a mixture of:

78% _____

21% _____

1% _____

List the properties of air:

_____

_____

_____

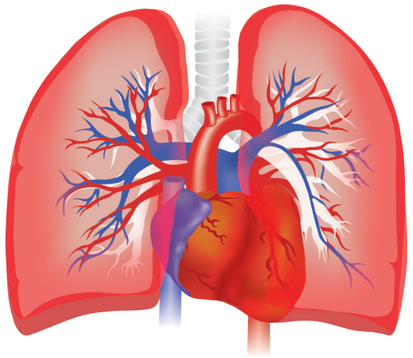
_____

**DID YOU KNOW?**

We breathe about _____ gallons of air each day!

# AIR QUALITY

**OBJECTIVE** | Students identify the structures and functions of different parts of the respiratory system, in order to understand how they are affected by air pollution. Students describe the composition and properties of air and identify sources of air pollution in their community.



Why does the quality of the air matter to human health?

| What are some **anthropogenic** (human made) sources of air pollution in your neighborhood? | What are some **natural** sources of air pollution? |
|---|---|
| | |

## DID YOU KNOW?

Exposure to air pollution may cause a wide range of health effects, including irritation of your eyes, nose and throat, lungs (respiratory) and heart (cardiovascular) disease.

**IDEA STARTER**

What can you do to improve air quality in your neighborhood?





# TESTING AIR QUALITY

**OBJECTIVE** | Student will be able to collect data using scientific equipment to measure air pollution.

**Particulate Matter (PM)** are microscopic solid particles or liquid droplets that are suspended in the air. PM is an air pollutant that negatively impact human health, It is measured in **µg/m³** (micrograms per cubic meter).

**Ground Level Ozone ($O_3$)** is formed by a reaction of pollutants, heat, and sunlight.

**Carbon Dioxide ($CO_2$)** is an important, heat-trapping (greenhouse) gas released naturally through the process of respiration, and human activities such as burning fossil fuels.

## DID YOU KNOW?

High concentrations of fine particulate matter causes a lot of different health problems in people, from asthma attacks to heart attacks!

An **AIRBEAM** is an instrument that measures:

- PM 1.0, 2.5 and 10.0 µg/m³
- Relative Humidity (RH%)
- Temperature ( F)

An **AIR QUALITY EGG** is an instrument that measures:

- Ozone (PPM)
- Carbon Dioxide (PPM)

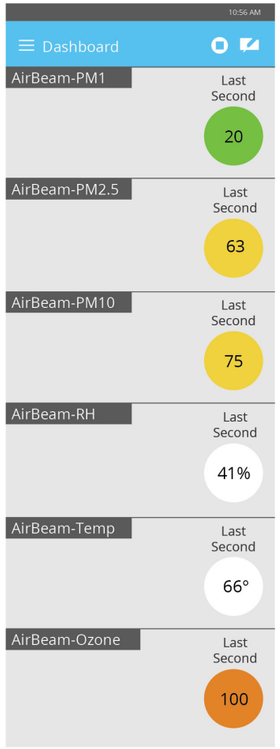
GUIDE TO AIR QUALITY INDEX (AQI) CATEGORIES

| 0-50 | 51-100 | 101-150 | 151-200 | 201-300 |
|---|---|---|---|---|
| GOOD | MODERATE | UNHEALTHY FOR SENSITIVE GROUPS | UNHEALTHY | VERY UNHEALTHY |

The **Air Quality Index (AQI)** is a color index used to communicate to the public the daily air quality and its associated health effects. The AQI is calculated based on measurements of ground-level ozone, particulate matter, carbon monoxide, sulfur dioxide and nitrogen dioxide.

# READING AIR QUALITY

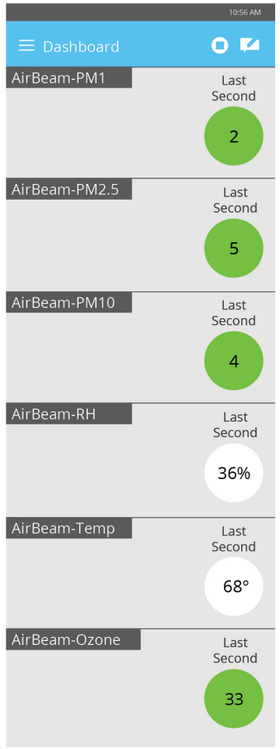
**SITE 1**

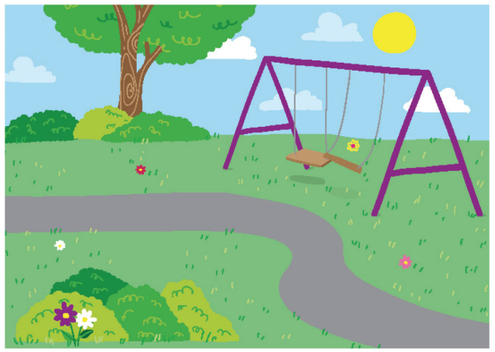



Compare the data from the Airbeam with the images of the playground below. Why do you think children are playing outside at one site, and not the other?

Record the data in the table.
Note what color "code" each day is.

**SITE 2**



**SITE 1**

**SITE 2**







## DATA COLLECTION

**OBJECTIVE |** Students will collect and record local air quality data (with accurate units), using an AirBeam tool or online current and forecasted air quality data.

| | Particulate Matter 1.0 µg/m³ | Particulate Matter 2.5 µg/m³ | Particulate Matter 10 µg/m³ | Ozone PPM | Carbon Dioxide* PPM | AQI |
|---|---|---|---|---|---|---|
| Site 1 | | | | | | ◯ |
| Site 2 | | | | | | ◯ |

What is reading for ground level ozone and particulate matter in DC today?

Ground level ozone pollution-O3 _____ PPM

Particulate Matter-PM _____ µg/m³

**DID YOU KNOW?**

Air pollutant concentrations are measured in Parts per Million (PPM) or in mass per volume (µg/m³, micrograms per cubic meter). This is how scientists measure Carbon Dioxide, Ozone, and Particulate Matter.

Temperature: _____ °F

Relative Humidity _____ %

Visit Online AQI resources:

- Air Quality Index – *airnow.gov*
- World AQI – *waqi.info*
- Local AQI historical and current forecast – *cleanairpartners.net*
- *Aircasting.habitatmap.org*

**GUIDE TO AIR QUALITY INDEX CATEGORIES**

| | | |
|---|---|---|
| 0-50 | GOOD | |
| 51-100 | MODERATE | |
| 101-150 | UNHEALTHY FOR SENSITIVE GROUPS | |
| 151-200 | UNHEALTHY | |
| 201-300 | VERY UNHEALTHY | |

# THINK LIKE AN URBAN FORESTER

**OBJECTIVE** | Students learn that trees species can be identified using different characteristics: leaves, bark, flowers, fruits and seeds. Students learn that each seed dispersal structure has a specific function.

| LEAVES | BARK | FLOWERS, FRUITS AND SEEDS |
|---|---|---|
| Scavenge fallen leaves on the ground. Leaves are a common way of identifying trees.<br><br>Describe the leaves:<br><br>Are the edges lobbed? Smooth? Toothed?<br>Is the leaf texture dull, fuzzy or waxy? Observe the patterns of the veins. | A diversity of patterns, textures and other characteristics of bark can help you identify a tree. Come in close and gently touch the tree's bark.<br><br>Is the bark scaly, smooth, is it peeling, does it have ridges?<br><br>Describe what is unique about the tree's bark. | Look up, look down! Depending on the time of the year you may see flowers, fruits and/or seeds. Flowers can be showy or small, they're about reproduction. Fruits and seeds are all about dispersal.<br><br>How are seeds being dispersed? How does the structure of the seed help with its dispersal (function)? |
|  |  |  |

Can you identify a tree in your neighborhood? Consider the characteristics (leaves, bark, flowers, fruits and seeds). Visit *caseytrees.org* to find common tree species in DC.

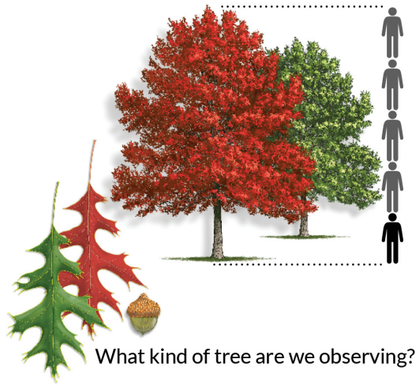
10





# TREE DETECTIVE

**OBJECTIVE** | Students learn characteristics of tree species by making tree specific trading cards.

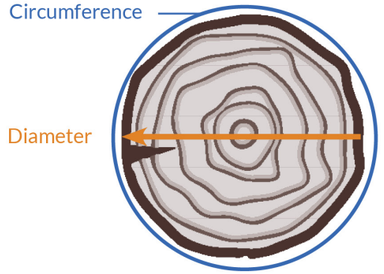


What kind of tree are we observing?

_____

How tall is this tree? You have measured this tree is 5 Pauls tall. Paul is 6 feet tall.

_____ x _____ = Height




**Diameter = Circumference ÷ 3.14**

You measure a circumference of 32 inches.

_____ = _____ ÷ 3.14

## TREE HEALTH

Tree health is based on indicators from different features of the tree. Observe the tree. If the tree part appears healthy, give it a check. Then, determine the tree's health on the scale below.

1. ☐ BARK ☐ BRANCHES ☐ LEAVES ☐ FRUIT/FLOWERS ☐ ROOTS _____/5
2. **TREE HEALTH** (circle one) EXCELLENT GOOD FAIR POOR DYING
3. **TREE EXPOSURE TO SUNLIGHT** *(circle one)* FULL SUN PARTIAL SUN FULL SHADE
4. Is this tree healthy? Provide evidence to support your claim.

_____

_____

*Trees that have everything they need are healthy and successful!*

# THINK LIKE AN ARBORIST

**OBJECTIVE** | Students select an appropriate tree species for their schoolyard or backyard. Students assess their space for the needs of a tree-soil space, sunlight and access to water. They consider the benefits of different species of tree.

## Yoshino Cherry
*Prunus × yedoensis*

**HEIGHT**: 35-45 ft.

**STRENGTHS**: Beautiful flowers in spring, fits in small spaces.

**WEAKNESS**: I am difficult to prune and susceptible to fungus.

## Red Maple
*Acer Rubrum*

**HEIGHT**: 40-60 ft.

**STRENGTHS**: Loves water! Plant me in areas that flood

**WEAKNESS**: My shallow roots may disrupt your sidewalks, or be in the way of your lawnmower.

## Tuliptree
*Liriodendron tulipifera*

**HEIGHT**: 70-90 ft.

**STRENGTHS**:I grow tall and straight. I absorb hundreds of pounds of carbon every year.

**WEAKNESS**: Oops! I dropped something. My 10 ft branch.

Look at the drawing of your neighborhood on page 3. Which of these tree species would you plant in your neighborhood?

_____

Why would you plant this tree? *Consider: how much sunlight does this space get? Is there water nearby? How much soil is available, and do people walk there?*

_____

_____

Draw your tree here. What benefits will it provide?







# TREE BENEFITS WITH iTREE

**OBJECTIVE** | S tudents quantify the benefits- ecosystem services- that trees provide. Students understand the role of trees in improving air quality, sequestering carbon and intercepting water.

| TREE MEASUREMENTS | |
|---|---|
| Tree Species | |
| DBH | |
| Tree Health | |

| BREAKDOWN | ENVIRONMENTAL BENEFIT |
|---|---|
| Storm Water Interception | _____ gallons |
| $CO_2$ Capture | _____ pounds |
| Air Pollutant Absorption | $ _____ saved |

## DID YOU KNOW?

Trees provide ecosystem services for humans and the environment. An ecosystem is a community of living and nonliving things, think all 4 spheres working together! Ecosystem services are the important benefits that come from healthy ecosystems.

1. This year, these trees will remove _____ $PM_{2.5}$.

2. In ten years, these trees will remove _____ $PM_{2.5}$.

3. In DC we currently have _____ trees.

4. _____ x _____ = _____
   # of trees in DC  lbs of PM absorbed

## WANGARI MAATHAI

**Wangari stated, "A tree is worth more than its wood."**
What other benefits or ecosystem services does a tree provide?
What are some concrete actions that you can take to restore the human impact in your neighborhood?


**Wangari Maathai** won a Nobel Peace Prize in 2004.

Photo source: *The New York Times*





## DRAW A TREE

Draw a tree and the ways to care for it.

### DID YOU KNOW?

The larger and healthier a tree grows, the more these benefits add up! Young trees need 25 gallons of water EVERY WEEK to stay alive and reach this potential. You can help them by watering thirsty trees in the hot summer months!

List the ways trees benefit your environment:

APPENDIX

# TREE CARE AND TREE PLANTING

## ACTIVITY SUMMARY

**Option 1 Tree Care:**
Students assess young trees at the school for indicators of health and disease. With this knowledge, students partake in tree care: watering, mulching, and weeding. Students also learn about threats to trees in the urban environment. Casey Trees uses activities, such as a watering relay and tree care trivia, to emphasize to students what it means to be a tree steward.

**Option 2 Tree Planting:**
Plant trees at your school with Casey Trees. Students will have an opportunity to plant a tree (or many!) on school property. Donated by Casey Trees and in conjunction with their staff, students can plant a tree(s) after the investigations as a way to take action. Schools interested in culminating this curriculum with a tree planting are encouraged to apply one season in advance through the Casey Trees website (caseytrees.org).

**Proposed Tree Planting Day Schedule (Morning or Afternoon):**
Students will be instructed to wear appropriate clothing and footwear prior to planting day. One or more tree(s) will be delivered on site and upon start of the class time, students will be escorted outside to begin the ceremonial tree planting. Before planting, students will review some of the concepts and share some of their favorite moments. Then the class will participate in digging, unbundling, planting, and a first watering.

| Morning | Afternoon | |
|---|---|---|
| 8:00 am | 11:30 am | Casey Trees team arrival/setup (unload trees, arrange tools in circle, check in with instructor.) |
| 9:00 am | 12:30 pm | Students meet outside at tool circle for opening remarks and safety briefing |
| 9:15 am | 12:45 pm | Planting begins |
| 10:45 am | 2:15 pm | Planting finishes |
| 11:00 am | 2:30 pm | Casey Trees is packed up and leaves school |





## WHAT TO EXPECT FROM CASEY TREES

**Casey Trees Planning**
- ☑ Map making
- ☑ “Planting Plan” assistance
- ☑ Site visit
- ☑ Staff presentation
- ☑ Watering rehearsal instruction

**On Planting Day Casey Trees will provide:**
- ☑ Trees
- ☑ Mulch
- ☑ Tools
- ☑ Technical Assistance

**Your Planning**
- ☑ Ensure your administration and facilities/maintenance is aware of and on board with tree planting
- ☑ With the help of CT staff, choose tree species and tree planting locations
- ☑ Ensure there is a steady and reliable water source for the new tree

**What Casey Trees needs from you on Planting Day**
- ☑ Organization and supervision of students
- ☑ Provide 1 Adult for each tree that we will plant to help lead student groups
- ☑ Ensure watering equipment is set up and working
- ☑ Help water the trees after the planting
- ☑ Recruitment of parent volunteers if necessary
- ☑ Site preparation and site cleanup
- ☑ Media (optional)

APPENDIX

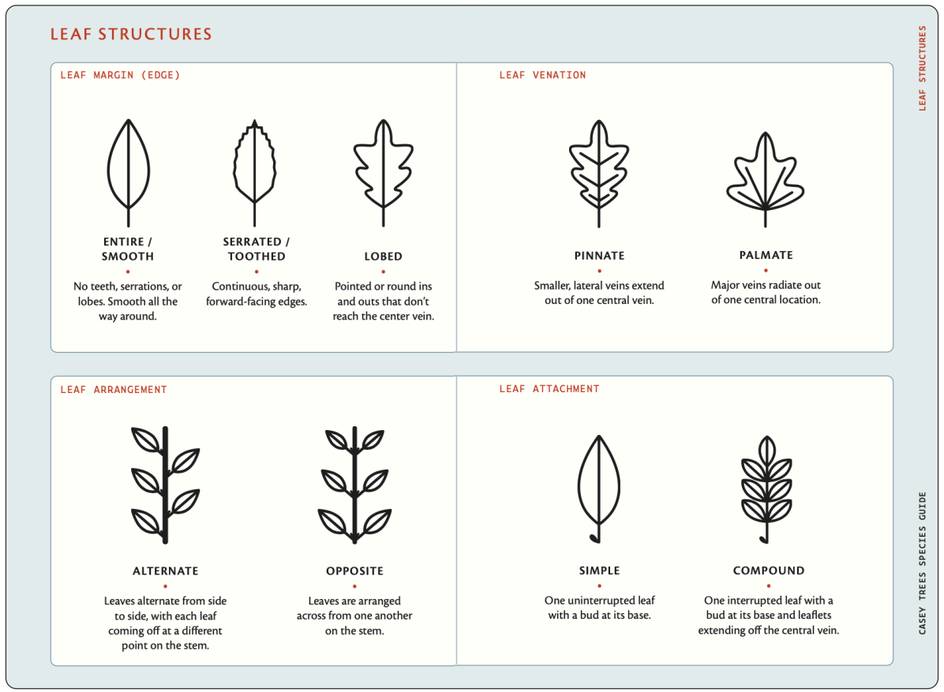
# HOW TO USE THE CASEY TREES *SPECIES GUIDE*

The mission of Casey Trees is to restore, enhance, and protect the tree canopy of our nation's capital. We developed this guide to deepen your involvement with, and enrich your understanding of, the fascinating world of trees in and around Washington, D.C. This guide showcases the most commonly found trees in Washington, D.C., parks. It was written primarily for those new to tree identification, avoids highly technical terms, and contains helpful illustrations.

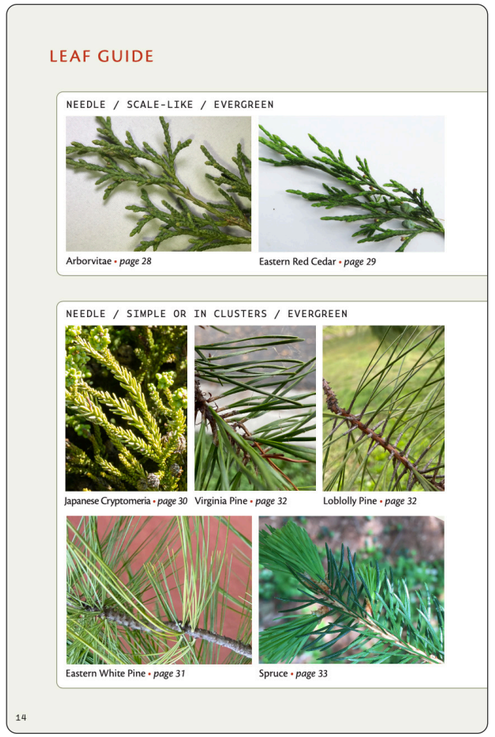
Tree identification is easier when leaves and/or fruits/flowers are available to see. Key characteristics for tree ID include: ***overall form, leaf shape, leaf attachment, leaf arrangement, flowers/ fruit,*** and ***bark.***

**The basic steps for tree ID and how this guide can help:**

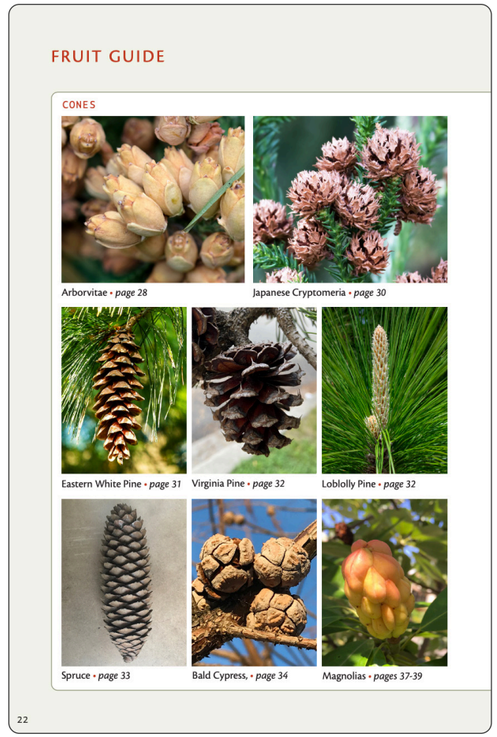
**1. Review the common terms of leaf shape, leaf attachment, and leaf arrangement.**






**2. Examine the leaves of the tree and compare in the beginning of the Leaf Guide. These are arranged based on *leaf shape, leaf attachment, and leaf arrangement.***




**3. If you have fruits, compare those in the Fruit Guide. These are organized into the following categories: *cones; berry-like; fleshy circular fruit; acorn or nut; seed gathering or cluster; samara (winged fruit); seed pod or bean-like.***

**RIVER BIRCH** • *Betula nigra*

| LEAF ARRANGEMENT | LEAF PERSISTENCE | TREE SHAPE |
|---|---|---|
| Simple, Alternate | Deciduous | Airy, Oval, Pyramidal |

| LEAF | BARK |
|---|---|
| Triangular, short-stalked, double-serrated 3" leaves with v-shaped symmetrical base; green above and whitish under leaf | Reddish, yellow, and/or gray, peeling in shaggy sheets maturing to rough, gray-orange with poorly defined ridges and blocks |

| FRUIT | FLOWER |
|---|---|
| Slim, hop-like flower (catkin), numerous tiny winged seeds packed between bracts, matures in spring while leaves emerge | Slender, drooping, inconspicuous flowers without petals (2–3" long) |

NOTES

Most often planted as a multi-stem tree (in groups of 2–3) for aesthetic reasons, due to airy, spreading crown appearance

**4. When you want more information about the entire tree based on one of these characters, turn to the directed page and review the species profile. Here is the river birch (*Betula nigra*), which highlights the characteristics that allow you to determine the type of tree.**



# NOTES

# WHO WE ARE

**D.C. Environmental Education Consortium** is a nonprofit organization 501(c)3 that provides opportunities for collaborating, networking, event coordination and program partnering among its members.

**Casey Trees** is a Washington, D.C.-based nonprofit established in 2002 committed to restoring, enhancing and protecting the tree canopy of the nation's capital.

**Clean Air Partners** is a nonprofit partnership chartered by the MWCOG and the BMC. We strive to improve public health and the environment by working with businesses, organizations and individuals throughout the region to raise awareness and reduce air pollution through voluntary actions.

Funding provided by **DC Office of the State Superintendent**